Analysis of Cerebrospinal Fluid in Brain Development

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Summary

All embryonic epithelia develop in relation to extracellular fluids, but the relationship of these fluids to epithelial and stem cell development is largely unexplored. The neuroepithelial progenitor cells, which give rise to the entire central nervous system, are in close relation to the cerebrospinal fluid (CSF). During the process of neurulation the neural groove forms the neural tube which is composed entirely of neuroepithelial cells. Once the neural tube is fused, the fluid within the lumen is considered cerebrospinal fluid, whereas before fusion is complete the neuroepithelium lining the inside of the neural tube is still in contact with amniotic fluid. As the neural tube develops, the rostral portion gives rise to the telencephalic vesicles which will develop into the cerebral cortex. Within the neural tube, highly vascularized secretory epithelial cells begin to invaginate at specific locations to form the specialized choroid plexus.

The CSF is primarily produced by the choroid plexus in the lateral, third, and fourth ventricles within the brain. It circulates throughout the entire central nervous system and is the endogenous fluid media bathing the brain and spinal cord.

During development all embryonic neural progenitor cells are in contact with the CSF. Cerebral cortical neurons differentiate from neuroepithelial progenitor cells along the ventricular surface, immediately adjacent to the CSF filled ventricular space. Some neuroepithelial progenitor cells divide symmetrically to give rise to two neuroepithelial daughter cells to expand the pool of cortical progenitor cells which maintain contact with

the CSF. Other progenitor cells divide asymmetrically to generate a single neuroepithelial daughter cell that retains contact with the ventricle, as well a basal progenitor cell or a differentiated neuron that withdraws from the ventricular zone and loses contact with the CSF. This suggests a hypothesis that the contact of neuroepithelial cells with CSF provides important instructional cues for proliferating neural progenitor cells and neurogenesis.

This thesis focuses on the analysis of the CSF during brain development. Understanding the factors within the CSF will elucidate the endogenous niche required during brain development. It will also provide important information to better understand regulatory signals for stem cell proliferation and neurogenesis.

Here we present an extensive proteomic analysis of embryonic CSF. We undertake a systematic and unbiased proteomic analysis of human embryonic CSF from Carnegie Stage 19-20 (approximately 48-51 days post ovulation). We also present an extensive proteome analysis of rat embryonic CSF from three different time points during critical periods of cortical development E12.5, E14.5, and E17.5. We catalogue the first human embryonic CSF proteome and compare it to an extensive proteomic analysis of the rat embryonic CSF. We describe the common proteins found between the human and rat embryonic CSF. We find that embryonic CSF is a complex fluid harboring a large number of functionally diverse proteins. Furthermore, using various gene ontology programs we categorize the proteins in the embryonic CSF and compare the subcellular localization, molecular function, and biological process of embryonic human and rat CSF. Through side-by-side comparisons, we found great similarity in the composition and biological function of proteins present in the embryonic CSF of humans and rats. We

find 130 proteins shared between the human and rat embryonic CSF and many similarities in protein categories when classified based on molecular function and biological process. We identified a large collection of protease inhibitors, extracellular matrix proteins, and transport proteins in CSF. We also found a surprising suite of signaling and intracellular proteins not predicted by previous proteomic analysis. We hope that this molecular information may set the groundwork for more targeted analyses into how these proteins might function individually and in concert to stimulate neuronal proliferation and differentiation. The proteomic analysis of the embryonic rat CSF also revealed a number of age-dependent changes in the CSF proteome.

While the intimate relationship of the CSF to neuroepithelial cells suggests potential roles of the CSF in development, age dependent functions of the CSF in the developing neuroepithelium are largely unexplored. By developing a new cortical explant culture system that permits a "mix and match" approach for exposing cortical tissue to CSF collected at different ages, we show that embryonic CSF stimulates proliferation and maintenance of neural progenitor cells in an age-dependent fashion. CSF taken from the rat lateral ventricle during the peak of neurogenesis dramatically stimulates progenitor proliferation, whereas CSF from earlier ages (E13, 14) or later ages (P6 or adult) shows more modest effects.

Western analysis identifies many age-dependent changes in the CSF proteome, including a transient increase in IGF2 during peak neurogenesis that may relate to the changing effects of CSF on proliferation. Indeed, embryonic CSF activates the IGF1 receptor and the AKT and the mitogen-activated protein kinase (MAPK) downstream signaling pathways. Further, neutralizing IGF2 in the CSF diminishes the CSF's

stimulatory role in cortical progenitor cell proliferation, while supplementing basal media with IGF2 is sufficient to enhance proliferation in cortical explants and neural stem cells, suggesting that IGF2 released into the CSF plays an essential role in regulating the timing of proliferation of neuroepithelial progenitor cells of the cerebral cortex.

The adult neural stem cell niche within the subventricular zone also contains cells that contact the CSF, though the potential significance of this contact between CSF and neural stem cells is unknown. Mass spectrometry analysis of adult rat CSF shows that the embryonic and adult rat CSF proteome share many similarities in protein categories based on molecular function and biological properties. The similarities suggest that the CSF has certain fundamental functions throughout life, involved in tissue and fluid homeostasis, transport and transfer of lipids, metals, and hormones, as well as a number of signaling and regulatory molecules that are essential irrespective of age. We show that adult CSF promotes survival of embryonic explants and stimulates proliferation of both embryonic and adult neural progenitor cells, albeit to a lesser extent than embryonic CSF. Taken together our results show that the CSF maintains fundamental functions for tissue and fluid homeostasis throughout development and into the adult. In addition, adult CSF contains signaling molecules which can support survival of explants without any exogenous factors, and proliferation of neural progenitor cells.

In this thesis, we have elucidated that embryonic CSF plays a fundamental, dynamic role in defining an endogenous niche for the survival and proliferation of cortical neural progenitors, and as a global regulator of neurogenesis--despite a more traditional view of the CSF as a fluid cushion that bathes the central nervous system, or as a passive sink for biomarkers of central nervous system function and pathology.

Changing levels of secreted growth factors and other regulatory molecules, such as IGF2, in the CSF strongly suggests a role for the CSF as a vehicle for orchestrating cortical neurogenesis. IGF2 and other molecules appear to be released into the CSF from the choroid plexus, which appears in the lateral ventricles between E13 and E15. Presumably, signaling molecules such as IGF2 diffuse widely in the CSF to regulate cortical precursors that, in the case of the embryonic human brain, may be long distances away from the source of the factor. The presence of proliferation-inducing factors in the CSF suggests that an important aspect of neural differentiation may be the simple isolation of developing cells from the growth-promoting environment created by the CSF, by the withdrawal of the apical ventricular process, which invariably coincides with neural differentiation.

Together, our findings show that the CSF proteome is a dynamic, active niche for neural stem cell and progenitor cell proliferation, survival, and maintenance and may represent an important therapeutic target.

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Chapter 1

Introduction

Introduction

This thesis focuses on the analysis of the cerebrospinal fluid (CSF) in brain development. The CSF is a complex fluid that bathes the cerebrum and the spine. It is primarily composed of factors that are actively secreted by the choroid plexus. When the brain and spine develop, all the progenitor cells within the neural tube contact the CSF. Therefore the CSF is an endogenous fluid media that bathes the entire central nervous system during development. Understanding the factors within the CSF will elucidate the endogenous niche required during brain development. The factors may provide important regulatory signals for stem cell proliferation and neurogenesis.

The introduction is separated into seven distinct subsections all which are relevant to the analysis of the CSF in brain development. The seven sections are: Historical views of the ventricular system and cerebrospinal fluid; 20th century views of CSF; Potential functions of CSF; Potential functions of CSF during early brain development; Cortical development; Insulin growth factor signaling in development; and Stem cells and their niche.

Historical views of the ventricular system and cerebrospinal fluid

The CSF has interested scientists, physicians and philosophers for over 2,000 years. The concept of such a fluid within the head dates back to Hippocrates (460-370 BC) who described "hydrocephalus", a condition that causes swelling of the ventricles, or cavities, within the brain due to improper CSF circulation. Hippocrates knew that the swelling was caused by a liquid that he thought to be water, hence the name hydrocephalus, or "water in the head"[1, 2]. Since the head was spherical in nature, similar

to other organs that collected fluids such as the bladder and uterus, Hippocrates thought that the head and the brain were organs specifically designed to draw water in from the rest of the body, but he did not suggest ideas about what the normal function of that water might be in the brain[2].

If there is anyone in history who had the most influence on describing the function of the ventricles and the CSF it must have been Galen of Pergamon. Initially, circa 300-250 BC, Herophilus and Erasistratus described the ventricles of the brain and suggested they play a role in muscular contraction[2]. This theory was further refined by Galen who was a philosopher and physician intimately interested with the workings of the human body. Because human dissections were prohibited by Roman law, he performed dissections on a number of other species. Galen found clear fluid in the ventricles of Ox brains, and proposed that the fluid provided energy for the entire body[1]. He theorized that an external spirit (pneuma) came in from the lungs during respiration and was carried to the heart. In the heart, this external spirit combined with venous blood, which contained the natural spirit (pneuma physicon), originally formed from chyle in the liver, to give rise to the vital spirit (pneuma zoticon)[2, 3]. The vital spirit was distributed throughout the entire body to all the organs by the blood vessels and when it reached the base of the brain was transformed into an animal spirit (pneuma psychicon) before entering the ventricles of the brain. This conversion was performed by a specific organ (termed the rete mirabile) at the base of the brain that boiled and filtered the vital spirit into a purely refined animal spirit. Through the nerves this animal spirit was carried to contract the muscles of the body and energize the entire physical being[2, 3]. The

animal spirit has been described to travel through the nerves, "as sunshine passes through the air or water."[2]

Having studied ox brains, Galen also described the ventricles and postulated that the conversion of the vital spirit into the animal spirit generated waste that was removed by connections through the ventricles[2]. He described one connection toward the front of the brain that passed through the nasal passages, and the second connection towards the back of the brain. Therefore, Galen had proposed three spaces within the brain to properly disperse the spirit. Amazingly, Galen was describing 2,000 years ago the circulation of the CSF from the lateral ventricles, to the third ventricle and down to the fourth ventricle. At that point, the ventricles were considered to store animal spirit and distribute it throughout the body, as well to remove the by-products generated from the alchemical conversion of spirits. As is seen in Figure 1.1a, Leonardo da Vinci in 1490 drew the ventricles of the brain as three contiguous spaces from anterior to posterior. Due to a great paucity in anatomical dissections, Galen's description of the ventricles amazingly lasted until the beginning of the 16th century. His prevailing theory of a fluid within the ventricles as a spirit (pneuma) lasted for over 1,500 years, until the re-birth of human anatomy at the time of the Renaissance.

Surprisingly, 14 years after da Vinci's drawing of the three spherical ventricles in 1490, da Vinci was the first to use scientific experimentation to determine the actual anatomy of the ventricular system. In 1504, da Vinci created a wax cast of ox ventricles and was the first to accurately depict the lateral, third, and fourth ventricles and their respective connections (Figure 1.1b).

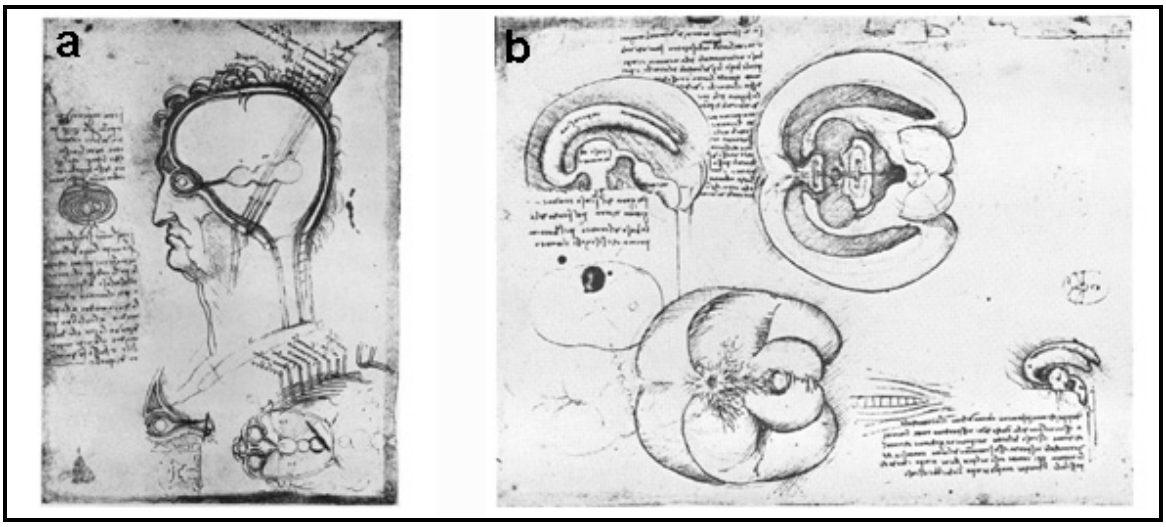

Figure 1.1. Diagrams of the ventricular system drawn by Leonardo da Vinci. (a) Diagram drawn in approximately 1490 depicting three spherical connected ventricles within the brain. (b) Diagram drawn in approximately 1504 showing an accurate representation of the ventricles. This diagram was drawn from a wax casting of ox ventricles. Adapted from Woollam, D. H. The historical significance of the cerebrospinal fluid. Med Hist 1, 91-114 (1957).

In the years to follow and with the increase in illegal human anatomical dissections, Andreas Vesalius was the first to provide an accurate description of the lateral ventricles, the choroid plexus, as well as the aqueduct that connected the third and fourth ventricles in humans[2] (Figure 1.2).

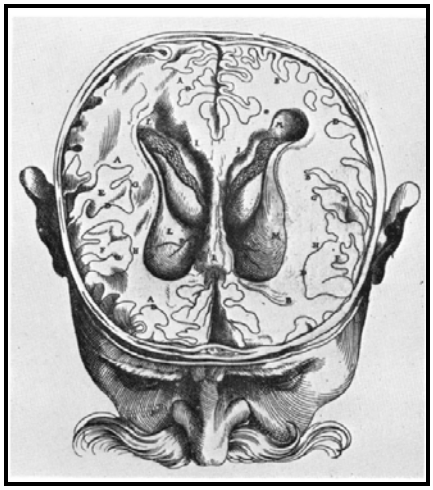

Figure 1.2. Diagram representing the lateral ventricles and choroid plexus from a human dissection drawn by Andreas Vesalius in 1543. Adapted from Woollam, D. H. The historical significance of the cerebrospinal fluid. Med Hist 1, 91-114 (1957).

Between the time of Galen's death and the early 1500's there was much speculation as to the function of the ventricles. Throughout the middle-ages the ventricles were assigned specific mental attributes likely based on observations of symptoms from head traumas[2]. The anterior ventricle contained the functions for imagination, the middle was attributed to cognition, and the posterior to memory[2]. These mental functions of the three ventricles were believed to be true throughout the Renaissance period and beyond. Our anatomical term, thalamus, derived from the Greek word for "chamber," reflects the focus of the Greeks and their students on the fluid in the brain as the site of the soul, rather than the walls of the tube enclosing it.

Surprisingly however, although the anatomy of the ventricles had been well studied during the Renaissance, due in large part to an increase in anatomical dissections, the description and identification of the CSF was still lacking. Although Galen had described a fluid within the ventricles of the ox brain, very few accounts of CSF had been made. This might have been due in part to the autopsy methods at that time that cut the head off the body and therefore any fluid within the brain would quickly leak out[4]. Despite Galen's description, the CSF was finally documented by a number of people in the 1700's. Emanuel Swedenborg, a Swedish engineer who had studied numerous anatomical dissections referred to the CSF in 1740 as a "spirituous lymph" and a "highly gifted juice."[4] Why is it that people such as Swedenborg and Galen who come into contact with the CSF associate it with a spirit? Had Galen influenced Swedenborg? What did Swedenborg really mean by a "highly gifted juice?" It is apparent from descriptions such as these that the CSF has always had mysterious and spiritual properties associated with it.

In attempting to demystify the CSF, another documented description of the presence of fluid within and surrounding the brain was made by Domenico Cotugno in 1764[2, 3], who wrote:

"the whole space between the dura mater and the medulla is always filled; not by the medulla; …nor by water vapour; but by water, similar to that about the heart which the pericardium holds, which fills the ventricles of the brain and the labyrinths of the ear, as well as other cavities of the body inaccessible to air."[2]

Little did Contugno know that the fluid he was describing is indeed 99% water[5]. Contugno's findings however remained obscure because any fluid within the ventricles and surrounding the brain was thought to be a cause of disease. Then, in 1824 while performing an autopsy, Francois Magendie discovered a clear fluid in the spinal canal and realized that the fluid was an endogenous liquid bathing the nervous system[2, 3]. He later rediscovered Cotugno's observations and described the presence of CSF within the ventricles, surrounding the brain, and bathing the spinal cord[6]. He made observations regarding the connections of the inner ventricles with the outer sub-arachnoid space, as well as the connections and continuity of the fluid from the ventricles down to the spinal cord. Shortly thereafter by 1876 the formation of the CSF by the choroid plexus, as well as its circulation and absorption, were clearly demonstrated by Ernest Key and Gustav Retzius[3]. By this time Galen's theories were no longer valid. However, from what we know today, his intuition into the production of the fluid, its function, its circulation, and its removal are fairly similar in theory given the limited information he had to work with.

20th century views of CSF

Galen was the first to describe an alchemical transformation that happened at the base of the brain as the vital spirit coming from the blood vessels had to be transformed into the animal spirit and emerge into the ventricles. Galen's description about 2,000 years ago of the production of the CSF is amazingly accurate. Today we know that the CSF is primarily produced by a specialized organ. It is made by the highly vascularized choroid plexus located within the lateral, third and fourth ventricles of the brain. Although it is not an alchemical process, the choroid plexus consists of capillaries with highly fenestrated endothelial cells covered by epithelial cells[5]. The epithelial cells contain tight junctions that are present very early in development in a number of species[5, 7-9] thereby preventing passive diffusion of molecules into the CSF from the blood[5, 7-9]. The choroid plexus actively secretes CSF into the ventricles and creates the blood-CSF barrier[5, 10].

Galen also described a movement of the spirit throughout the nerves of the body and waste being removed through other areas, which implies a circulation by the CSF and a mechanism for its clearance. Indeed, the CSF circulates within the central nervous system (CNS) and is cleared back into the blood supply. From the lateral ventricles, it travels through the foramen of Monro into the third ventricle and then via the aqueduct of Sylvius into the fourth ventricle and continues down the central canal of the spinal cord. From the fourth ventricle it exists via the foramen of Luschka and Magendie to flow over the surface of the brain and the spinal cord. The fluid primarily exits the CNS via arachnoid granulations in the sagittal sinus and along the spinal nerve roots. Galen was quite accurate in his depiction of the production and circulation of the CSF as well as his

speculation that it traveled down the spinal cord and out the nerves. What is the function of this fluid that is constantly produced and circulates within our brain and spinal cord? To understand the function of the CSF, it is important to know what is in the fluid.

It was at the turn of the 20th century that scientists started to study the constituents of the CSF. To study the CSF, a technique had to be designed to collect the fluid. In 1891, Heinrich Quinke a physician working with children with hydrocephalus was developing the lumbar puncture as a treatment to remove the excess fluid within the ventricles[11]. The lumbar puncture technique quickly became a safe, reliable, and consistent method of CSF extraction[12]. Quinke started analyzing the fluid by counting cells, determining protein concentration, and assessing it for bacteria. By 1893 glucose levels were observed to decrease in patients with bacterial and tuberculous meningitis and since then, CSF glucose levels have been a standard clinical measurement[3].

Today we know the CSF contains a number of factors which in the healthy brain appear to constantly be replenished[13]. The CSF contains ions, proteins, lipids, hormones, cholesterol, glucose, and many other molecules and metabolites[5]. It is believed that an adult human has approximately 150ml of CSF circulating within the central nervous system at any given time[5]. We produce about 500ml of CSF per day which means the CSF turns over three to four times per day[5]. Therefore there must be a balance between CSF production and absorption which has been shown to be altered in aging and neurodegenerative diseases[14-16].

To date, the majority of research based on the analysis of the CSF has been for the discovery of disease biomarkers. Because of its intimate contact with the tissues of the central nervous system, biomarkers within the CSF have been found for a number of

neurological diseases. The majority of biomarkers found in the CSF are linked to dementia (Alzheimer's and Parkinson's disease), CNS tumors (gliomas), infectious diseases (meningitis), as well as for multiple sclerosis, amyotrophic lateral sclerosis, schizophrenia and other diseases[17-22]. CSF protein biomarkers have been shown to be important for differential diagnosis, disease prognosis, and for assessment of treatment efficacy[17-21]. However, these descriptive studies did little to address the function of these proteins and other markers in the CSF, seeming to suggest instead, that their presence in the CSF were generally a by-product.

Potential functions of CSF

CSF has been described to have many functions. It has been described as an intermediary between blood and brain for the transport of nutrients and growth factors, and as a fluid buffer for the brain to protect both the brain and the large vessels that supply blood to the brain[23, 24]. It has also been proposed to be involved in eliminating toxins and other metabolic by-products[24, 25]. A mathematical analysis taking into account the pulsatile nature of CSF flow proposed that the CSF pulsations buffer the capillary bed from the effects of arterial pulsations that might otherwise prevent linear blood flow due to the mechanics of the brain being enclosed in the skull[25]. CSF has been reported to contain nerve growth factor (NGF), transforming growth factor alpha (TGF-alpha), and levels of these are altered in neurological and developmental disorders[25-29], but potential functions of these factors has not been demonstrated. One of the most interesting recent studies and one that was highly influential on this work, showed that the ciliary action of the ependyma lining the adult lateral ventricle created a directional CSF flow pattern

within the ventricle[30]. When the pattern of flow was mapped using dyes injected into the ventricle, the flow directly paralleled the migration of neuroblasts within the subventricular zone[30]. Sawamoto et al. went on to show that ciliary action was not only required for neuroblast migration, but it also created a gradient of SLIT2 protein, a chemorepulsive factor for neuronal olfactory bulb migration, within the CSF[30]. This suggests that CSF factors might have instructive roles for developing neurons or neural progenitors.

Interestingly, factors within the CSF have been shown to affect a number of behaviors including sleep and appetite. CSF has been shown to contain factors that help regulate the wake/sleep cycle. For instance, CSF was collected from laboratory animals which had been sleep deprived has been shown to induce states of deep sleep when infused into control animals[31]. A number of brain fatty acids such as Oleamide (cis-9,10-octadecenoamide), have been isolated from the CSF of sleep deprived animals which induce sleep when injected into the CSF of control animals[32, 33]. Oleamide may have many functions including binding to the cannabinoid receptors and GABA receptors[34, 35]. In addition to sleep inducing factors present in the CSF, a wake promoting factor has also been found. Low hypocretin-1 levels in the CSF were found in people with narcolepsy[36]. When hypocretin-1 is infused into the lateral ventricles it induces wakefulness[37]. Another factor known to be released into the CSF is melatonin[38]. It is produced by the pineal gland and has been shown to be a hormone which helps regulate circadian rhythms as well as being a free radical scavanger[38, 39].

Factors within the CSF have also been shown to affect appetite. The CSF contains leptin, a peptide hormone which regulates satiety. It has been shown that low

leptin CSF to serum ratios are inversely correlated with body mass index (BMI) in some individuals. Therefore, a potential factor leading to increased BMI may be due to the improper transport of leptin across the blood brain barrier[40]. Hence, due to its intimate contact with the thalamus, hypothalamus, and pineal gland, the CSF may function not only as a fluid transporter for metabolites and proteins, but also seems to convey some peptide signals that regulate essential behavioral states.

Potential functions of CSF during early brain development

Potential roles of CSF during prenatal brain development have been even less intensely examined than functions in the adult, despite the fact that exposure to fluids dominates the development of all epithelia including the nervous system. During embryogenesis, the primitive streak arises during the process of gastrulation, when the epiblast cell layer, in contact with the amniotic fluid, invaginates and creates the first midline of the embryo[41]. The invagination and migration of the cells along the primitive streak ultimately creates an embryo with three cell layers, the endoderm, mesoderm and ectoderm[41]. The ectoderm is the outermost cell layer in contact with the amniotic fluid and will give rise to the entire CNS[41]. The CNS starts to be created by the process of neurulation[41]. During this process the flat neural plate creases to form the neural groove whose folds fuse to give rise to the neural tube[41]. The neural tube fuses beginning roughly in the middle of the embryo and continues to fuse both rostrally and caudally as development proceeds. Interestingly, all the cells along the neural groove are in contact with the amniotic fluid. As the groove fuses to become the neural tube, the fluid within the lumen is then referred to as cerebrospinal fluid[41]. Hence, there is a period in

development when little distinction is made between the amniotic fluid and cerebrospinal fluid because the open neural tube allows for the mixing of these two fluids[42]. On the other hand, as the tube fuses, the developing neural tube begins to secrete fluid into its lumen, and cerebrospinal fluid within the tube begins to differentiate from the amniotic fluid outside the tube[42]. Once the neural tube closes a positive cerebrospinal fluid pressure can be measured in the developing tube believed to provide an expansive force to the developing tube indicating active secretion from the developing neuroepithelial cells[43, 44]. Interestingly, the CSF pressure may actually provide a mechanical force within the tube required for brain enlargement[43-45]. Thus, gastrulation and neurulation are processes where tissues and cells are developing in relation to surrounding fluids, bathed by their endogenous media.

Just recently the role of the CSF in brain development has started to be explored. Some initial cues to the roles of CSF-borne signals came by studying the hydrocephalic Texas (H-Tx) rat. CSF isolated from the lateral ventricles of affected H-Tx embryos inhibited in vitro proliferation of neuronal progenitors isolated from control embryos, suggesting that factors within the CSF of the H-Tx embyros inhibit proliferation[46-48]. Because very little was known of the contents of the CSF, just recently Parada et al. have provided an analysis of the protein composition of embryonic CSF[49, 50]. These studies analyze the proteome of the chick and rat embryonic CSF using spot-picking from a 2-D gel and identify 26 and 31 proteins, respectively. The embryonic CSF of the chick and rat revealed many similarities, with both containing proteins of the extracellular matrix, regulators of osmotic pressure, ion carriers, hormone binding proteins, regulators of lipid metabolism, and various enzymes and enzyme regulators. Parada et al. noted one of the

differences between rat and chicken CSF was an increased number and complexity of apolipoproteins found in the rat which they speculate may be related to neuronal complexity[49, 50]. Recently they show that the apolipoproteins within the CSF are important for neural differentiation[51]. The embryonic CSF has also been shown to contain factors that regulate survival and proliferation of neuroepithelial cells[47, 52, 53], and FGF-2 has been identified in the chick CSF as a vital trophic factor[52]. These studies have shown a vital role for CSF in supporting brain development. Understanding the environmental niche in which the brain develops may lead to a better understanding of factors regulating cortical development.

Cortical development

The mammalian cerebral cortex is a complex organ with numerous cell types organized into distinct layers which contribute to the functional complexity of the brain. Every cell within the adult mammalian CNS is generated from cells which at one point in development comprised of the neuroepithelium of the developing neural tube[41]. The principal cells comprising the neural tube are neuroepithelial cells (NEPs), undifferentiated neural progenitor cells that will give rise to all the various cells of the central nervous system[54, 55]. The NEPs are radially arranged pseudo-stratified columnar epithelial bipolar cells whose processes span the entire thickness of the neural tube[56-58]. During development, there is expansion in number and size of the NEPs throughout the entire tube, but specifically at the most rostral portion of the neural tube that forms the telencephalic vesicles that give rise to the mammalian cerebral cortex. As the embryo develops, the cells within the neural tube proliferate to give rise to increasing numbers of

progenitor cells from which the neurons will differentiate. At approximately embryonic day 9-10 (E9-10) in the mouse, the NEPs transition and give rise to the radial glial cells[56]. This transition can be immuno-histologically visualized with nestin, an intermediate filament, and the antigen RC2[56], which defines the radial glial cells as a distinct population, although they have similar behaviors.

The NEPs and the radial glial cells are very similar in many respects which may play a role defining them as the neural progenitor cells[59-62]. (Although there is a beautiful and extensive history to the discovery of the neural progenitor cells, it is beyond the scope of this introduction.) Both NEPs and radial glial cells undergo interkinetic nuclear migration which is a synchronization of the nuclear movement to the cell cycle[55, 56]. The nucleus moves away from the apical surface during G1, and enters S phase as it reaches the top of its basal movement and then starts to migrate back towards the ventricle through G2 and enters mitosis along the apical ventricular surface[55]. It is not yet understood why cells undergo interkinetic nuclear migration and especially why they undergo mitosis along the ventricle. It is hypothesized that mitotic spindle orientation may segregate apical membrane components which determine cell fate, although this is still poorly understood[63]. The apical membrane components may be essential for regulating proliferative signals coming from the CSF.

The NEPs and the radial glial cells are also similar morphologically. They both extend from the ventricular (apical) surface to the pial (basal) surface and therefore remain in contact with the lumen of the neural tube and the developing telencephalic ventricle[54, 56, 58]. They maintain their contact with the apical surface throughout development and each cell contains a primary cilium that extends into the CSF[64]. In

contrast, neurons and differentiating cells retract their connection from the apical surface and migrate away from the ventricle (Figure 1.3)[60].

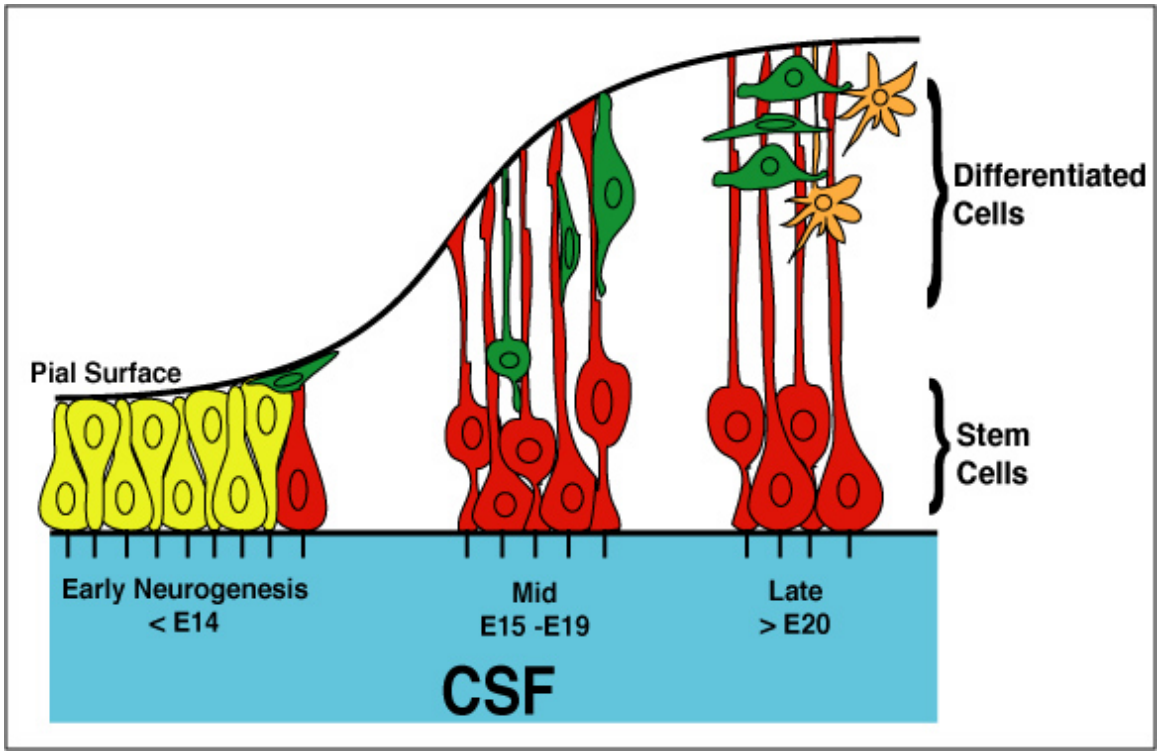

Figure 1.3. Neuroepithelial cells and radial glial cells are neural stem cells in contact with the CSF. NEPs (yellow cells) give rise to radial glial cells (red) and post-mitotic neurons (green) early in neurogenesis. Both NEPs and radial glial cells contact ventricular and pial surface. Differentiated cells retract their connection to the ventricle and migrate radially towards the pia. Radial glial cells maintain contact with the CSF throughout development and give rise to neurons (green) in early and mid neurogenesis, and glia (orange) later in neurogenesis.

To expand the progenitor cell pool, both neuroepithelial progenitor cells (NEPs) and radial glial cells undergo symmetric proliferative cell divisions[54]. In this case, a single NEP gives rise to two daughter NEPs, or in the case of radial glial cells, one single radial glial cell gives rise to two daughter radial glial cells[54]. This type of division will lead to an exponential increase in the number of progenitor cells as well as an increase in the size of the developing brain. Since both cell types actively proliferate they are continuously engaged within the cell cycle. The distinct histological zone of proliferative

progenitor cells along the apical surface of the developing cortex is termed the ventricular zone (VZ)[55, 65]. The NEPs and radial glial cells in the VZ, regardless of the stage they are in within the cell cycle, can be labeled by using markers such as Sox2 and Pax6[66]. To visualize the mitotically active cells, well established markers for identifying cells in mitosis such as the Phospho-Histone H3 (PH3) can be used which will reveal that mitotically active cells, generally speaking, directly border the ventricle within the VZ. Therefore, one of the first steps in creating a complex multi-cellular organ is to generate, via proliferative symmetric divisions, an extensive pool of progenitor cells which can give rise to the various classes of differentiated neurons.

The development of a complex multi-cellular cortex requires the differentiation of the progenitor cells into post-mitotic neurons. At a certain stage in development some progenitor cells undergo a shift of proliferative capacity. Instead of undergoing symmetric proliferative divisions, the progenitor cells begin to undergo asymmetric differentiative (neurogenic) divisions[54]. In this type of division a progenitor cell will either give rise to another daughter progenitor cell and a differentiating neuron (asymmetric mono-differentiative), or it will give rise to two differentiating neurons (symmetric differentiative)[54]. When a progenitor cell undergoes mitosis at the apical side of the ventricle within the VZ to give rise to a neuron, the neuron migrates in a radial fashion away from ventricle towards the pial surface. When a progenitor cell divides and produces a neuron, the neuron exits the cell cycle. The first neurons are born and migrate away from the VZ and establish a neuronal layer just deep to the pia which is known as the preplate[65]. In rat embryos the preplate is first visualized at E12 and is generated between E12 and E14[67, 68]. The cells within the preplate are the Cajal-Retzius (CR) cells

and other pioneer neurons[69]. Once the preplate is established a second wave of neurons is generated which splits the preplate into two layers known as the outer marginal zone and the inner subplate. This second wave of neurons migrates in between the marginal zone and the subplate to begin forming the cortical plate (Figure 1.4)[55, 65].

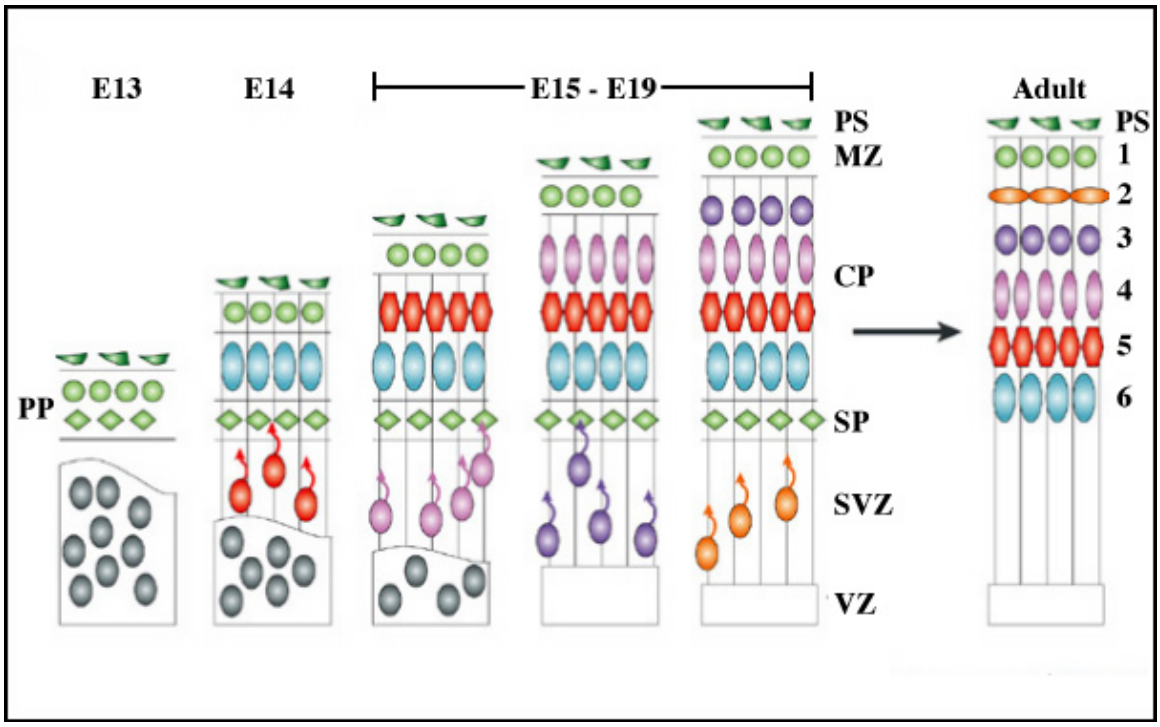

Figure 1.4. Schematic Diagram of Rat Cortical Development. Development of cortical plate occurs "inside-out," earliest born cortical plate neurons migrate away from VZ to deep cortical layers, later born cortical plate neurons migrate past early born neurons to develop more superficial layers. PP - preplate; VZ - ventricular zone; SVZ - subventricular zone; SP – subplate; CP – cortical plate; MZ – marginal zone; PS – pial surface. Adapted from: Life is a journey: a genetic look at neocortical development Amitabh Gupta, Li-Huei Tsai & Anthony Wynshaw-Boris *Nature Reviews Genetics* **3**, 342-355 (May 2002)

The cortical plate forms in an "inside-out" manner, in which the earliest born neurons create the deep layers of the cortical plate, and the later-born neurons migrate radially past the earlier born neurons to settle at more superficial layers[55, 65]. The majority of cortical plate development in the mouse occurs between E14 to E18[65, 70, 71], which corresponds from E15 to E20 in the rat[72]. Despite great variability between

mammalian species in the size of the cerebral cortex, layers 2-4 of the cortex are consistently the most densely and highly populated by neurons, and are born in the mouse between E14-E17 (rat E15-E19)[70-72]. Birth dating studies have revealed that the mouse undergoes neurogenesis in approximately 11 cell cycles from E11 to E17, and that the majority of the neurons which migrate to layer 2-4 are generated in the last 4 cell cycles[70, 71]. The cortical plate along with the marginal zone will ultimately give rise to the mature six-layered cortex.

In the developing cortex at the onset of neurogenesis, a second type of mitotically active progenitor cell appears that divides just superficial to the VZ in the subventricular zone (SVZ) known as the intermediate or basal progenitor. These cells had been histologically recognized over 100 years ago, however their functional significance was only recently understood[73]. The cells within the SVZ have been shown to generate neurons in the embryonic cerebral cortex[74]. The basal progenitors undergo symmetric proliferative divisions in which one basal progenitor gives rise to two daughter basal progenitors, or symmetric differentiative (neurogenic) divisions in which one basal progenitor divides to form two daughter neurons[74-76]. Hence, the basal progenitors are derived from mitoses of the neuroepithelial or radial glial progenitors and act as an intermediary cell type which generates neurons. They are histologically distinct from other apical progenitors, since basal progenitors lack an apical connection with the ventricular surface, do not undergo interkinetic nuclear migration, and express specific markers such as the transcription factors Tbr2, Cux1 and Cux2[76-78]. The signaling mechanisms which direct the change in potency of progenitor cells is not very well understood. It is likely that distinct environmental niches and/or signaling factors that the

cells are exposed to regulate fate changes in progenitor cells[79, 80]. There are a number of signaling pathways implicated in neuronal progenitor and stem cell proliferation one of which is IGF signaling.

Insulin growth factor (IGF) signaling in development

The IGF signaling pathway is a well characterized signaling cascade that plays important roles in development[81, 82]. Insulin like growth factor 1 (IGF1), and Insulin like growth factor 2 (IGF2) are the ligands within the IGF signaling family that are known to bind the various IGF receptors with different biological activities. IGF1 and IGF2 bind the IGF1-Receptor (IGF1R) which induces survival and proliferation via the AKT and MAP-kinase pathways[81]. IGF2 binding to the IGF2R induces endocytosis of the ligand and therefore acts as a sink to remove the ligand from the environment[81].

IGF signaling has been shown to be important in embryonic growth[81, 82]. The importance of IGF2 during embryologic growth is elucidated in an elegant study by Baker et al. comparing the IGF1 knockout (KO) mouse and the IGF2 KO mouse[82]. By looking at embryo weight at various ages they show that at E13.5 wild-type (wt) embryos weigh about 0.124 grams (g). In contrast the IGF1 KO weighed 0.111g and the IGF2 KO weighed 0.088g. At E13.5 the IGF2 KO weighed 70% of wt weight. At E17.5, the IGF2 KO weighed 0.599g, compared to 0.623g (IGF1 KO) and 0.956g (wt). At E17.5 the IGF2 KO weighed 63% of wt weight. However, at E18.5, IGF2 KO weighed 0.937g compared to 0.926g (IGF1 KO) and 1.5g (wt). Therefore, between E17.5 and E18.5 the IGF2 KO mouse grew a total of 0.338g, more a third of its weight. This implies that IGF2 signaling is important in early embryologic development, and that a compensatory

mechanism may be activated at E17.5 to stimulate growth of the embryo later in development. This could be from IGF1 signaling which is known to be expressed from mid-late gestation onwards.

IGF signaling is one of the main signaling families expressed early in the oocyte and the developing blastocyst. In cows, both IGF1 and IGF2 are present at all stages from the mature oocyte to the blastocyst of the preimplantation embryo[83]. In both mouse and human, only IGF2 transcripts are detected as early as the two cell stage and continue to be present throughout blastocyst development[84, 85]. Therefore, the developing embryo during the preimplantation stages is already receiving IGF signaling for growth and development.

IGF signaling is also shown to be essential in the central nervous system. In the mouse embryo the IGF1 mRNA expression has been shown to begin at E14 and is predominantly in neurons[86]. Its peak expression however is in the subventricular zone and interneurons between P0 and P14[86]. The IGF2 transcript is primarily expressed in the brain meninges and choroid plexus throughout development[87, 88]. Overexpression of IGF1 in embryonic neural progenitor cells using a nestin promoter showed that IGF signaling increases progenitor cell-cycle reentry and decreases cell cycle length[89]. In addition, IGF1 has been shown to inhibit apoptosis in the developing cortex[90]. Interestingly, both IGF1 and IGF2 can cross the blood-CSF and blood-brain barrier[91, 92]. Therefore, IGF signals do not have to be made within the cortical mantle to affect proliferation and growth of the neural progenitor cells. Therefore it is possible that IGF signals may be coming from the CSF to stimulate proliferation of cortical progenitor cells

along the ventricle. Other signaling factors are also important is stem cell proliferation and may be important in defining a stem cell niche.

Stem cells and their niche

The classical defining characteristics of a stem cell are its capacity for self-renewal and its ability to differentiate into specialized cell types. In defined media conditions that induce stem cell proliferation, a stem cell should maintain an undifferentiated state. When the media conditions are changed to induce differentiation, a stem cell will give rise to differentiated cell types. A stem cell is also characterized by its potency. Totipotent stem cells are found early in the embryo up until approximately the eight cell stage. At this point in development, the isolation of a single cell can give rise to embryonic and extra-embryonic cell types[93-95]. Pluripotent stem cells are found within the inner cell mass of the developing blastocyst and give rise to cells derived from any of the three germ layers, endoderm, mesoderm, and ectoderm. Multipotent cells are more specialized than pluripotent cells in that they give rise to the differentiated cells of a specific tissue type. Multipotent stem cells have been discovered for many tissue types including, skin, muscle, blood, intestine, and brain.

The isolation and characterization of multipotent stem cells is important to science and medicine to not only understand the biology and signaling factors essential to maintain stem cells throughout development, but also because of their high potential therapeutic value. Studying stem cells has been challenging because removing them from their endogenous location often leads to differentiation. A stem cell's microenvironment or niche is often required for the maintenance of its undifferentiated

state, as well as to receive important signals which induce differentiation when necessary[96]. A stem cell may receive simultaneous opposing signals to self-renew and differentiate which must be balanced and regulated to maintain tissue homeostasis. The stem cell niche regulates the balance between self-renewal and differentiation.

To study multipotential neural stem cells and attempt to elucidate the signaling factors important for self-renewal, in vitro growth conditions have been established[97]. In 1994, Davis and Temple reported the isolation and proliferation of cortical rat neural stem cells in vitro[98, 99]. In an elegant demonstration from single cells isolated from E12-E14 rat cortex, they were able to show both self-renewal and differentiation of a single cortical neural stem cell into three cell types, neurons, astrocytes, and oligodendrocytes, revealing the presence of a common precursor. Interestingly, the culture media used to grow the stem cells in vitro was serum-free medium (DMEM B27 plus N2) which had been conditioned by cortical astrocytes and meningeal cells. Meningeal cells secrete many factors which are found in the CSF, including factors such as Transferrin, Cystatin C, and Insulin-like Growth Factor 2 (IGF2)[100]. In addition, the stem cells were placed in wells containing sonicated membrane homogenates from the glioblastoma cell line C6[101]. Membrane homogenates from specific cell types stimulate division of single neural stem cells, suggesting that certain membrane bound factors are important for stem cell proliferation[99]. The importance of membrane contact is consistent with the observation that neural stem cells prematurely differentiate when grown as single cells, but continue to proliferate when grown in aggregates[99]. In fact, initially plating cell aggregates with 4-8 cells remarkably increases proliferation of progenitor cells when compared to single cells or pairs[99]. This suggests that cell contact, or at least membrane associated factors,

are important for cortical stem cell proliferation and maintenance of a multipotential cell fate[99, 102]. However, attempting to elucidate the specific factors important for neural stem cell proliferation has been challenging.

The discovery of culture conditions that isolate and expand neural stem cells has been paramount in studying their biology[103, 104]. One assay that is most commonly used is the neurosphere assay, which has provided the ability to study the stem cells' potential to multiply and differentiate in various media conditions[103, 104]. Neurospheres represent three-dimensional spherical cell clusters that are generated in vitro by plating mitotically active cells at a clonal density in supportive media on a non-adhesive substrate. The neurosphere assay is intended to select for a pure population of proliferative cells that originated from a single stem cell. Post-mitotic cells such as neurons are not supported on a non-adhesive substrate and therefore rarely survive in these media conditions. In contrast, if single stem cells are plated directly on an adhesive substrate the majority of cells quickly differentiate and only a few cells continue to proliferate[103, 104]. When a neurosphere is transferred onto an adhesive substrate such as poly-L-lysine or poly-ornithine, the sphere attaches to the culture plate and peripheral cells differentiate into astrocytes or neurons and migrate away from the sphere[103, 104]. Therefore the neurosphere contains multipotential stem cells that have the potential to differentiate into a number of different cell types. By growing neurospheres, specific conditions were identified in which progenitor cells could be expanded in vitro, that has been important in elucidating some of the specific signaling factors involved in stem cell proliferation.

A number of mitogenic factors have been identified to stimulate proliferation in various tissues. Epidermal growth factor (EGF) has been shown to be a powerful

mitogen in a number of tissues including skin, liver, and intestine, as well as for astrocytes and oligodendrocytes[105, 106]. Reynolds and Weiss identified EGF as a mitogen for the generation of neurospheres in vitro from cells isolated from both adult and embryonic brain[103, 104]. In addition, transforming growth factor alpha (TGF-alpha), an EGF homolog, was also shown to generate spheres from the embryonic brain[103]. However, basic fibroblast growth factor (FGF2), nerve growth factor (NGF), platelet-derived growth factor (PDGF), or transforming growth factor beta (TGF-β) could not mimic the effects of EGF[103, 104]. Using EGF to induce proliferation of the neural stem cells as neurospheres quickly led to an effective way to generate large numbers of stem cells to study their behavior. In addition the assay became a standard method to identify stem cell populations in various areas of the central nervous system. Although Reynolds and Weiss were not able to generate neurospheres in the presence of FGF2 in their first study, subsequent studies revealed the importance of FGF2 for neural stem cell proliferation[107-109]. Using the neurosphere assay, proliferative multipotential stem cells have been generated from fetal and adult human, and rat and mouse CNS tissues, using either EGF and/or FGF2 with a combination of other serum-free media components[110]. Over the years, there have been a number of factors acting alone or in concert which have been shown to effect neural stem cell proliferation[107, 108, 110-117]. It is likely that within the endogenous environment, multiple growth factors acting together regulate the proliferation and maintenance of neural stem cells. And because it is likely that neural stem cells, and perhaps all stem cells, are regulated by their environment,[118] a key to understanding the innate biology of neural stem cells may come from studying their endogenous environment.

Throughout development and into adulthood, one common factor of embryonic neural progenitor cells and adult neural stem cells in the SVZ is that they contact the CSF. NEPs, radial glial cells, and the adult stem cells extend a primary cilium into the CSF (Figure 1.5). The primary cilium is analogous to an antenna monitoring the external environment to obtain signaling cues from the extracellular matrix and has been shown to be essential to generate adult neural stem cells in vivo[112]. Histologically, loss of a connection with the CSF correlates with the differentiation of neural stem cells. This intriguing anatomical relationship supports the hypothesis that direct contact with CSF may be required for cells to maintain a stem cell fate, but, factors in the CSF that may regulate proliferation and maintenance of neural stem cells or provide signals for neurogenesis, are not known.

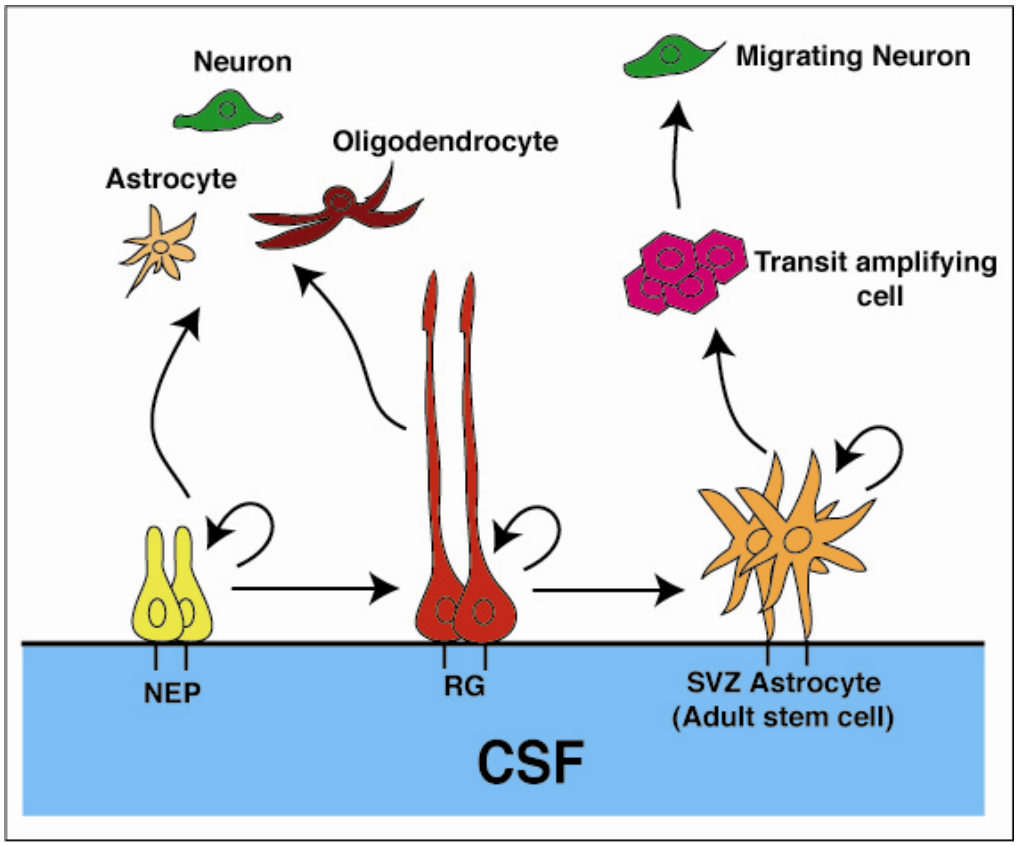

Figure 1.5. Neural stem cells contact the CSF. Neuroepithelial precursors (NEP) and radial glial cells (RG) are the embryonic progenitor cells that give rise to neurons, astrocytes, and oligodendroctyes. SVZ astrocytes, the adult stem cells, give rise to rapidly dividing transit amplifying cells which differentiate to become migrating neurons. NEPs, RGs and SVZ astrocytes maintain contact with the CSF to retain multipotential stem cell fate.

The similarities of the adult stem cell niche within the SVZ contacting the CSF and the entire population of the embryonic neural progenitor cells contacting the CSF, led me to hypothesize that signals within the CSF are important for regulating stem cell proliferation and neurogenesis. To better understand the role of the CSF, I wanted to know what factors were in the CSF at various times in development. However, a comprehensive analysis of the proteins within the embryonic CSF had never been performed. Therefore, we performed the first comprehensive mass spectrometry analysis of embryonic human and rat CSF. We catalogue the embryonic human proteome and

compared it to the embryonic rat proteome at different times in development. We found that embryonic CSF is a dynamic complex fluid containing a large number of functionally diverse proteins. There is great similarity in the composition and biological function of proteins present in the embryonic CSF of humans and rats. Mass spectrometry and western analysis of the rat CSF identified many age-dependent changes in the CSF proteome. We show that embryonic CSF stimulates proliferation and maintenance of neural progenitor cells in an age-dependent fashion. CSF taken from the rat lateral ventricle during neurogenesis dramatically stimulates progenitor proliferation, whereas CSF from earlier ages (E13, E14) or later ages (P6 and adult) shows more modest effects. Together, our findings show that the CSF proteome is a dynamic, active niche for neural stem cell and progenitor cell proliferation, survival, and maintenance and may represent an important therapeutic target. Understanding the endogenous signals and environment that neural stem cells are exposed to will not only reveal a lot about the biology and regulation of neural stem cells, but also may lead to potential therapies for neurodegenerative diseases, stroke, and trauma.

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Chapter 2

Proteomic Analysis of Human and Rat Embryonic CSF

A Comparative Proteomic Analysis of Human and Rat Embryonic

Cerebrospinal Fluid

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Summary

During vertebrate central nervous system development, the apical neuroepithelium is bathed with embryonic Cerebrospinal Fluid (e-CSF) which plays regulatory roles in cortical cell proliferation and maintenance. Here we report the first proteomic analysis of human e-CSF and compare it to an extensive proteomic analysis of rat e-CSF. As expected, we identified a large collection of protease inhibitors, extracellular matrix proteins, and transport proteins in CSF. However, we also found a surprising suite of signaling and intracellular proteins not predicted by previous proteomic analysis. Some of the intracellular proteins are likely to represent the contents of micro-vesicles recently described within the CSF[1]. Defining the rich composition of e-CSF will enable a greater understanding of its concerted actions during critical stages of brain development.

Introduction

During the process of neurulation the neural groove forms and the neural folds fuse to form the neural tube. Once the neural tube is fused, the fluid within the lumen is considered cerebrospinal fluid (CSF), whereas before fusion is complete the neuroepithelium lining the inside of the neural tube is still in contact with amniotic fluid[2]. During the early stages of neural tube growth and development, groups of specialized neuroepithelial cells lining the neural tube are believed to secrete fluid into the neural tube space in order to support growth and development of the embryo[3]. As the neural tube continues to elongate and develop, specific highly vascularized secretory epithelial cell types begin to invaginate at specific locations within the neural tube to form the specialized choroid plexus.

The choroid plexus is a highly vascularized epithelial cell structure that during development is believed to be involved in the specific intracellular transfer of proteins into the CSF from the blood[4]. The choroid plexus develops in the lateral ventricles, and in the third and fourth ventricles of the brain. In rats the choroid plexus can be first identified as early as embryonic day 13 (E13) as a midline structure and by E15 it represents paired structures protruding into the lateral ventricles[5]. In the human embryo the choroid plexus begins to develop in the lateral and fourth ventricle at Carnegie Stage (CS) 18, approximately 44 days post-ovulation[6]. The first appearance of cerebral cortical neurons in the human embryo occurs at CS 21, shortly following the appearance of the choroid plexus and the production of CSF[6], and a similar temporal sequence is seen in mice and rats.

Although the role of the CSF during embryogenesis is just starting to be studied, several recent papers suggest an important role for CSF in brain development[7-12]. Miyan et al. have shown that rat cortical cells are viable and proliferate in e-CSF[11], and recent studies have been begun to test discrete signaling factors that may regulate neurogenesis. Gato et al. and Martin et al. have studied the role of chick e-CSF in regulating survival, proliferation and neurogenesis of neuroepithelial cells, and identified FGF-2 in the chick CSF as a vital trophic factor[7, 8]. Intriguingly, in mutant animals, CSF factors that may inhibit proliferation have been suggested. In studies of the hydrocephalic Texas (H-Tx) rat it has been found that cell proliferation in the ventricular zone decreases, and although cell migration still occurs, there is a decrease in the number of migrating cells[9, 11]. In addition, CSF from the lateral ventricles of affected H-Tx fetuses can completely inhibit in vitro proliferation of neuronal progenitors isolated from a normal fetus at 10% CSF addition to the media, suggesting that factors intrinsic to the CSF of the H-Tx fetuses are present that inhibit proliferation[9, 11, 12].

The identification of other CSF factors that may play developmental roles has been impeded by our limited understanding of the components of the CSF. However, recent reports have provided our first glimpse of the protein composition of e-CSF[13, 14]. Chick and rat e-CSF have been analyzed in proteomic studies and revealed many similarities, with both containing proteins of the extracellular matrix, regulators of osmotic pressure, ion carriers, hormone binding proteins, regulators of lipid metabolism, and various enzymes and enzyme regulators. One of the most striking differences between rat and chicken CSF as noted by Parada et al. was the increased number and complexity of apolipoproteins found in the rat which may be related to neuronal

complexity[13, 14]. The studies by Parada et al. are the first attempts at analyzing the proteome of the chick and rat e-CSF and have so far identified only 31 proteins within the rat e-CSF.

Here we undertake a systematic and unbiased proteomic analysis of human e-CSF from Carnegie Stage 19-20 (approximately 48-51 days post ovulation). We also report an extensive proteome analysis of rat e-CSF from three different time points E12.5, E14.5, and E17.5 during cortical development and list all the proteins that are common among the three time points as well as those proteins that are different.

We report a list of the common proteins found between the human and rat e-CSF. Furthermore, using various gene ontology programs we categorize the proteins in the e-CSF and compare the subcellular localization, molecular function, and biological process of embryonic human and rat CSF. We find 130 proteins shared between the human and rat e-CSF and that there are many similarities in the categories of proteins found within the CSF based on molecular function and biological process. This systematic analysis of proteins common to many ages lays the groundwork for analysis of changing CSF components that may have more specific developmental roles.

Methods

Isolation of CSF from human embryos: Human embryos were collected through the joint MRC-Wellcome Trust Human Developmental Biology Resource at the University of Newcastle, Institute of Human Genetics. The embryos at CS 19-20 were placed in ice cold sterile Phosphate Buffered Saline (PBS) solution and all extra-embryonic membranes and tissues were removed. The embryos were washed in sterile PBS and carefully placed on the dissection platform under the microscope. A Hamilton syringe was placed carefully into the fourth ventricle and the CSF was collected paying close attention not to make contact with the neuroepithelium lining of the fourth ventricle. The samples used for analysis had no microscopically visible contaminating neuroepithelial cells or red blood cells. Nonetheless, the CSF samples were centrifuged at 10,000*g* at 4 °C for 10 minutes to remove any intact contaminating cells and then were frozen at -80°C until further analysis.

Isolation of CSF from rat embryos: Rat embryos (Sprague Dawley) at stage E12.5, E14.5 and E17.5 were removed from extra-embryonic membranes and tissues and placed in sterile Hanks Balanced Salt Solution (HBSS). Each embryo was handled individually and washed in HBSS, gently patted dry and placed on a microdissection tray. The CSF was carefully aspirated from each rat embryo under the microscope with a pulled tip glass microcapillary pipette (Drummond Scientific Company 20ul). The needle was steadily held within the inside of the ventricle so as to prevent major contact with the neuroepithelial wall and the CSF was slowly aspirated. For E17.5, the embryo was placed on its back and the glass needle was inserted into the left lateral ventricle and then into the right lateral ventricle to collect the maximum amount of CSF from the lateral

ventricles. See Supporting Information Movie 1 for CSF sample collection technique from an E17.5 rat embryo. For E12.5, the embryo was placed on its side and the glass needle was inserted directly into the lateral ventricle. Due to the patency of the neural tube at this stage, the CSF was collected from the developing lateral, third and fourth ventricle. For E14.5, the embryo was also placed on its side and the glass needle was either inserted into the lateral ventricle or into the fourth ventricle and the CSF was collected from each location separately. Figure 2.1A is a diagram depicting CSF isolation from E14.5 rat. CSF for each analysis was collected from two entire litters and pooled as one sample. To minimize protein degradation, CSF samples were kept at 4 °C during collection. CSF samples were centrifuged at 10,000*g* at 4 °C for 10 minutes to remove any contaminating cells. The samples that we used for analysis had no visible sign of contaminating neuroepithelium cells or red blood cells as we could detect under the microscope. Samples were frozen at -80°C until further analysis.

Figure 2.1. Extraction and SDS-PAGE analysis of human and rat embryonic CSF. (A) Image of hematoxylin and eosin sagittal section of E14.5 rat showing CSF aspiration technique and the position of the syringe needle relative to surrounding tissues in the lateral ventricle (LV) and the 4th ventricle (4thV). Inset image of E14.5 rat embryo provides orientation. Red arrow head is (4thV) and red arrow is the mouth/chin. (B) CSF aspirated from the 4th ventricle of a CS20 human embryo (CS20) and a CS19 human embryo (CS19) was separated by size by SDS-PAGE on a 7.5% or 10% polyacrylamide gel respectively. For clarity, the CS20 sample shows 1/7th of the sample used in the final analysis. (C) CSF aspirated from the lateral ventricles (LV) of E12.5, E14.5 and E17.5 rat. During the procedure to collect CSF from E12.5, the micro-thin capillary needle is placed into the lateral ventricle of the E12.5 rat and due to the patency of the neural tube at that point in development, the CSF is acquired from the lateral ventricle, the third ventricle and the fourth ventricle. This is clearly visible as a sequential collapse of ventricles as the CSF is being aspirated. CSF from E14.5 rat can be collected from both the lateral ventricles (LV) and from the 4th ventricle (4th V). The arrow in all samples represents Apolipoprotein-B.

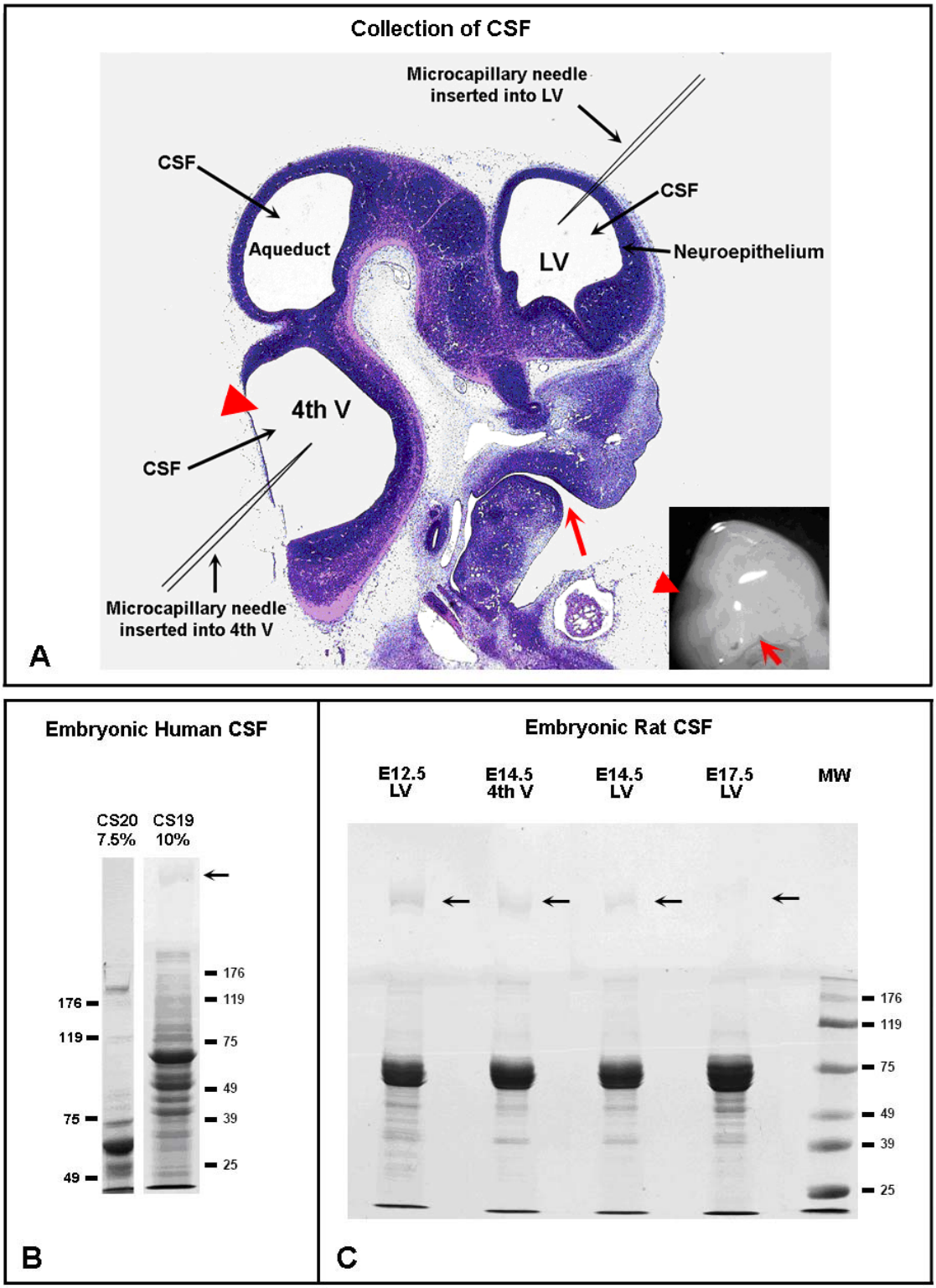


Figure 2.1 continued

In-Gel Digestion and Mass Spectrometry: Frozen CSF samples were thawed on ice. Sample buffer was added and the samples were boiled for 5 minutes and subjected to SDS-PAGE using either 10% or 7.5% polyacrylamide (37.5:1 acrylamide:bis-acrylamide) gels as indicated in Figure 2.1B-C. Each gel lane (which included the 4.2% polyacrylamide stacking gel) was cut into ten regions and each region was diced and subjected to in-gel digestion with sequencing grade modified trypsin (Promega, 6 ng/µl) in 50mM ammonium bicarbonate overnight at 37 ºC. Peptides were extracted with 50% acetonitrile (MeCN), 2.5% formic acid (FA) and then dried. Peptides were then resuspended in 2.5% MeCN, 2.5% FA and loaded using an autosampler onto a microcapillary column packed with 12cm of reverse phase MagicC18 material (5 µm, 200Å, Michrom Bioresources, Inc.). Elution was performed with a 5-35% MeCN (0.1 % FA) gradient over 60 minutes, after a 15 minute isocratic loading at 2.5% MeCN, 0.5% FA. Mass spectra were acquired in LTQ and LTQ-XL linear ion trap mass spectrometers (Termo Electron) over the entire 75 minutes using ten MS/MS scans following each survey scan. Raw data were searched against either the human or rat IPI forward and reverse concatenated databases using Sequest software requiring tryptic peptide matches with a 2 Da mass tolerance[15]. Cysteine residues were required to have a static increase in 71.0 Da for acrylamide adduction and differential modification of 16.0 Da on methionine residues was permitted. The resultant top matches for all analyses of each gel lane were compiled. Each list was then filtered independently using a dCn2 score of 0.2 and Xcorr scores of 1.8, 2.0 and 2.5 for singly, doubly and tripled charged ions respectively. Proteins on these filtered lists that had two or more peptides were retained. However

keratin proteins were removed as they are known contaminants in most gel-based proteomic analyses. Based on the number of reverse database false-positives that were also retained following these filtering criteria, we estimate the following false-positive rates for the proteins in each sample: rat E12.5 lateral ventricle (LV), 0.45%; rat E14.5LV, 0.30%; rat E17.5LV, 0.50%; rat E14.5 4th ventricle, <0.00%; and human CS 20, <0.00%. For the human CS 19 sample the estimated false-positive rate for proteins identified by more than three peptides is <0.00%. The dataset of proteins for the embryonic mouse brain was extracted from LC-MS/MS data collected from 16 strong cation exchange (SCX) fractions generated during our previous study of the forebrain and midbrain extracts of E16.5 mouse embryos[16]. We compiled the LC-MS/MS data from four SCX fractions in the middle of the SCX gradient (not enriched for phosphopeptides) from each of the four regions of the gel and the top 200 identified proteins were subjected to further analysis.

Results

Human Embryonic Proteome

Human CSF was collected from the fourth ventricle, as mentioned above, from two independent embryos at Carnegie Stage (CS) 19-20. From the first embryo (CS19) a total of 15ul was collected, and from the second embryo (CS20) a total of 70ul was collected. The CSF from these two independent samples was separated by 1-D SDS-PAGE and Figure 2.1B shows the Coomassie stained protein pattern of the CSF from CS20 and CS19 embryos run on 7.5% and 10% polyacrylamide gels respectively. The two human e-CSF samples were analyzed separately. Appendix 1 Table 1.1 shows the

proteomic analysis of the CSF collected from the CS20 embryo and lists 188 proteins with 2 or more peptides identified.

Using a number of protein analysis programs such as UniProt, Gene Ontology™ (GO), and the PANTHER (Protein Analysis Through Evolutionary Relationships) classification system we categorized the proteins found from the mass spectrometry data and list subcellular localization, protein function, tissue specificity, and relevant notes pertaining to each protein (Appendix 1 Table 1.1)[17]. Analysis of the CSF from the CS19 human sample revealed 772 proteins with more than three peptides identified. The search results from this analysis suggested the presence of a number of non-CSF contaminants including 7 different mitochondrial specific precursor proteins such as the mitochondrial precursors for 4-Aminobutyrate Aminotransferase, Fumarate Hydratase, and Isoform Dut-M of Deoxyuridine 5'-Triphosphate Nucleotidohydrolase, whereas no mitochondrial precursor proteins were identified in the rat CSF or in the CS20 human CSF sample. Therefore, the CS19 list was not further considered in the comparison to rat CSF. However, the proteins from this analysis are presented in Appendix 1 Table 1.2 as this list is certainly enriched for human e-CSF proteins.

The substantial differences between this sample and the other human and rat samples suggest that this sample contained multiple impurities, likely from lysed blood and/or neuroepithelial cells. Nonetheless the differences also highlight that the MS analysis is highly sensitive to contaminants, and that the absence of mitochondrial proteins in other samples indicates that they are probably quite pure.

Rat Embryonic Proteome

CSF was collected from the lateral ventricle of E12.5, E14.5 and E17.5 rat embryos and from the fourth ventricle of E14.5 rat embryos. CSF from two litters (approximately 20-24 rat embryos) was pooled for each time point and was separated by 1-D SDS-PAGE and the proteins were visualized with Coomassie blue stain. Figure 2.1C shows the Coomassie stained protein pattern of CSF collected from all three time points. Mass spectrometry analysis of the rat CSF was performed separately for E12.5 (Appendix 1 Table 1.4), E14.5 lateral ventricle (Appendix 1 Table 1.5), E14.5 fourth ventricle (Appendix 1 Table 1.6), and E17.5 lateral ventricle (Appendix 1 Table 1.7). There were 423 proteins identified in E12.5 LV CSF, 318 proteins in E14.5 LV, 249 proteins in E14.5 4^{th}V, and 382 proteins in E17.5 LV. There are 137 proteins common to E12.5, E14.5, and E17.5 rat CSF samples that are presented in Appendix 1 Table 1.3 which includes the name of the protein, its molecular weight, subcellular localization, function, tissue specificity. Also included are any relevant notes about each protein.

Interestingly, there are 61 proteins identified in E12.5 LV, E14.5 LV, and E17.5 LV that were not identified in E14.5 4^{th}V and only 5 proteins identified in E12.5 LV, E14.5 4^{th}V, and E17.5 LV that were not identified in E14.5 LV. This does not appear to be simply due to an overall reduction in E14.5 4^{th}V protein concentration as similar numbers of peptides were identified for the proteins found in common with LV CSF samples. Instead, the difference suggests potential differences in the protein composition of CSF between the lateral and fourth ventricles, though further studies would be needed to confirm this and to assess its significance.

Parada et al identified 31 proteins within the rat e-CSF finding an abundance of extracellular matrix proteins, enzymes and enzyme regulators which is consistent with our study[14]. We identified in this study a much larger number of proteins within the CSF while identifying 24 of the 31 previously identified proteins. The 7 proteins that we did not find are the following: calreticulin, DJ-1, EEf1 g, laminin receptor 1, malate dehydrogenase 1, set beta isoform, and tyrosine 3-monooxygenase/tryptophan 5-monooxygenase activation protein theta polypeptide. The differences between our study and the study by Parada et al appear to be more a consequence of methodology rather than true sample differences. Parada et al chose for mass spectrometry the most prominent silver-stained e-CSF proteins resolved by two-dimensional electrophoresis, whereas we performed an analysis of the entire e-CSF separated by one-dimensional electrophoresis. Although our one-dimensional approach enabled a more comprehensive analysis which would be unwieldy for an entire two dimensional gel, the study by Parada et al is complementary with ours as some proteins resolved in two dimensions would have a reduced likelihood of becoming suppressed due to co-migration in one dimension with abundant protein species such as albumin.

Although our analyses are only semi-quantitative, we found interesting differences between our various rat e-CSF samples. Apolipoprotein M is found in both E14.5 LV and E14.5 4thV but our analysis did not identify it in either E12.5 LV or E17.5 LV, phosphatidylethanolamine binding protein was found only in the E17.5 LV, collagen alpha 1 (XI) was identified in E14.5 and E17.5 LV, and phosphatase 2 (alpha isoform of regulatory subunit A) was found in E12.5 LV. Also, apolipoprotein D, an apolipoprotein that was not identified by Parada et al was identified only in the E14.5 4^{th}V.

Comparison of Human and Rat CSF

In a comparison of proteins found in the human e-CSF to the proteins found in the rat e-CSF, we found that of the 188 proteins identified in the human e-CSF, 135 human proteins were identified in any one of the four samples of embryonic rat CSF. 83 of those proteins were present in all four samples of embryonic rat CSF. Appendix 1 Table 1.1 includes the human proteins found common to rat CSF. We have indicated the specific rat samples in which each protein was identified. Out of the top 50 proteins found in the human CSF, 45 were also found in the rat CSF.

Proteins common to human and rat CSF presumably represent proteins related to fundamental CSF functions. For example, e-CSF contains many transport and carrier proteins including transferrin, albumin, alpha-fetoprotein, transthyretin, ceruloplasmin, and plasma retinol-binding protein that are all involved in either metal ion or vitamin transport through fluid or across cell membranes. There are a number of apolipoproteins involved in the transport and metabolism of lipids and fatty acids in the CSF as reported in this paper and by Parada et al[14]. There are also a large number of enzymes and protease inhibitors in the CSF that are involved in regulating immune response and maintaining homeostasis.

Other proteins common to rat and human CSF may play more specific roles in neurogenesis. One factor in the e-CSF is Amyloid Beta A4 Protein Precursor (APP), which we identified in rat CSF at E12.5, E14.5, and E17.5 and human CSF at CS20. This protein is normally present in brain and a soluble form is known to circulate in adult CSF[18]. The soluble form of APP has been shown to stimulate proliferation of embryonic neural stem cells as well as adult neural progenitor cells from the subventricular zone[19-21].

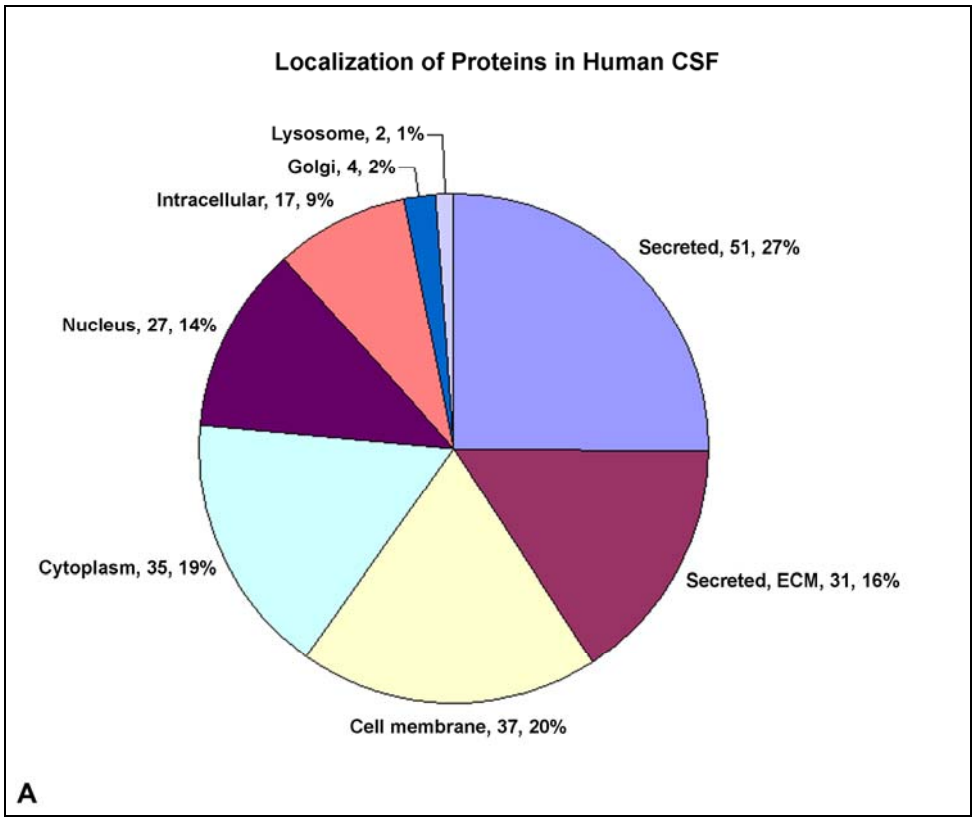
APP may play a role during neurogenesis not only within the cell but may be released in the extracellular space and taken up in the CSF in order to diffuse throughout the CSF and may play a function at more distant sites. Similarly, Tenascin, which we found in all CSF samples from rat and human from CS 20, is a secreted extracellular matrix glycoprotein implicated in axon guidance during development and regeneration[22], which was recently shown to be expressed in progenitor cells in the ventricular zone of the developing brain. CSF contains multiple critical extracellular matrix factors including fibronectin, laminin, tenascin, fibulin, versican, and neurocan core protein. Since many of these factors can support or orient neuronal migration, it raises the possibility that they may also be acting in the CSF as external cues for proliferating and differentiating neuronal progenitor cells.

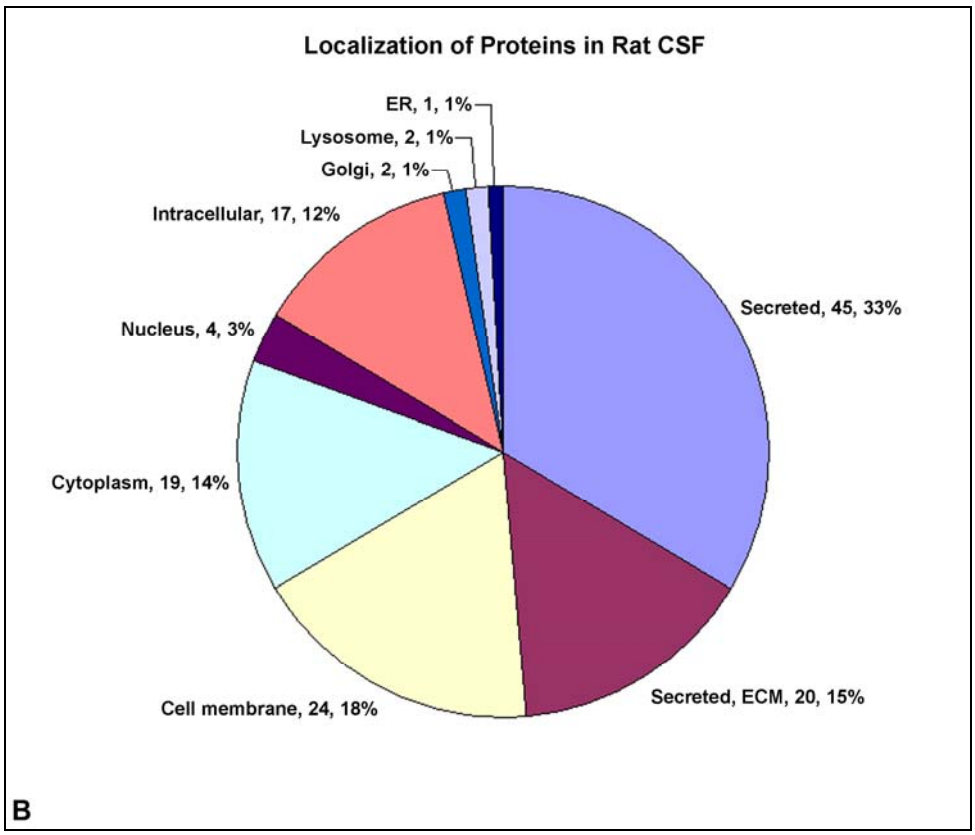
Few proteins were identified that may be exclusive to rat or human e-CSF. The protein Pigment Epithelium Derived Factor (PEDF) was only found in the human e-CSF and is known to circulate in the adult CSF and is significantly decreased in CSF of patients with frontotemporal dementia[23]. This secreted serine protease inhibitor, known to be released by retinal pigment cell into the matrix, is a known neurotrophic protein involved in survival and potentially differentiation of specific neurons[24]. PEDF is known to act on photoreceptor cells but also may play a role in spinal motor neuronal survival. It is likely that PEDF is released by the photoreceptor cells into the matrix and taken up by the CSF and may act on cell types and neurons by diffusion through the CSF. Similarly, the Neuronal Cell Adhesion Molecule L1-Like Protein, also found only in the human e-CSF is known to play important roles in neurite outgrowth and neuronal survival[25-27].

Conversely, we only observed the Extracellular Superoxide Dismutase, a protein known to remove free radicals that can be toxic to cells in rat e-CSF. One of the functions of the e-CSF may be the removal of toxins and toxin metabolic byproducts and therefore it would important to have proteins within the CSF that help neutralize some of the toxic products released into the CSF. Additionally, we found in the rat e-CSF Mannose 6-phosphate/Insulin-like Growth Factor II Receptor (IGF2R), which a soluble form of the receptor has been found in the serum, amniotic fluid and urine of both rodents and humans, affecting organ size based on its interaction with IGF2 and other factors[28-32]. Confirmation of these apparent differences would require Western blotting, and may lead to studies of their intriguing biological potential in the e-CSF.

Subcellular localization. To compare the e-CSF of human and rat further we analyzed the 188 proteins found in the human e-CSF and the 137 proteins in the rat e-CSF present in all samples based on subcellular localization, molecular function, and biological process.

Figure 2.2. Classification and comparison of proteins based on subcellular localization. Graphic representation of the subcellular localization of proteins in CS 20 embryonic human CSF (A), embryonic rat CSF (B), and E16.5 mouse brain (C). The percentage of protein localization is calculated based on the total number of proteins localized to each space divided by the total number of proteins in the CSF that we were able to assign localization (human CSF-187 proteins, rat CSF-137 proteins, and mouse brain-179 proteins). Some proteins were localized to multiple compartments within the cell. (D) Comparison between human CSF, rat CSF and mouse brain of the number of protein from each category based on localization.





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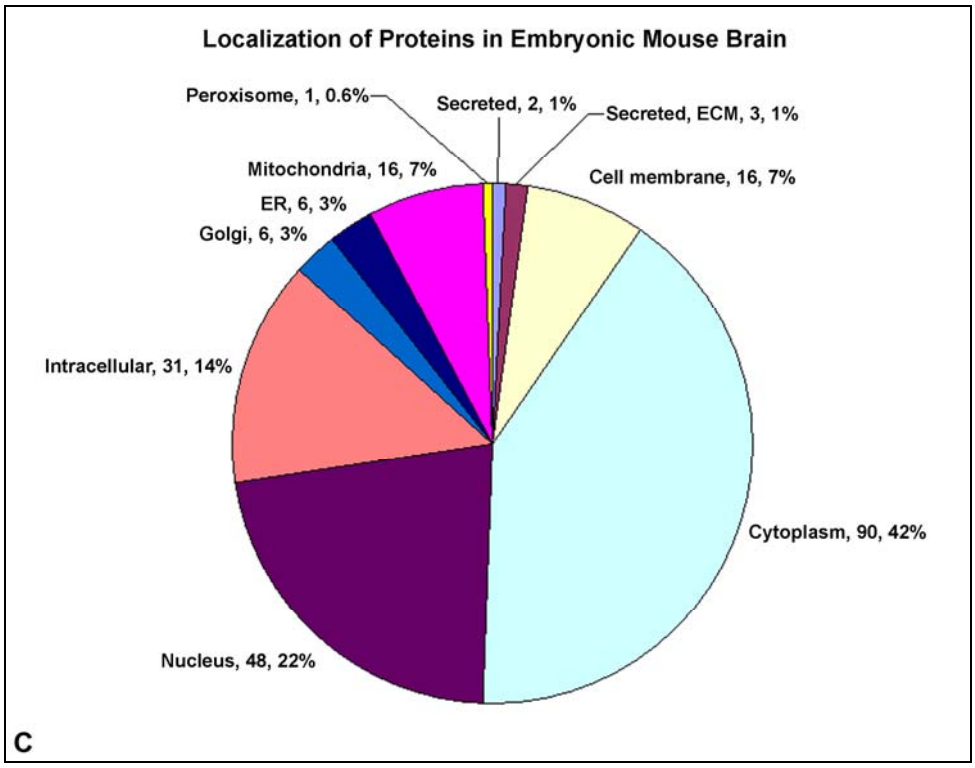


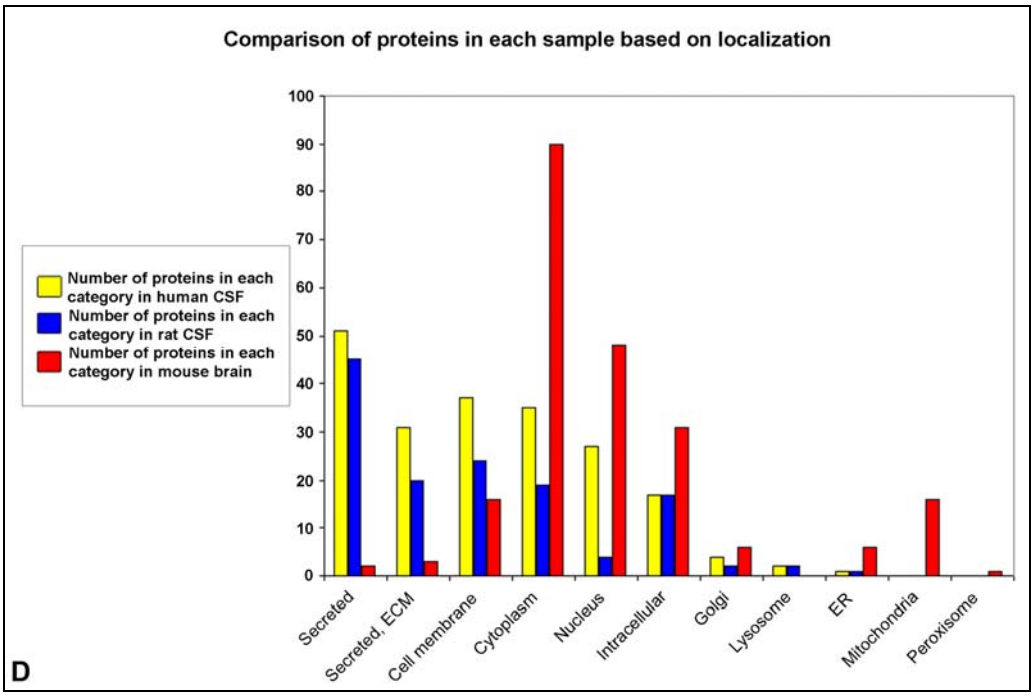


Figure 2.2 continued

The subcellular localization of each protein in the CSF is shown in Appendix 1 Table 1.1 and Appendix 1 Table 1.3. Figure 2.2 shows that the majority of proteins found in the human (A) and rat (B) e-CSF are secreted proteins which compose 27% and 33% of the total proteins found within the CSF respectively. The second most common localization of proteins found in the e-CSF of both humans and rats are cell membrane proteins, composing 20% and 18% respectively. The relatively high percentage of membrane proteins is consistent with the recent discovery of membrane bound particles in the CSF[1].

Out of 188 proteins found in the human e-CSF, 19% are cytoplasmic proteins, 16% are secreted proteins found in the extracellular space or extracellular matrix (ECM), 14% are nuclear proteins, and 9% are intracellular proteins that could not be specifically localized to one compartment. Out of 137 proteins present in all rat e-CSF samples 14% are cytoplasmic proteins, 15% are ECM proteins, 3% are nuclear proteins, and 12% are intracellular proteins. As a control to assess subcellular localization in a protein population of embryonic brain, we chose to analyze the top 200 proteins identified from E16.5 mouse forebrain and midbrain in a previous study[16]. Figure 2.2C shows that 42% of these proteins are in the cytoplasm, 22% nuclear, 14% intracellular, 7% at the cell membrane, and 7% mitochondrial. Strikingly no mitochondrial proteins were found in the CSF. Out of the 200 proteins analyzed from embryonic mouse brain, two are secreted and three are found in the extracellular space or matrix. Figure 2.2D shows a graphical representation of the comparison of embryonic human CSF, rat CSF and mouse brain based on localization. The e-CSF as compared to brain tissue clearly has an abundant number of secreted proteins, extracellular matrix proteins, and cell membrane proteins as

opposed to an overwhelming majority of cytoplasmic, nuclear, and mitochondrial proteins found in the brain tissue.

Molecular Function and Biological Process. For a more comprehensive understanding of the classes of proteins found in the embryonic human and rat CSF we used the PANTHER protein ontology database to classify the proteins into distinct categories of molecular function and biological process. Panther identified 180 out of 188 proteins with a total number of 237 functional hits for the human e-CSF, 119 out of 137 proteins with a total number of 155 functional hits for the rat e-CSF, and 191 out of 200 proteins with a total number of 234 functional hits for embryonic mouse brain. Table 2.1 shows the percentage of proteins assigned to each functional category in the embryonic human CSF, embryonic rat CSF, and E16.5 embryonic mouse brain. Panther analysis of molecular function reveals the majority of proteins found within the human and rat CSF share similar functional categories (Table 2.1, Figure 2.3, and Figure 2.4). The comparison of relevant protein categories in each sample is shown in Figure 2.3. Figure 2.4 represents functional classification of the samples as individual pie charts including the absolute number of proteins assigned to each function group.

Table 2.1. List of protein categories based on molecular function for embryonic human CSF, rat CSF and mouse brain.

Human CSF	Percent proteins in each category	Rat CSF	Percent proteins in each category	Mouse brain	Percent proteins in each category
Cell adhesion	11.1%	Cell adhesion	12.6%	Cell adhesion	2.60%
Chaperone	5.0%	Chaperone	5.0%	Chaperone	8.40%
Cytoskeletal	7.2%	Cytoskeletal	8.4%	Cytoskeletal	11.50%
Defense/Immunity	8.3%	Defense/Immunity	6.7%	Defense/Immunity	0.00%
Extracellular matrix	15.6%	Extracellular matrix	10.9%	Extracellular matrix	0.50%
Hydrolase	2.2%	Hydrolase	1.7%	Hydrolase	6.30%
Kinase	1.1%	Kinase	2.5%	Kinase	2.60%
Ligase	0.6%	Ligase	0.8%	Ligase	3.70%
Membrane traffic	1.1%	Membrane traffic	0.8%	Membrane traffic	2.60%
Miscellaneous	4.4%	Miscellaneous	3.4%	Miscellaneous	2.60%
Unclassified	7.2%	Unclassified	5.9%	Unclassified	14.70%
Nucleic acid binding	10.0%	Nucleic acid binding	5.0%	Nucleic acid binding	18.30%
Oxidoreductase	2.8%	Oxidoreductase	5.0%	Oxidoreductase	4.70%
Phosphatase	1.1%	Phosphatase	2.5%	Phosphatase	1.60%
Protease	7.2%	Protease	6.0%	Protease	1.60%
Receptor	7.8%	Receptor	10.1%	Receptor	2.10%
Calcium binding	2.8%	Calcium binding	4.2%	Calcium binding	3.70%
Regulatory molecule	13.3%	Regulatory molecule	12.6%	Regulatory molecule	8.40%
Signaling molecule	6.1%	Signaling molecule	6.0%	Signaling molecule	1.60%
Synthase and synthetase	0.6%	Synthase and synthetase	1.0%	Synthase and synthetase	2.60%
Transcription factor	1.1%	Transcription factor	1.0%	Transcription factor	3.70%
Transfer/Carrier	8.3%	Transfer/Carrier	12.6%	Transfer/Carrier	3.70%
Transferase	1.7%	Transferase	1.0%	Transferase	4.70%
Transporter	3.9%	Transporter	3.4%	Transporter	4.70%
Cell junction protein	1.1%	Cell junction protein	0%	Cell junction protein	0%
Lyase	0%	Lyase	0%	Lyase	1.60%
Ion channel	0%	Ion channel	0%	Ion channel	1.60%
Isomerase	0%	Isomerase	1.7%	Isomerase	1.00%

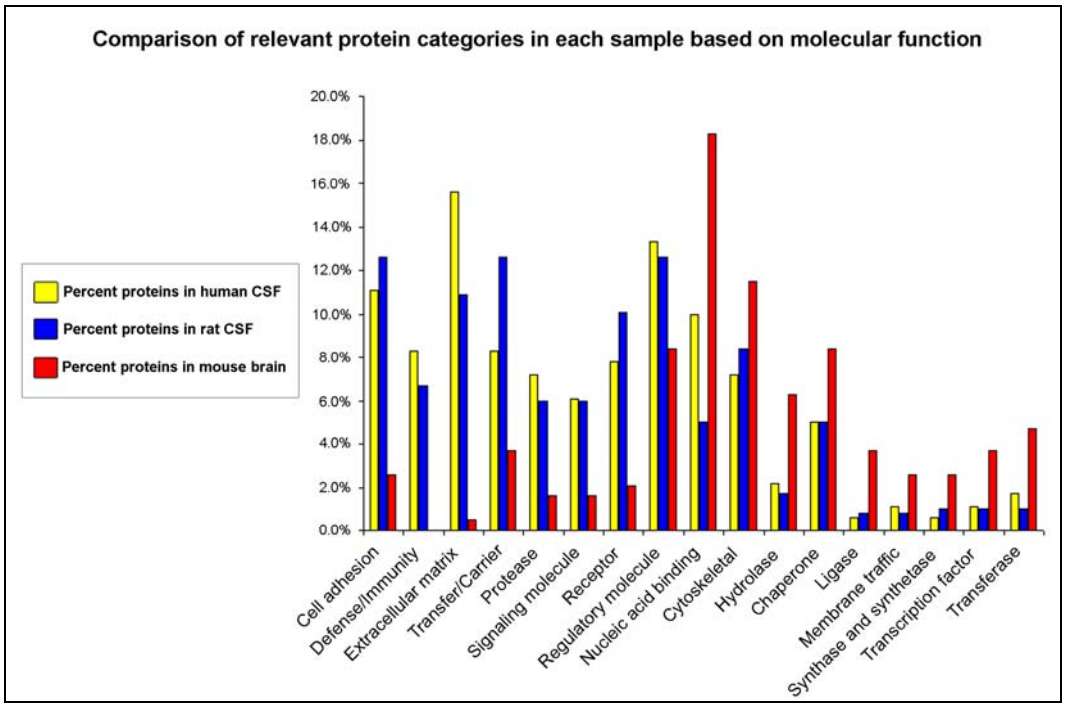
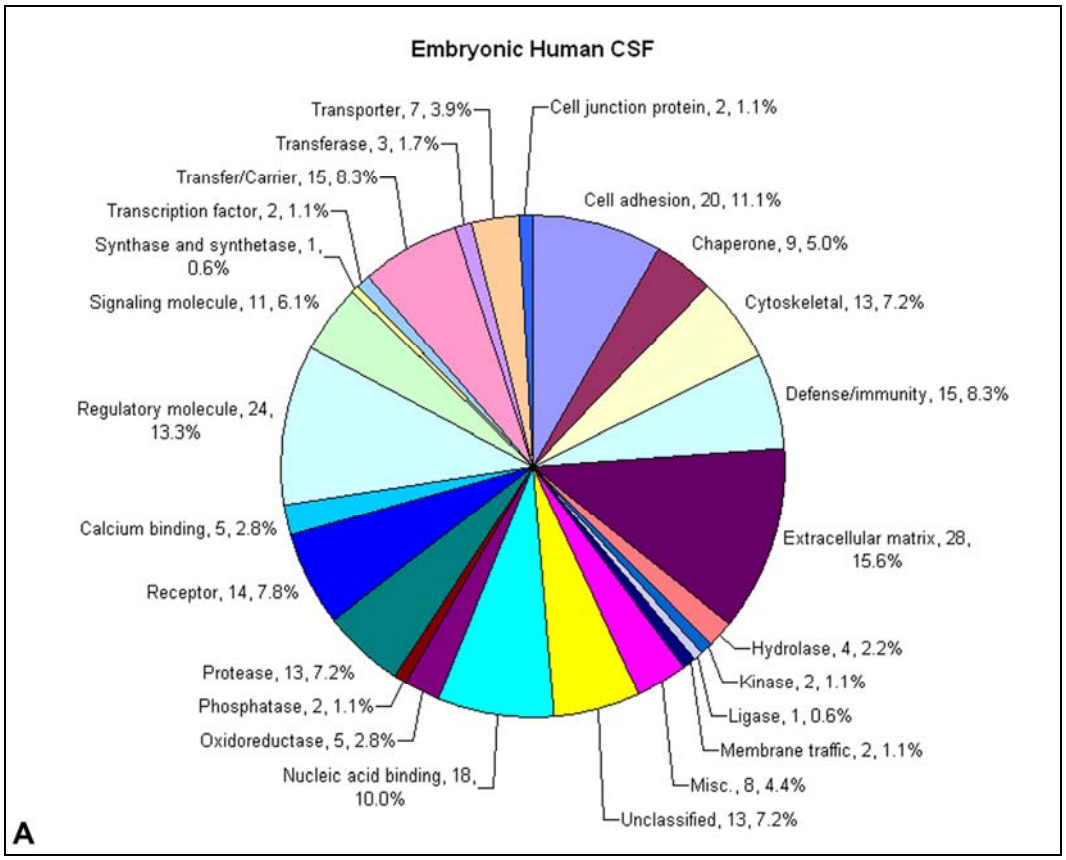
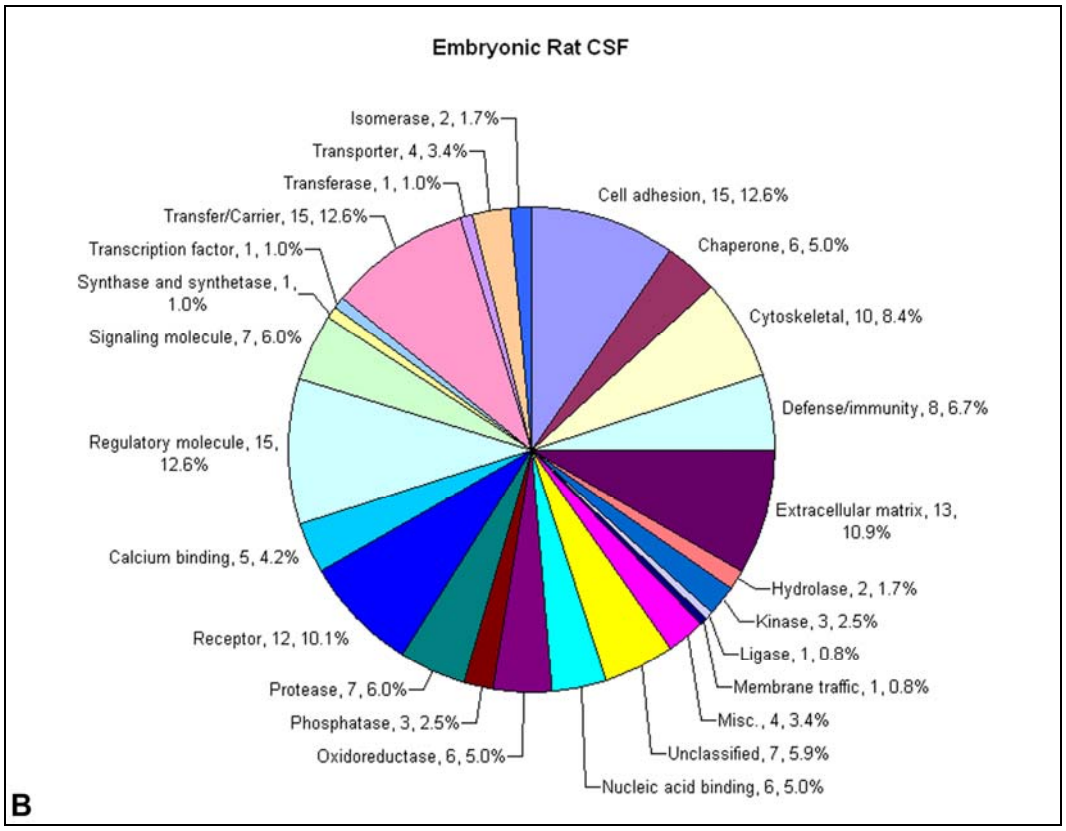


Figure 2.3. Comparison of proteins based on molecular function. Proteins present in embryonic human CSF, embryonic rat CSF, and embryonic mouse brain were analyzed using the Panther gene ontology database and classified according to molecular function. Chart includes protein category name and percentage is calculated from number of proteins assigned to each category over total number of proteins analyzed. We show a comparison between human CSF, rat CSF and mouse brain of the relative percentages from relevant categories based on molecular function.

Figure 2.4. Classification of proteins based on molecular function. Proteins present in embryonic human CSF (A), embryonic rat CSF (B), and embryonic mouse brain (C) were analyzed using the Panther gene ontology database and classified according to molecular function. Chart includes protein category name, number of proteins assigned to each category, and percentage of proteins assigned to each category. Proteins can be assigned to more than one category based on molecular function.





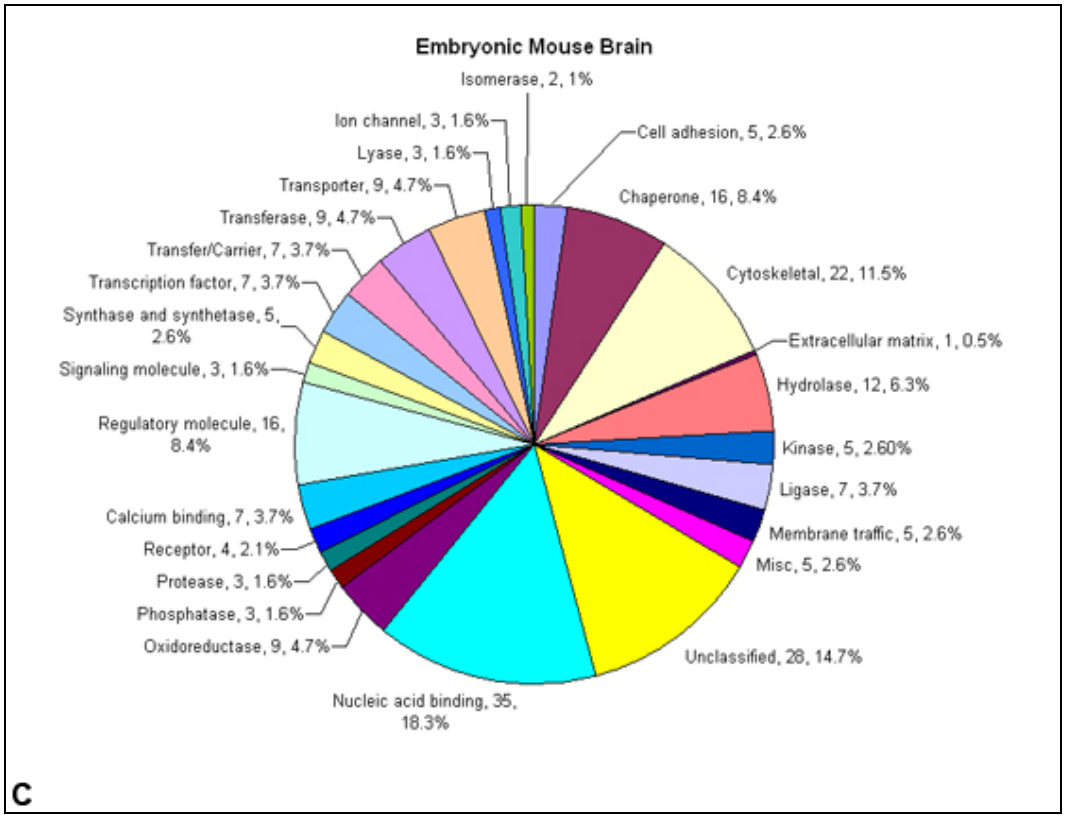


Figure 2.4 continued

Proteins involved in extracellular matrix function make up, respectively, 16% and 11% of the majority of proteins found in the e-CSF of humans and rats. Other abundant categories of proteins found in the e-CSF include regulatory molecules such as protease inhibitors (human-13%, rat-13%), cell adhesion proteins (human-11%, rat-13%), nucleic acid binding proteins (human-10%, rat-5%), transfer/carrier proteins (human-8%, rat-13%), immune defense proteins (human-8%, rat-7%), and receptors (human-8%, rat-10%). The total number of enzymes also is a large component of the CSF. The embryonic human CSF has a total of 28 different functional enzymes (16%) and embryonic rat CSF has a total of 23 different functional enzymes (19%). Furthermore, the e-CSF is composed of a large number of different enzyme classes, and is particularly high in proteases (human-7%, rat-6%), and oxidoreductases (human-3%, rat-5%).

Panther analysis reveals distinct functional groups of proteins present in the CSF as compared to embryonic tissue. Protein categories in the embryonic human and rat CSF are quite similar and to control for random similarity in categorization based on molecular function we compared the CSF protein samples to a sample of 200 most abundant proteins in embryonic E16.5 mouse brain (Table 2.1). The comparison of relevant protein categories in each sample is shown in Figure 2.3. The two largest categories of proteins in the embryonic mouse brain include nucleic acid binding proteins (18.3%) and cytoskeletal proteins (11.5%). Interestingly, proteins involved in defense and immunity which comprised 7-8% of e-CSF were completely absent from the top 200 proteins in the embryonic mouse brain sample. One category of proteins that appears to be similar in all three comparisons is the regulatory molecules (13.3% in human CSF, 12.6% in rat CSF, and 8.4% in mouse brain). We further classified the regulatory

molecules into smaller categories and although the larger classification shows similar percentages of regulatory molecules, the sub-classification clearly distinguishes the e-CSF samples from the embryonic brain sample (Figure 2.5).

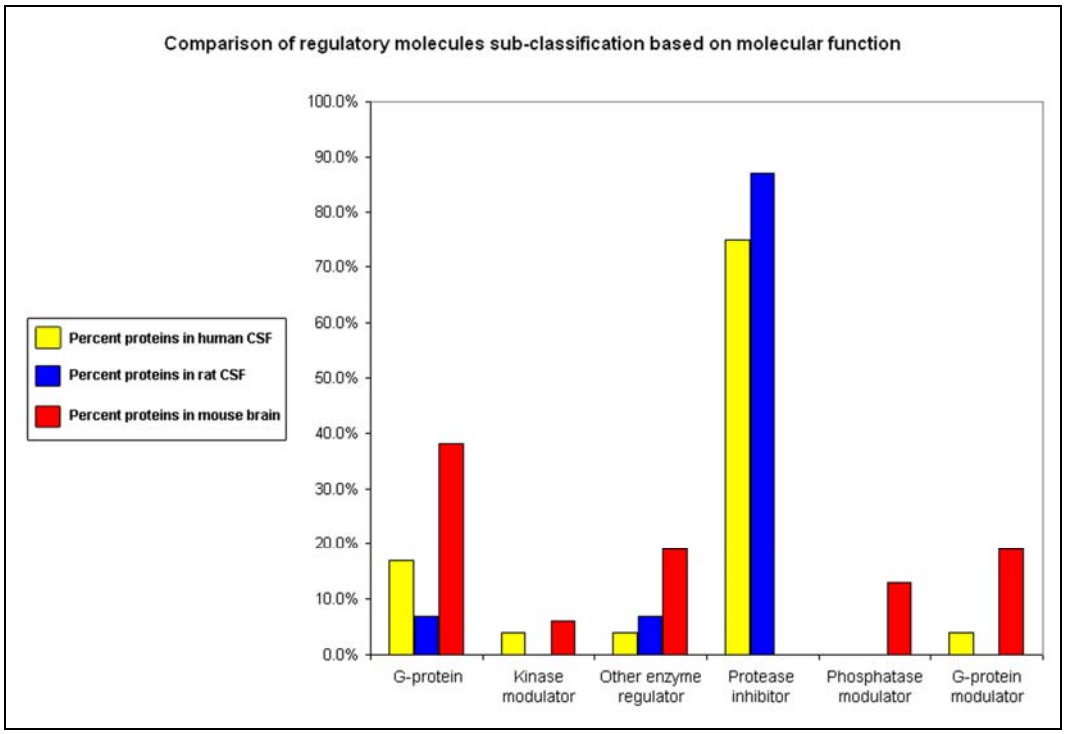


Figure 2.5. Sub-classification of regulatory molecules based on molecular function. Regulatory molecules present in the embryonic human CSF, rat CSF, and embryonic mouse brain were further sub-classified based on molecular function. Although in figure 3 the percentage of regulatory molecules found in CSF and mouse brain appeared similar, further sub-classification clearly shows a distinct similarity in protein classes between CSF samples and a distinct difference in protein classes between CSF and brain samples.

The majority of proteins in the e-CSF within the regulatory molecule class are sub-classified as protease inhibitors comprising 75% and 87% of proteins within the class in human and rat CSF respectively as compared to 0% in the mouse brain (Figure 2.5). Based on molecular function the most abundant classes of protein present in the e-CSF are found to be proteins of the extracellular matrix, regulatory molecules, transfer/carrier proteins, cell adhesion proteins, and proteins involved in immunity and defense.

Panther analysis of proteins based on biological process reveals strong similarity between the embryonic human and rat CSF and differences between the CSF and the embryonic brain (Table 2.2, Figure 2.6, and Figure 2.7). The five most abundant classes in both embryonic human and rat CSF are protein metabolism and modification, signal transduction, immunity and defense, cell adhesion, and developmental processes. The majority of proteins in the analysis of the embryonic mouse brain are involved in protein metabolism and modification, nucleic acid metabolism, intracellular protein traffic, cell cycle, and cell structure and motility. Comparing the analysis of the mouse brain with the e-CSF shows that the CSF samples contain proteins that are enriched for a number of various biological processes that are distinct from that of embryonic brain tissue (Figure 2.6).

Table 2.2. List of protein categories based on biological process for embryonic human CSF, rat CSF and mouse brain.

Human CSF	Percent proteins in each category	Rat CSF	Percent proteins in each category	Mouse brain	Percent proteins in each category
Neuronal activities	0.6%	Neuronal activities	0.8%	Neuronal activities	1.60%
Signal transduction	25.0%	Signal transduction	26.1%	Signal transduction	8.90%
Developmental processes	16.1%	Developmental processes	16.8%	Developmental processes	7.30%
Cell proliferation and differentiation	4.4%	Cell proliferation and differentiation	6.7%	Cell proliferation and differentiation	3.70%
Coenzyme and prosthetic group metabolism	0.6%	Coenzyme and prosthetic group metabolism	1.7%	Coenzyme and prosthetic group metabolism	1.60%
Cell structure and motility	13.9%	Cell structure and motility	16.0%	Cell structure and motility	10.50%
Immunity and defense	22.2%	Immunity and defense	18.5%	Immunity and defense	4.20%
Apoptosis	2.8%	Apoptosis	2.5%	Apoptosis	3.10%
Oncogenesis	2.2%	Oncogenesis	3.4%	Oncogenesis	2.10%
Muscle contraction	0.6%	Muscle contraction	0.8%	Muscle contraction	0.50%
Transport	8.9%	Transport	15.1%	Transport	9.40%
Blood circulation and gas exchange	5.0%	Blood circulation and gas exchange	5.9%	Blood circulation and gas exchange	0.50%
Carbohydrate metabolism	1.1%	Carbohydrate metabolism	1.7%	Carbohydrate metabolism	3.70%
Nucleoside, nucleotide and nucleic acid metabolism	10.6%	Nucleoside, nucleotide and nucleic acid metabolism	5.0%	Nucleoside, nucleotide and nucleic acid metabolism	18.80%
Homeostasis	0.6%	Homeostasis	2.5%	Homeostasis	1.60%
Protein metabolism and modification	27.8%	Protein metabolism and modification	27.7%	Protein metabolism and modification	24.60%
Cell cycle	6.7%	Cell cycle	7.6%	Cell cycle	11.00%
Intracellular protein traffic	9.4%	Intracellular protein traffic	11.8%	Intracellular protein traffic	13.10%
Cell adhesion	20.0%	Cell adhesion	17.6%	Cell adhesion	1.60%
Lipid, fatty acid and steroid metabolism	3.3%	Lipid, fatty acid and steroid metabolism	5.9%	Lipid, fatty acid and steroid metabolism	3.10%
Sensory perception	1.1%	Sensory perception	1.7%	Sensory perception	0.50%
Electron transport	0.6%	Electron transport	0.8%	Electron transport	1.00%
Amino acid metabolism	0.6%	Amino acid metabolism	0.8%	Amino acid metabolism	1.00%
Biological process unclassified	5.0%	Biological process unclassified	5.0%	Biological process unclassified	15.20%
Protein targeting and localization	2.2%	Protein targeting and localization	2.5%	Protein targeting and localization	4.20%
Miscellaneous	1.1%	Miscellaneous	0.8%	Miscellaneous	1.60%
Phosphate metabolism	0.0%	Phosphate metabolism	0.0%	Phosphate metabolism	0.50%
Other metabolism	0.0%	Other metabolism	0.0%	Other metabolism	1.00%

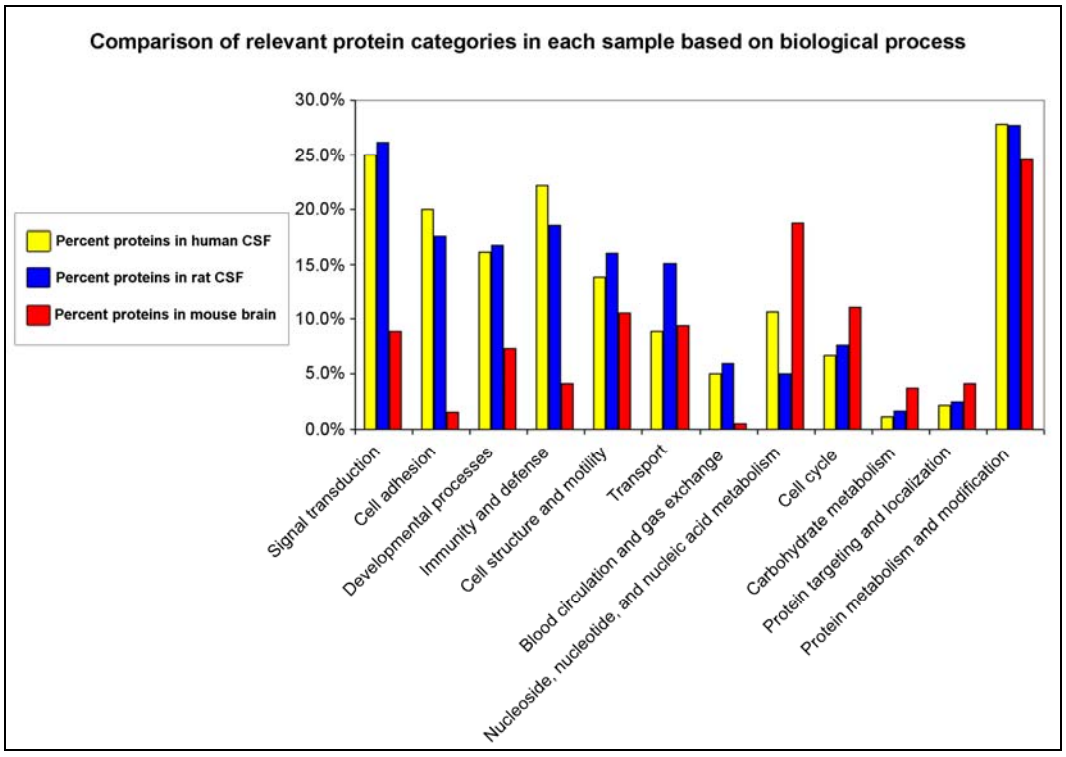
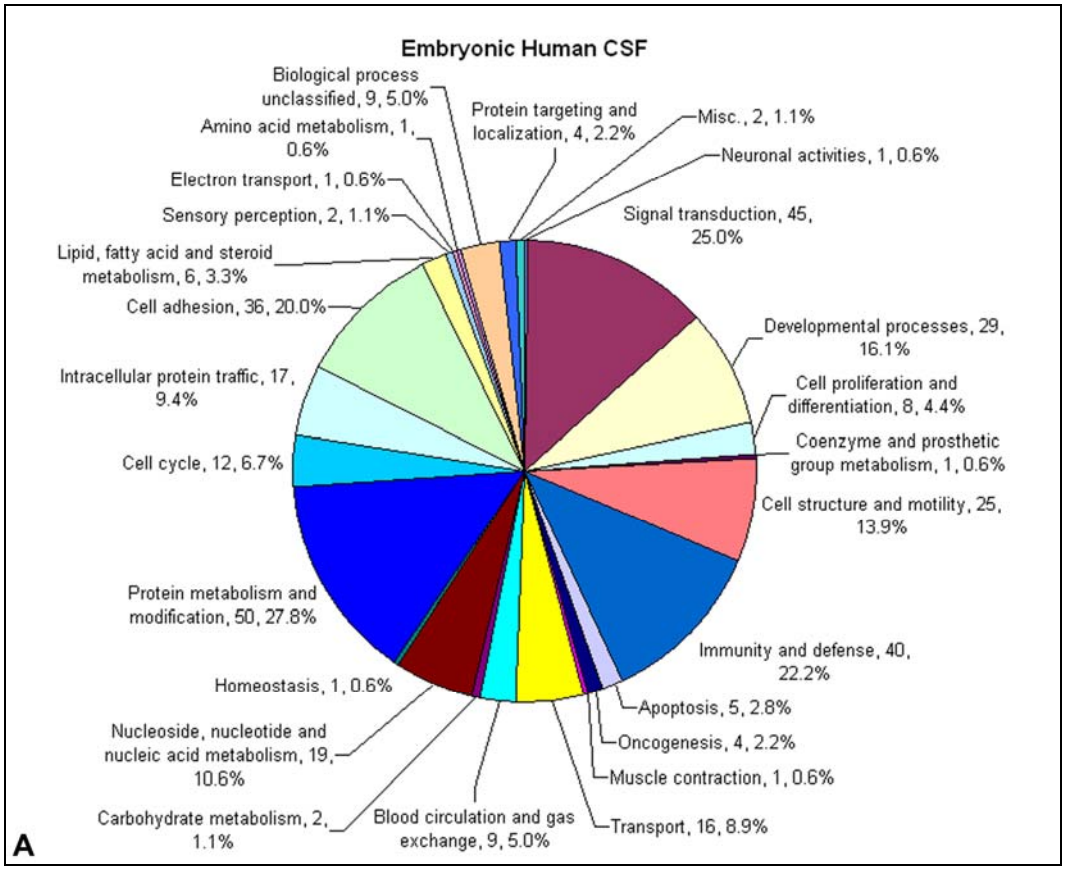
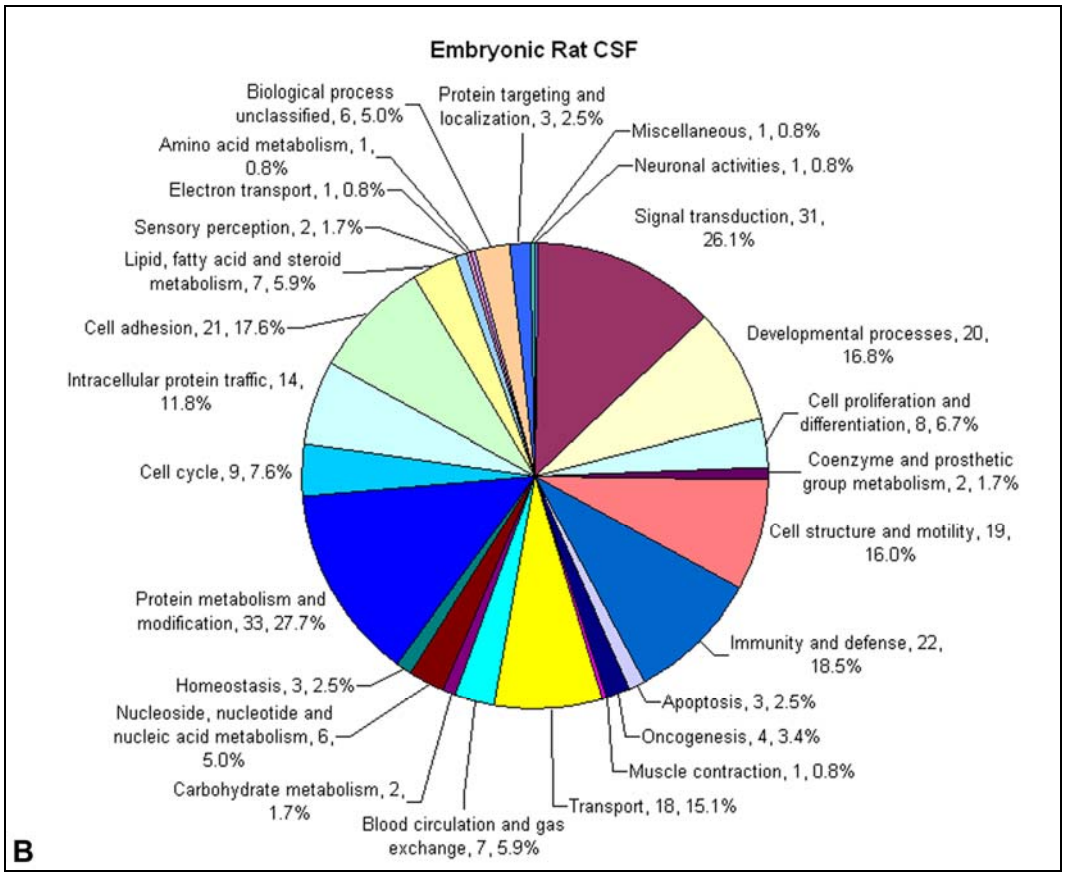


Figure 2.6. Comparison of proteins based on biological process. Proteins present in embryonic human CSF, embryonic rat CSF, and embryonic mouse brain were analyzed using the Panther gene ontology database and classified according to the biological process the proteins are involved with. Chart includes protein category name and percentage is calculated from number of proteins assigned to each category over total number of proteins analyzed. We show a comparison between human CSF, rat CSF and mouse brain of the relative numbers from relevant categories based on biological process.

Figure 2.7. Classification of proteins based on biological process. Proteins present in embryonic human CSF (A), embryonic rat CSF (B), and embryonic mouse brain (C) were analyzed using the Panther gene ontology database and classified according to the biological process the proteins are involved with. Chart includes protein category name, number of proteins assigned to each category, and percentage of proteins assigned to each category. Proteins can be assigned to more than one category based on biological process.





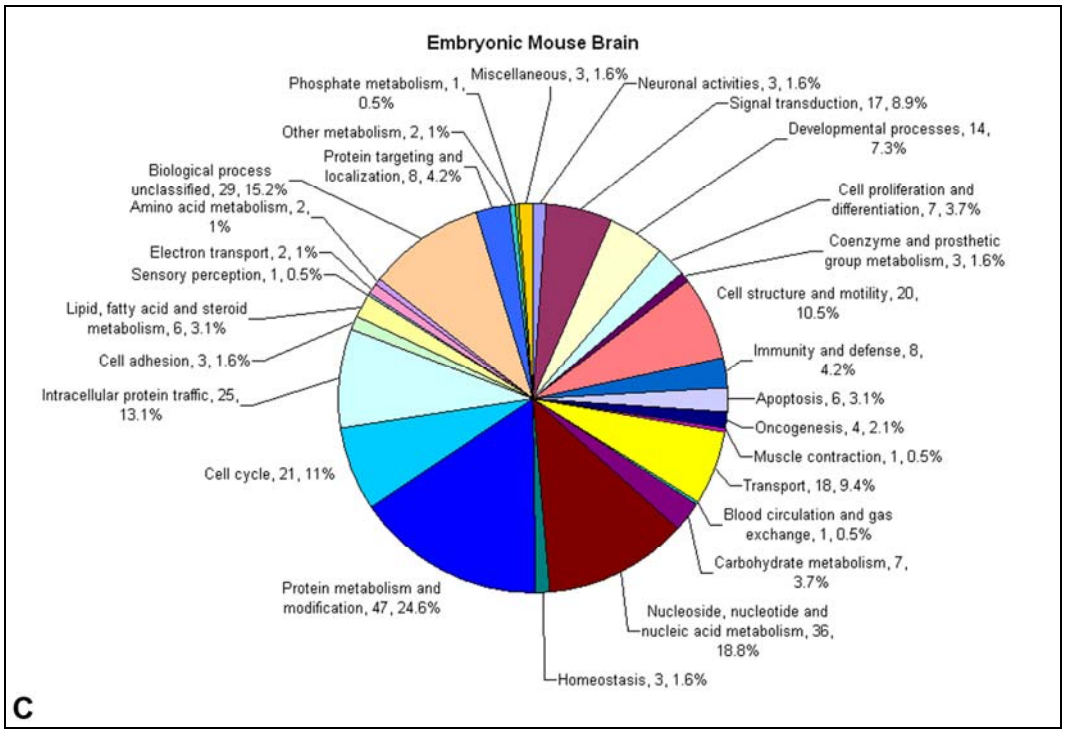


Figure 2.7 continued

Interestingly, all three samples are most abundant in proteins involved in protein metabolism and modification (Figure 2.6). However, Panther analysis shows that CSF and brain show different types of proteins even among the same overall class (Figure 2.8). Sub-classification of this category reveals the majority of proteins in the mouse brain involved in protein biosynthesis (30%) and protein modification (28%) with only 19% of proteins involved in proteolysis (Figure 2.8). However in both the human and rat e-CSF the overwhelming majority of proteins in both samples are involved in proteolysis comprising 58% in humans and 54% in rats (Figure 2.8). This class of biological processes includes the large number of protease inhibitors and proteases found within the CSF.

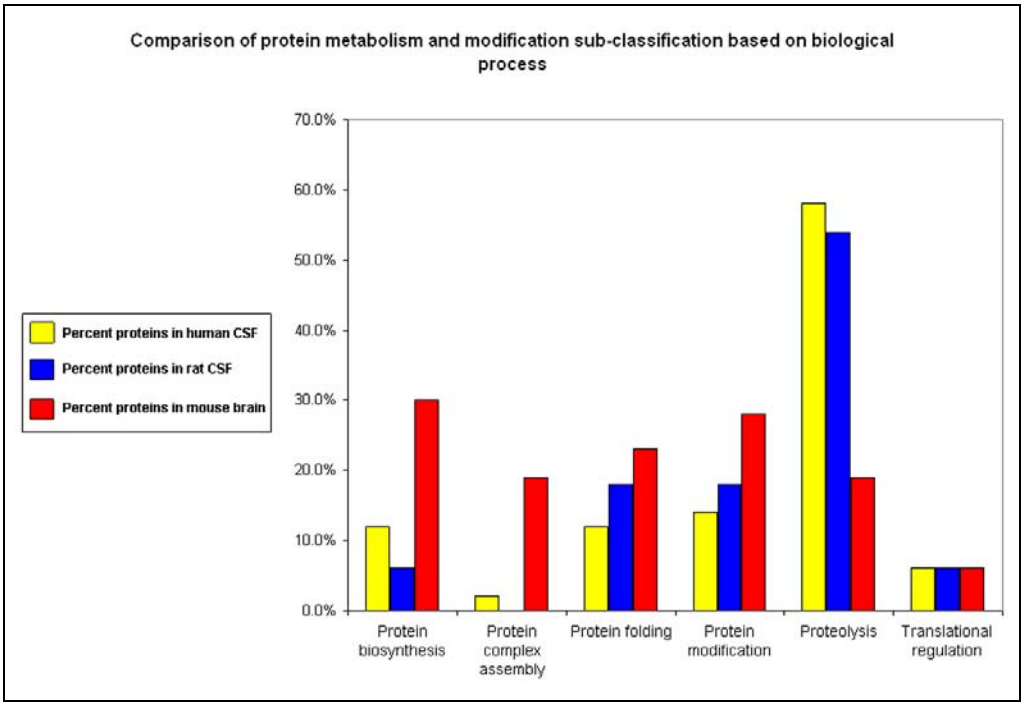


Figure 2.8. Sub-classification of protein metabolism and modification based on biological process. Proteins involved in protein metabolism and modification present in the embryonic human CSF, rat CSF, and embryonic mouse brain were further sub-classified based on biological process. Although in figure 4 the percentage of proteins involved in protein metabolism and modification found in CSF and mouse brain appeared similar, further sub-classification clearly shows a distinct similarity in protein classes between CSF samples and a distinct difference in protein classes between CSF and brain samples.

The similarities between the embryonic human and rat CSF are quite apparent when the proteins are classified into groups and analyzed on the basis of subcellular localization, molecular function and biological process. Based on the analysis of the functional characteristics of the proteins found in the e-CSF, it is clear that the CSF is a very heterogeneous mixture of many types of classes of proteins with varying functions. It is also becoming apparent that the e-CSF is much more complex than previously thought. This may be due to active secretion from the choroid plexus into the CSF, or from the contents within the extracellular membrane bound particles that are present in the rodent CSF during development, or potentially to aposomes budding from the choroid plexus and floating within the CSF that have been shown previously to support protein translation[4, 33, 34]. Whether or not these particles or aposomes have any function during development still needs to be determined.

Although we did not find the growth factor FGF-2 as reported by Martin et al [8], many growth factors are in low abundance and are of smaller molecular weight making them more challenging to identify by multiple peptide assignments using mass spectrometry on a complex mixture. Therefore a further proteomic exploration of the CSF may involve approaches to remove some of the very abundant proteins prior to analysis. In addition targeted western blots may be used for the determination of the presence of specific growth factors in the CSF. Nevertheless, we did identify a number of protein factors with signaling capacity such as PEDF, APP, apolipoproteins, tenascin and soluble IGF2R as discussed above.

Conclusion

An in-depth analysis of the composition of the CSF bathing the developing neuroepithelium of the vertebrate central nervous system is important to an understanding of the optimal fluid environment promoting and maintaining embryonic neurogenesis. Here we present an extensive proteomic analysis of e-CSF, and present the first large-scale analysis of human e-CSF. We have found that e-CSF is a complex fluid harboring a large number of functionally diverse proteins. Through side-by-side comparisons, we have found great similarity in the composition and biological function of proteins present in the e-CSF of humans and rats. We anticipate this wealth of molecular information will set the groundwork for more targeted analyses into how these proteins might function individually and in concert to stimulate neuronal proliferation and differentiation to effectuate proper brain development.

Acknowledgements

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Chapter 3

The cerebrospinal fluid (CSF) proteome provides a niche for neural progenitor cells

The cerebrospinal fluid (CSF) proteome provides a niche for neural progenitor cells

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Contributions: M.D.Z. and M.K.L. primarily contributed to the project. M.D.Z, M.K.L., A.S.L., and C.A.W. designed all experiments; M.D.Z. and M.K.L. performed all cortical explant experiments and western blotting; M.D.Z. performed IHC, CSF collection, and neurosphere assays. M.K.L. performed primary cortical cell culture experiments. Co-authors collaborated in the following manner: X.C. performed neurosphere assays; J.Y. assisted with IHC, western blotting, and cortical explants.

SUMMARY

All embryonic epithelia develop in relation to extracellular fluids, but the role of these fluids in epithelial development is largely unexplored. Here we show that embryonic cerebrospinal fluid (CSF), which contacts all neuroepithelial progenitor cells at their apical membrane, stimulates proliferation and maintenance of neural progenitor cells in an age-dependent fashion. CSF taken from the rat lateral ventricle during neurogenesis dramatically stimulates progenitor proliferation, whereas CSF from earlier ages (E13, 14) or later ages shows more modest effects. Mass spectrometry and Western analysis identify many age-dependent changes in the CSF proteome, including a transient increase in IGF2 during peak neurogenesis. Indeed, embryonic CSF activates the IGF1 receptor and the AKT and the mitogen-activated protein kinase (MAPK) downstream signaling pathways. Further, neutralizing IGF2 in the CSF diminishes the CSF's stimulatory role in cortical progenitor cell proliferation, while supplementing basal media with IGF2 is sufficient to enhance proliferation in cortical explants and neural stem cells. Together, our findings show that the CSF proteome is a dynamic, active niche for neural stem cell and progenitor cell proliferation, survival, and maintenance and may represent an important therapeutic target.

Cerebral cortical neurons differentiate from neuroepithelial progenitor cells along the ventricular surface, immediately adjacent to the CSF filled ventricular space. Some neuroepithelial progenitor cells divide symmetrically to give rise to two neuroepithelial daughter cells to expand the pool of cortical progenitor cells which maintain contact with the CSF[1, 2]. Other progenitor cells divide asymmetrically to generate a single neuroepithelial daughter cell that retains contact with the ventricle, as well a basal progenitor cell or a differentiated neuron that withdraws from the ventricular zone and loses contact with the CSF[3-6]. Hence, while the intimate relationship of the CSF to neuroepithelial cells suggests potential roles, age dependent functions of the CSF in the developing neuroepithelium remain largely unexplored.

Understanding the influence of CSF on cortical progenitors has relied on developing methods for obtaining substantial amounts of embryonic CSF and culturing techniques that enable the apical surface of the progenitors to be exposed to the CSF. We developed a cortical explant culture system in which embryonic cortex, dissected from a consistent location of the lateral telencephalic wall, is placed on polycarbonate membranes and floated on embryonic CSF (Figure 3.1a). This explant culturing technique allows for a "mix and match" approach for exposing cortical tissue to CSF collected at different ages.

Figure 3.1. Embryonic CSF supports cortical explant viability and stimulates proliferation of neural progenitor cells. (a) Schematic diagram of cortical explant dissections; 3-D image of E16 rat brain with dark box depicting region of dissection for explant. Cross section image of rat brain depicts medial and lateral border of explant dissection. Crossed arrows designate orientation of explant (E) on membrane with orienting cut at medial-caudal side (L-lateral, M-medial, C-caudal, R-rostral). **(b)** E17 rat cortex; E16 explants grown for 24 hours in 100% embryonic CSF (eCSF) and 100% artificial CSF (ACSF), respectively. Upper panels stained with anti-PH3 (red), and anti-Tuj1 (green), Hoechst (blue). Lower panels stained with anti-BrdU (red), and anti-Tuj1 (green). For BrdU labeling of E17 rat cortex, pregnant dam was administered a bolus of BrdU (60mg/kg) 3 hours prior to embryo removal. For BrdU labeling of explants, explants were administered BrdU (20uM) 30 minutes prior to fixation. Explants grown in 100% embryonic CSF in vitro maintain tissue histology similar to embryo in vivo. Explants grown in 100% embryonic CSF incorporated BrdU after 24 hours in vitro indicating cells undergoing DNA synthesis. Survival and proliferation of the explants grown with embryonic CSF are indicated by immunoreactivity for PH3 along the ventricular surface, BrdU incorporation (marking proliferating cells at the time of BrdU exposure) in the ventricular zone, and Tuj1-positive-staining neurons in the developing cortical plate. **(c)** E16 explants cultured in 100% E13, E17, or P6 CSF for 24 hours, were stained with anti-PH3 (red), anti-Vimentin 4A4 (green) and Hoechst (blue). **(d)** Quantification of total PH3-positive-staining cells per explant grown with E13, E17, or P6 CSF shown in (c). The number of PH3-positive-staining cells was significantly increased in explants cultured with E17 CSF compared to E13 or P6 CSF (E17 mean: 44.1 ± 1.43; E13 mean: 25 ± 4.2; P6 mean: 9.6 ± 0.9; n = 4; *t*-test; E17 vs. E13, $p<0.005$, E17 vs. P6, $p<0.0001$; E13 vs. P6, $p<0.05$), **(e)** Quantification of PH3-positive cells along the ventricle per explant grown with E13, E17, or P6 CSF shown in (c). The number of PH3-positive cells along the ventricle was significantly increased in explants cultured with E17 CSF compared to E13 or P6 CSF (E17 mean: 32.3 ± 0.79; E13 mean: 12.8 ± 3.9; P6 mean: 6.9 ± 0.73; n = 4; *t*-test; E17 vs. E13, $p<0.005$, E17 vs. P6, $p<0.0001$; E13 vs. P6, N.S.), **(f)** Quantification of Vimentin 4A4-positive cells per explant grown with E13, E17 or P6 CSF. The number of Vimentin 4A4-positive cells was significantly increased in explants cultured with E17 CSF compared to E13 or P6 CSF (E17 mean: 37.1 ± 1.4; E13 mean: 14.9 ± 1.9; P6 mean: 6.1 ± 1.05; n = 4; *t*-test; E17 vs. E13, $p<0.0001$, E17 vs. P6, $p<0.0001$; E13 vs. P6, $p<0.01$); **(g)** Single cells from dissociated primary neurospheres grown in: 20% E13/E14 CSF, 20% E17 CSF, or 20% P6 CSF for 10 DIV and stained with anti-GLAST and Hoechst. Primary dissociated spheres grown in E17 CSF proliferate and form spheres of slowly dividing GLAST positive cells. **(h)** Quantification of average number of spheres per cm^2 formed in the various conditions at 10 DIV shown in (g). Primary dissociated neurosphere cells generated a greater number of spheres when cultured in E17 CSF compared with cells grown in E13/E14 CSF or P6 CSF. (E17 mean: 274 ± 8; E13 mean: 77 ± 7; P6 mean: 110 ± 17.5; n = 3; *t*-test; E17 vs. E13, $p<0.0001$, E17 vs. P6, $p<0.005$; E13 vs. P6, N.S). The number of immuno-positive cells is represented as mean ± SEM.

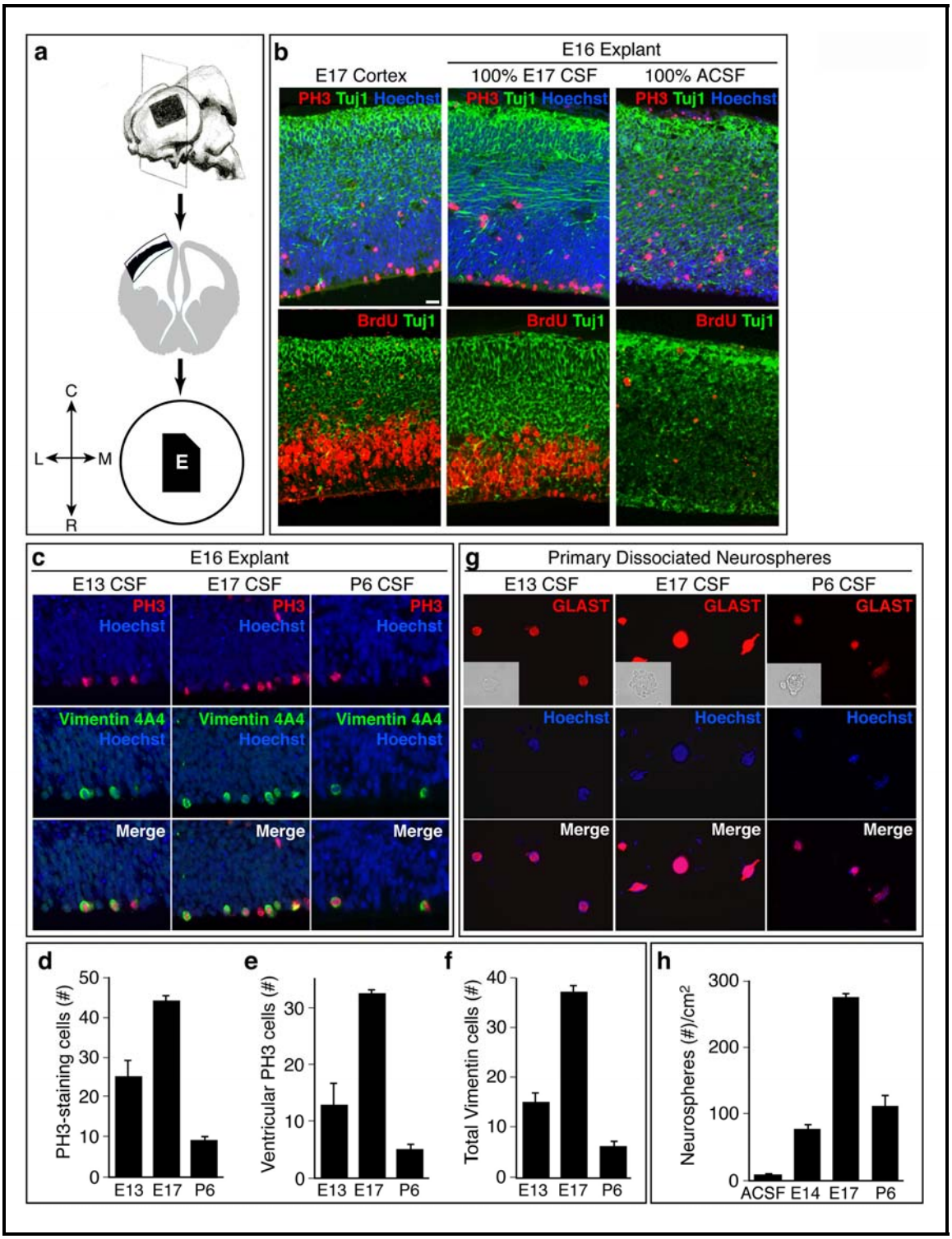

Figure 3.1 continued

We first determined whether cortical explants could survive and proliferate in the presence of embryonic CSF. We found that embryonic day 16 (E16) rat cortical explants cultured with 100% E17 CSF for 24 hours, without additional exogenous media or factors, retained remarkable tissue architecture, cell proliferation, and cell viability, approximating in vivo E17 rat cortex (Figure 3.1b). In contrast, culturing E16 explants with 100% artificial CSF (ACSF) failed to maintain the integrity of the embryonic cortical tissue reflected by decreased proliferation and mitotic activity, disorganized neuronal morphology, and a striking increase in cell death (Figure 3.1b and Figure 3.2). Thus, the embryonic CSF proteome appears to provide essential growth and survival factors for the developing cortex.

In order to determine whether the functional effect of the CSF varied with age we compared the effects of CSF from E13/E14 embryos, very early in cortical neurogenesis and the earliest age at which sufficient amounts of CSF could be obtained, with that from E17 embryos, near the middle of neurogenesis, and CSF from postnatal day 6 (P6) rats. E17 CSF increased the frequency of phospho-Histone H3 (PH3, a marker of cell division) labeled proliferating cells in E16 cortical explants compared to explants cultured with E13 CSF or P6 CSF (E17 mean: 44.1 ± 1.43; E13 mean: 25 ± 4.2; P6 mean: 9.6 ± 0.9; n = 4; E17 vs. E13, $p<0.005$, E17 vs. P6, $p<0.0001$; E13 vs. P6, $p<0.05$) (Figure 3.1c, d) with a greater than 2.5-fold increase in PH3-positive-staining cells along the ventricular zone (VZ) (E17 mean: 32.3 ± 0.79; E13 mean: 12.8 ± 3.9; P6 mean: 6.9 ± 0.73; n = 4, E17 vs. E13, $p<0.005$, E17 vs. P6, $p<0.0001$; E13 vs. P6, N.S.) (Figure 3.1e). To determine the identity of mitotic cells, explants were stained with a monoclonal antibody

raised against phosphorylated Vimentin (4A4), a marker of proliferating neural progenitor cells[7, 8]. E16 explants cultured in E17 CSF showed the greatest number of Vimentin 4A4 positive cells per explant compared to explants grown in E13 CSF or P6 CSF (E17 mean: 37.1 ± 1.4; E13 mean: 14.9 ± 1.9; P6 mean: 6.1 ± 1.05; n = 4, E17 vs. E13, $p<0.0001$, E17 vs. P6, $p<0.0001$; E13 vs. P6, N.S.) (Figure 3.1c, f). In contrast, no differences were seen in proliferation of basal progenitors marked with Tbr2, which do not normally contact the CSF directly (data not shown). Taken together, these data suggest that age-dependent differences in CSF signals are both supportive and instructive for precursor proliferation in the developing cortex.

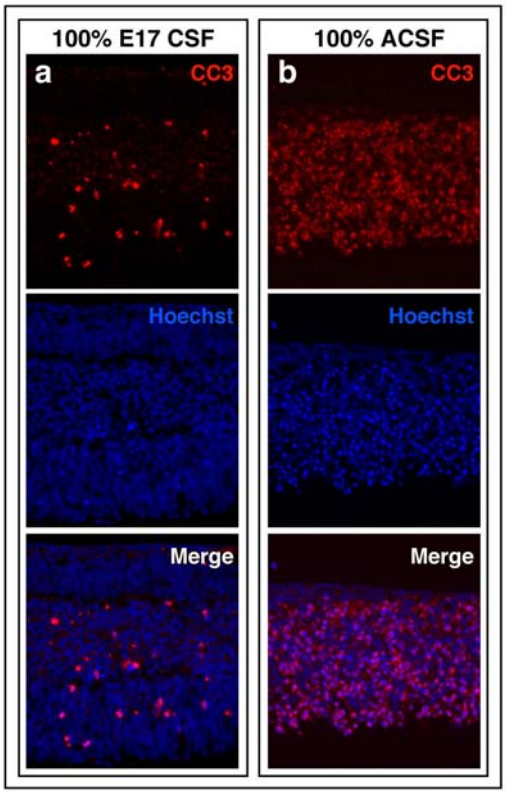

Figure 3.2. Embryonic CSF supports cortical explant survival. (a) E16 explants grown for 24 hours in 100% E17 CSF, and **(b)** 100% artificial CSF (ACSF) and stained with the apoptotic cell death marker Cleaved Caspase 3 (CC3). Explants grown in 100% embryonic CSF has decreased CC3 stain compared to explants grown in ACSF. The embryonic CSF supports tissue viability and survival.

We next tested if CSF is sufficient to maintain and stimulate proliferation of primary dissociated cortical progenitors cultured as "neurospheres", an in vitro experimental model for neural stem cells. Primary neurospheres derived from E14 rat embryos were dissociated, plated at clonal density, and cultured with CSF collected from E13/E14, E17, or P6. E13/E14, E17, and P6 CSF supported the generation of small neurospheres, composed primarily of GLAST positive cells, for up to 10 days in vitro (DIV), in the complete absence of supplemental FGF and EGF that are normally essential to maintain them (Figure 3.lg). Neurospheres failed to form in the presence of ACSF (data not shown). Consistent with our explant experiments, cells cultured in E17 CSF generated not only increased numbers of neurospheres (E17 mean: 274 ± 8; E13 mean: 77 ± 7; P6 mean: 110 ± 17.5; n = 3; E17 vs. E13, $p<0.0001$, E17 vs. P6, $p<0.005$; E13 vs. P6, N.S.) (Figure 3.1h), but also larger spheres (data not shown), indicating that E17 CSF contains instructive proliferative signals. Neurospheres grown in CSF retained responsiveness to FGF and EGF, indicating that the CSF maintains the stem cells in an uncommitted fate (Figure 3.3). CSF could maintain GLAST positive neural progenitor cells in culture for extended periods of time, at least up to 44 DIV (Figure 3.4), at which time both E13 and E17 CSF continued to maintain viable GLAST positive neurospheres, though E17 CSF promoted the survival of a greater number of neurospheres compared to E13 CSF. Together, these data demonstrate that CSF is sufficient to maintain and stimulate proliferation of cortical progenitor cells.

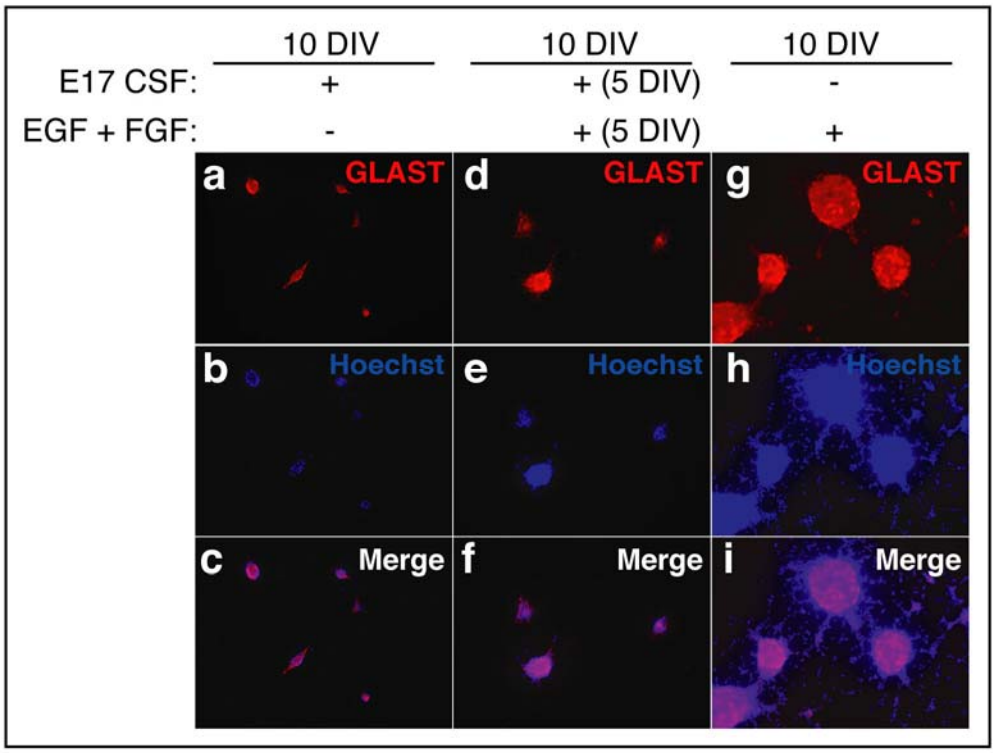

Figure 3.3. Neural stem cells grown in embryonic CSF maintain an undifferentiated state. (a - c) Dissociated cells from primary neurospheres cultured in E17 CSF for 10 DIV maintain GLAST immunoreactivity, suggesting the cells remain as neural progenitors when cultured in embryonic CSF. **(d - f)** Dissociated cells from primary neurospheres cultured in E17 CSF for 5 DIV and then supplemented with EGF and FGF. GLAST-positive-staining cells cultured in E17 CSF maintain responsiveness to EGF and FGF suggesting that stem cells cultured in CSF maintain undifferentiated and uncommitted state. **(g – h)** Dissociated cells from primary neurospheres cultured in EGF and FGF for 10 DIV.

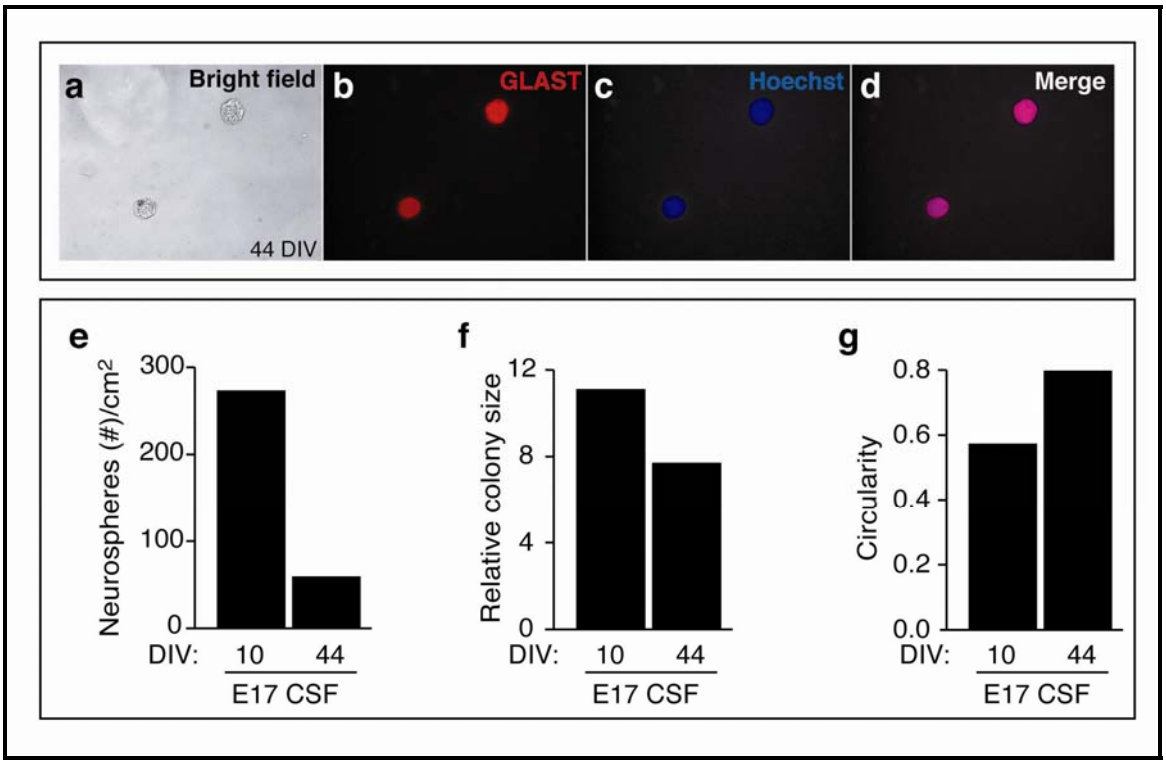

Figure 3.4. Embryonic CSF maintains GLAST-positive progenitor cells long term. **(a – d)** Dissociated cells from primary neurospheres cultured in E17 CSF for 44 DIV maintain GLAST-positive neural progenitors when cultured in embryonic CSF. **(e)** Quantification of number of spheres per cm^2 when cultured for 10 DIV versus 44 DIV. **(f)** Quantification of relative colony size of spheres cultured for 10 DIV versus 44 DIV. **(g)** Quantification of circularity of spheres cultured for 10 DIV versus 44 DIV.

In order to identify CSF specific factors essential for supporting proliferation of cortical progenitor cells, we extended our previous analysis of the CSF proteome[9]. Filtration analysis suggested that the CSF factors that maintain neurospheres range from 10kDa – 100kDa, suggesting they are proteins (data not shown). Total CSF protein concentration increased from E12 on, peaked at birth (P0) and declined dramatically into adulthood (Figure 3.5a). The overall protein composition of CSF visualized by silver staining shows a graded transition of constituents from E13 to adulthood (Figure 3.5b).

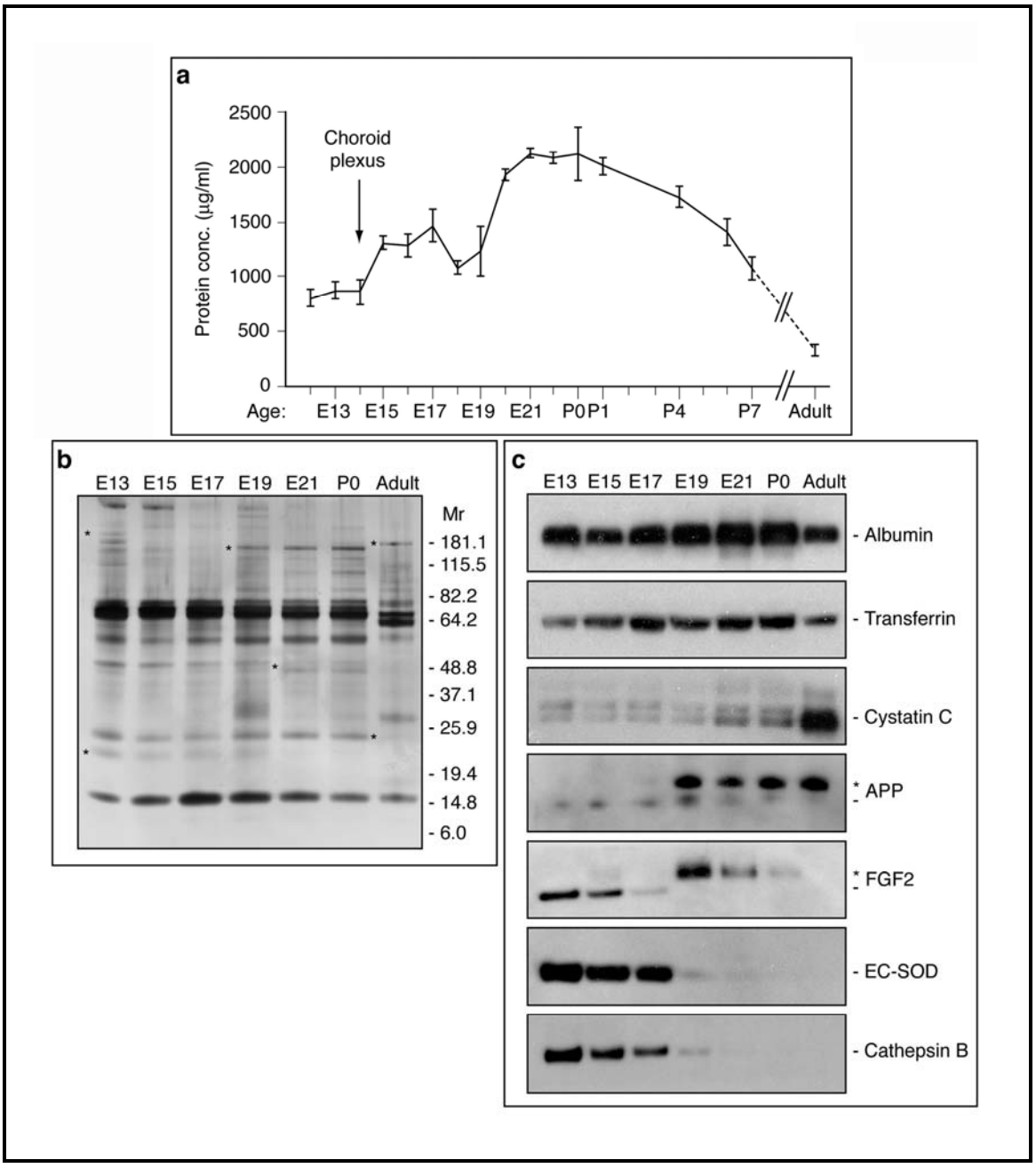

Figure 3.5. Dynamic changes in CSF protein concentration and composition during development. (a) Graph of total CSF protein concentration collected from rats at various stages in development, **(b)** Silver stain of CSF from different ages in development reveals a dynamic fluid with numerous changes in protein composition over time. Asterisks indicate proteins which have a dynamic expression in the CSF during development. **(c)** Western blot analysis of specific proteins identified in the embryonic CSF. CSF was collected from various ages during development and immunoblotted with antibodies to Albumin, Transferrin, FGF2, EC-SOD, Cathepsin B, Cystatin C, and Amyloid Precursor Protein (sAPP). Asterisks indicate higher molecular weight isoforms.

Immunoblot analysis of proteins identified by tandem mass spectrometry (LC-MS/MS)[9] revealed dynamic changes in many classes of proteins in CSF during development (Figure 3.5c and data not shown). For example, several proteins known to regulate proliferation of neural progenitors[10-14], including Transferrin, Cystatin C, FGF2, and soluble isoforms of the Amyloid Precursor Protein (sAPP), were expressed throughout development, and in some cases, continued to be expressed in the adult CSF (Figure 3.5c). Other proteins involved in tissue homeostasis such as the antioxidant and free radical scavenger, Extracellular Super Oxide Dismutase (EC-SOD, Sod3), and the protease Cathepsin B, were robustly expressed early in development but rapidly downregulated thereafter (Figure 3.5c).

In our E17 CSF proteome analysis we identified, among other peptides, several peptides corresponding to Insulin-like growth factor 2 (IGF2) (Figure 3.6a and Appendix 1 Table 1.8). IGF2 is a particularly compelling CSF resident protein given the crucial role of IGF signaling in prenatal growth and brain size, as well as in regulating neural progenitor cell division[15-17]. IGF2 is also essential in the embryonic stem (ES) cell niche[18]. Interestingly, we found that IGF2 is highly expressed in the CSF during development, first detected at E13 and maximally expressed during cortical neurogenesis (E15-E19), after which its expression declined postnatally (Figure 3.6b). The dynamic availability of IGF2 in the embryonic CSF raised the possibility that IGF signaling may contribute to the differential capacity of embryonic CSF between E13 and E17 to support cortical neural progenitor proliferation[18].

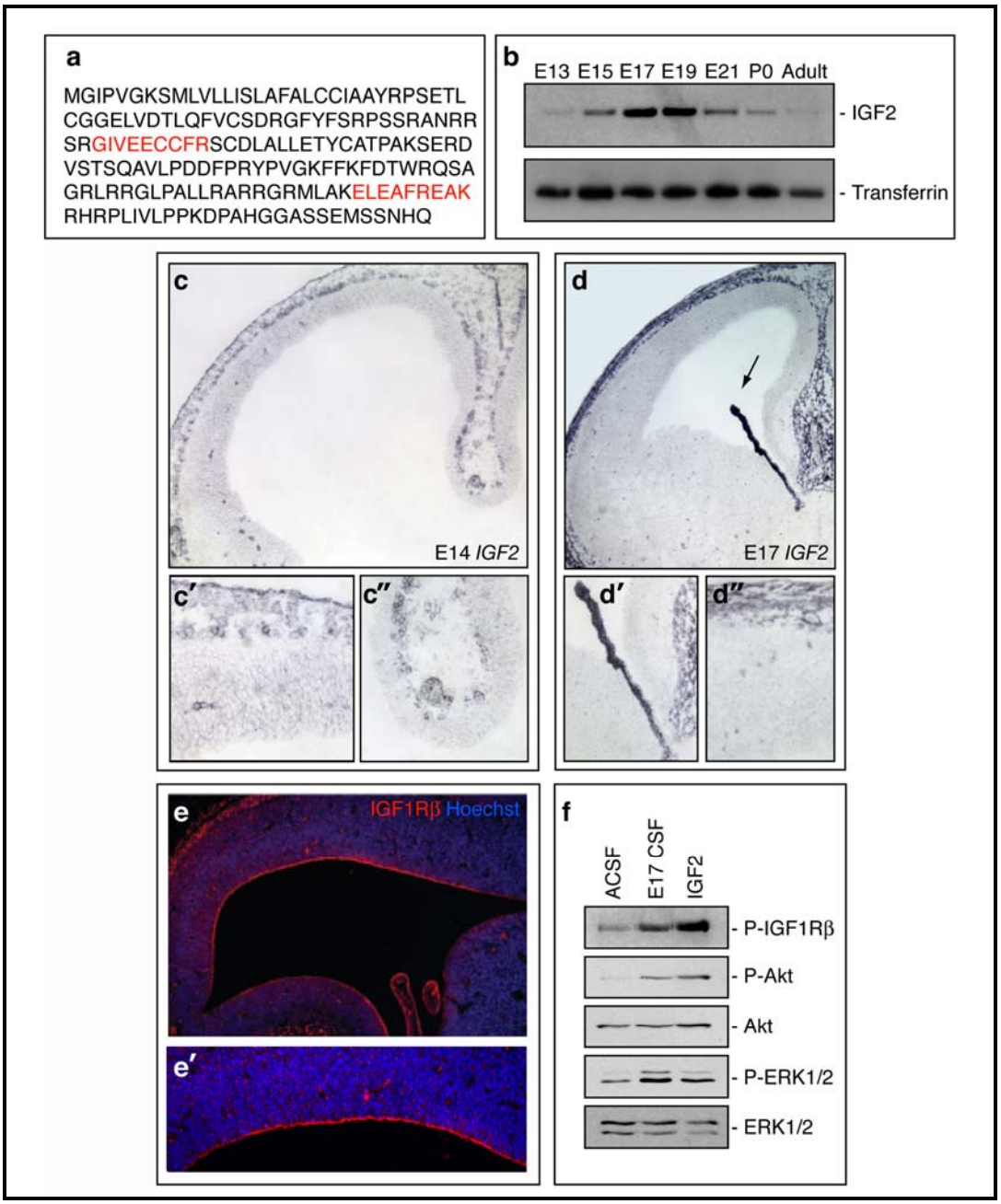

Figure 3.6. Embryonic CSF activates IGF signaling and provides a source of insulin signaling to progenitor cells. (a) IGF2 peptides recognized by LC-MS/MS in E17 CSF (red), **(b)** IGF2 levels are detectable by western blot at E13, gradually increasing until E19, and then decrease into adulthood, **(c)** In situ hybridization for *IGF2* at E14, **(c', c'')** magnified images show *IGF2* levels highest in leptomeninges and blood vessels within the cortex, **(d)** In situ hybridization for *IGF2* at E17, **(d', d'')** magnified images show *IGF2* levels are highest in the choroid plexus, leptomeninges and blood vessels within the cortex. Arrow points to choroid plexus. **(e)** 10X and **(e')** 20X image of IHC analysis of the E17 rat brain reveals IGF1R localization along the apical surface of the ventricle, **(f)** Lysates of cortical cells treated with ACSF, E17 CSF, or IGF2 for 5 minutes were immunoblotted with antibodies to p-IGF1R, p-AKT, AKT, P-ERK1/2, and ERK1/2.

To test if CSF could serve as a vehicle for IGF signaling, we assessed the expression of *IGF1* and *IGF2* mRNA in the developing cortex. We did not observe detectable levels of *IGF1* (data not shown) or *IGF2* mRNA in developing neural progenitor cells or the cortical mantle, confirming previous reports[19]. In contrast *IGF2* mRNA was highly expressed in the choroid plexus of E17 rat embryos, as well as in vascular endothelial cells and the leptomeninges of both E14 and E17 rat brain (Figure 3.6c, d). While vascular sources of signaling molecules are important for neural progenitor cell fate[20, 21], our IGF2 expression data suggest that the choroid plexus is the primary source of IGF2 in the CSF since the CSF is formed by secretion from the choroid plexus.

To determine if CSF-borne IGF2 can stimulate IGF signaling in the developing cortex, we first examined the localization of the IGF1 receptor (IGF1R) in the developing cortex. IGF1R, which binds IGF2 and is essential for the proliferative response to IGF signaling[22], localized to the apical, ventricular surface of radial neuroepithelial cells that contacts the CSF (Figure 3.6e). Further, embryonic CSF activated IGF signaling in primary cortical precursor cells and neurons via the IGF1 receptor, as reflected by induction of phosphorylated IGF1Rβ (p-IGF1Rβ) (Figure 3.6f). Embryonic CSF also stimulated the activation of the AKT and MAPK signaling pathways (Figure 3.6f), both downstream targets of IGF signaling as well as other growth-factor-stimulated signaling cascades. IGF2 treatment alone induced IGF signaling similar to embryonic CSF (Figure 3.6f). Taken together, our results demonstrate that cortical progenitor cells express cell surface receptors required for engaging CSF-borne cues such as IGF2, and reciprocally,

that CSF-borne factors are capable of inducing the activation of IGF signaling in cortical progenitor cells[16, 23, 24].

We next tested whether IGF2 could maintain GLAST-positive cortical progenitor cells in vitro by culturing primary neurosphere dissociated cells with IGF2 (Figure 3.7a). Interestingly, cells cultured in IGF2 formed small GLAST-positive-staining neurospheres (Figure 3.7a, b, c, d) indicating that IGF2 alone provides a modest proliferative signal and that cells retain their neural progenitor cell fate in the presence of IGF2 (IGF2 mean: 39.3 ± 4.1; control mean: 2.2 ± 0.75; n = 3; *t*-test; $p<0.005$). Also, the IGF-1R inhibitor, PPP, blocked the formation of spheres in the presence of E17 CSF (data not shown). We then determined whether IGF2 is both necessary and sufficient to induce maintenance and proliferation of neural progenitor cells along the ventricular zone in cortical explants. E16 cortical explants grown in E17 CSF control conditions showed numerous Vimentin 4A4-labeled, proliferating cells along the ventricle (Figure 3.7e). In contrast, E16 explants cultured in E17 CSF and in the presence of an IGF2 neutralizing antibody (IGF2 NAb) revealed a striking decrease of Vimentin 4A4-labeled-cells along the ventricle (Fig. 4e, f, g) (E17 control mean: 28.8 ± 4.3; E17 IGF2 NAb mean: 13.9 ± 2.0; n = 4, $p<0.05$). In addition, IGF2 (2ng/ml) addition to Neural Basal Media (NBM) plus 20% ACSF stimulated the proliferation of Vimentin 4A4 positive progenitor cells in E16 explants (IGF2 supplementation mean: 36.7 ± 2.1; control mean: 20.4 ± 4.46; n = 8, $p<0.005$) (Figure 3.7h, i, j) and in E13 explants (data not shown). While our data do not rule out roles for other components of the CSF proteome[11], these results show that CSF-borne IGF2 plays an essential regulating role in the proliferation of neural progenitor cells and in maintaining neural progenitor cell fate throughout development.

Figure 3.7. IGF2 maintains and stimulates proliferation of neural progenitor cells. **(a - d)** Single cells dissociated from primary neurospheres grown in control media or control media plus IGF2 (20ng/ml). Small secondary spheres cultured with IGF2 alone form after 10 DIV. ICC with anti-GLAST on secondary spheres shows GLAST immunoreactivity, indicating maintenance of neural progenitor cell identity with IGF2 alone. Quantification of number of spheres per cm^2 formed in the various conditions at 10 DIV. (IGF2 mean: 39.3 ± 4.1; control mean: 2.2 ± 0.75; n = 3; *t*-test; $p<0.005$) **(e, f)** E16 cortical explants cultured in control E17 CSF or E17 CSF with IGF2 neutralizing antibody (IGF2 NAb), stained with anti-Vimentin 4A4 (green) and Hoechst (blue). **(g)** Quantification of Vimentin 4A4-positive cells per explant grown with E17 control CSF or with IGF2 Nab shown in (e, f). The number of Vimentin 4A4-positive cells was decreased in explants cultured with E17 CSF plus IGF2 NAb compared to control E17 CSF (E17 control mean: 28.8 ± 4.3; E17 IGF2 NAb mean: 13.9 ± 2.0; n = 4; *t*-test; $p<0.05$). **(h, i)**. E16 cortical explants cultured with Neural Basal Media plus ACSF (control) or with supplemental IGF2 stained with anti-Vimentin 4A4 (green) and Hoechst (blue). **(j)** Quantification of Vimentin 4A4-positive cells per explant grown with control media or with supplemental IGF2 shown in (h, i). The number of Vimentin 4A4-positive cells was increased in explants cultured with IGF2 supplementation compared with control (IGF2 supplementation mean: 36.7 ± 2.1; control mean: 20.4 ± 4.46; n = 8; *t*-test; $p<0.005$). **(k)** Model depicting factors released from the choroid plexus into the CSF act over large distances to regulate progenitor cell survival, proliferation, and maintenance. We illustrate IGF2 as one secreted factor that regulates the maintenance of progenitor cell fate.

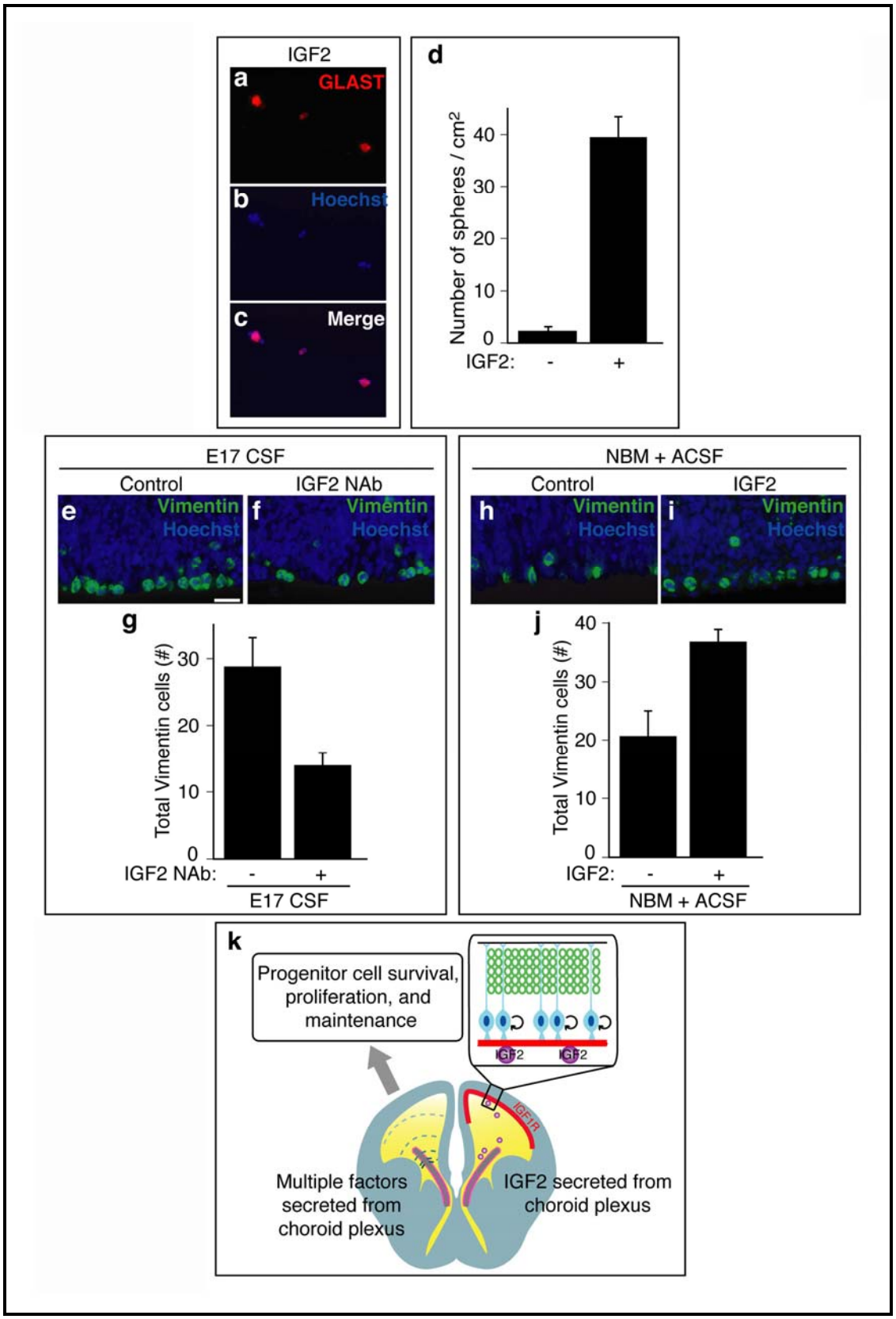

Figure 3.7 continued

We have elucidated that embryonic CSF plays a fundamental, dynamic role in defining an endogenous niche for the survival and proliferation of cortical neural progenitors, and as a global regulator of neurogenesis (Figure 3.7k) despite a more traditional view of the CSF as a fluid cushion that bathes the central nervous system, or as a passive sink for biomarkers of central nervous system function and pathology. Changing IGF2 levels in the CSF strongly suggests a role for the CSF as a vehicle for orchestrating cortical neurogenesis: IGF2 expression increases during development, is maximal during the peak of cortical neurogenesis in the rat brain (E15-E19), and declines as cortical neurogenesis nears completion around birth. IGF2 stimulates the proliferation of cortical progenitors and may maintain them in an uncommitted state through development. IGF2 and other molecules[11] appear to be released in the CSF by the choroid plexus, which appears in the lateral ventricles between E13 and E15. Presumably, signaling molecules such as IGF2 diffuse widely in the CSF to regulate cortical precursors that, in the case of the embryonic human brain, may be long distances away from the source of the factor. It is unclear whether there is a gradient of IGF2 in the embryonic CSF that might influence regional differences in proliferation across the cortical mantle[25], as has been shown for Slit in the adult CSF[26], or whether ciliary movement or diffusion through a far smaller volume equilibrates IGF2 concentration in the embryonic ventricles. The presence of proliferation-inducing factors in the CSF suggests that an important aspect of neural differentiation may be the simple isolation of developing cells from the growth-promoting environment created by the CSF, by the withdrawal of the apical ventricular process, which invariably coincides with neural differentiation[27].

Our findings have several important implications. First, CSF components, which can potentially be dispersed over large areas, may be more significant and pervasive regulators of development, stem cell renewal, disease, neurodegeneration and behavior than previously thought. Second, since the CNS represents just one example of an epithelium that grows in relation to an extracellular fluid, our findings may generalize to other epithelia which are likely to develop using similar rules, with a major contributor to the "stem cell niche" being the fluid that bathes the epithelium[18], similar to the microenvironment that invests hematopoietic stem cells, of which IGF2 is also an essential component[28, 29]. Finally, if a major component of the stem cell niche reflects secreted factors acting at large distances from their sources, a deeper understanding of the proteomic composition of extracellular fluids may provide unexpected ways to regulate stem cell behavior.

ACKNOWLEDGEMENTS

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METHODS

Embryonic CSF Isolation

CSF was isolated as previously described[9] with few modifications. Extra embryonic membranes were gently dissected and embryos remained connected to the placenta as CSF was collected. To minimize protein degradation, CSF samples were kept at 4°C during collection. Samples were centrifuged at 10,000*g* at 4°C for10 min to remove any contaminating cells. The samples used for analysis had no visible signs of contaminating neuroepithelial cells or red blood cells that could be detected under the microscope. Samples were stored at -80°C until further analysis.

Cortical Explants

Rat embryos were removed from extra-embryonic membranes and placed in sterile Hanks Balanced Salt Solution (HBSS). The lateral wall of the developing cortex was dissected using a fine scalpel and demarcated in the rostral-caudal direction by the width of the lateral ganglionic eminence, in the dorsal direction by the in-fold of the medial cortical wall, and in the lateral direction by the border with the lateral ganglionic eminence. The dissected cortex was transferred to a polycarbonate membrane (Whatman; 13mm, 8.0um) using a platinum wire loop. Explants were then cultured for 24 hours in conditions described in text. Artificial CSF (ACSF) was made fresh for each use. ACSF consisted of NaCl 119mM, KCl 2.5mM, $NaHCO_3$ 26mM, NaH_2PO_4 1mM, Glucose 11mM, $MgCl_2$ 2mM, $CaCl_2$ 2.8mM. Supplemental IGF2 (US Biologicals) was added to ACSF at a final concentration of 2ng/ml. 15ug of IGF2 neutralization antibody in 15ul of PBS (Millipore) was incubated with 100% E17 CSF for 1 hour rotating at 4˚C. As a control, 15ul of PBS was incubated with 100% E17 CSF. For BrdU labeling,

explants were pulsed with BrdU for 30 minutes immediately prior to fixation. Explants were fixed (60% methanol, 30% chloroform, and 10% acetic acid) for 5-10 minutes, washed with 70% ethanol, embedded in paraffin, and sectioned at 5um. Explant integrity was visualized by Hematoxylin and Eosin staining (data not shown).

Immunohistochemical and Immunoblot Analysis

The following antibodies were purchased: mouse anti-Tuj1 1:250 (Covance), rat anti-BrdU 1:400 (AbD Serotec), mouse anti-Vimentin 4A4 1:100 (Assay Designs), mouse anti-APP 1:100, guinea pig anti-GLAST 1:100 (Chemicon), anti-phospho-Histone H3 1:400 (Upstate), rabbit P-AKT 1:100, rabbit P-IGF1R, 1:100 (Cell Signaling), HRP conjugated anti-albumin 1:10,000, HRP conjugated anti-transferrin 1:1000 (Immunology Consultants Laboratory, Inc.), rabbit anti-Cystatin C 1:1000, rabbit anti-Cathepsin B 1:1000 (Abcam), rabbit anti-IGF2 1:100, rabbit anti-FGF2 1:100 (Santa Cruz Biotechnology), rabbit anti-EC-SOD 1:1000 (Stressgen),

Cortical Neurospheres

E14 rat cortex was dissected in sterile HBSS followed by gentle trituration. Primary spheres were generated in DMEM/F12 supplemented with heparin, N2, FGF (10ng/ml), and EGF (20ng/ml) and collected after 7-9 days in vitro (DIV). Primary spheres were then re-suspended in media without EGF or FGF, dissociated into single cells, plated at a final density of 2,500 cells/cm^2, and cultured in various media conditions as described in text. Fresh media was supplemented on day 4 of incubation. Cells were fixed in 4% paraformaldehyde and stained for GLAST after 10 DIV.

Cortical Cell Cultures

Cultures of mixed cortical progenitor cells and neurons were prepared. Briefly, mouse embryonic E13.5 cortices were isolated and dissociated by Papain Dissociation System according to the manufacturer's instructions (Worthington Biochem. Corp). Cells were cultured in NBM supplemented with 1% penicillin-streptomycin, 1% glutamine, N2, and bFGF (10ng/ml). The following day, cells were deprived of growth factors for 6 hours, followed by a 5 minute pulse of ACSF, embryonic CSF, or IGF2 (20ng/ml).

In Situ Hybridization

Non-radioactive in situ hybridization was performed as described[30], using a digoxigenin (DIG)-labelled cRNA probe generated from a TA vector (Invitrogen) clone of IGF1 or IGF2 cDNA and frozen rat brain sections.

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Chapter 4

Adult Rat CSF Promotes Neural Stem Cell Proliferation

Contributions: Mauro Zappaterra primarily contributed to the project. Mauro D. Zappaterra, Maria K. Lehtinen, Anthony S. LaMantia, and Christopher A. Walsh designed all experiments; M.D.Z. collected and analyzed all mass spec data. M.D.Z and M.K.L. performed all cortical explant experiments and cathepsin B inhibition assay; M.D.Z. performed IHC, CSF collection, and neurosphere assays. M.K.L. performed primary cortical cell culture experiments. X.C. performed neurosphere assays. Bryan Ballif performed mass spectrometry.

SUMMARY

An adult human produces approximately 500ml of cerebrospinal fluid (CSF) a day that circulates throughout the entire nervous system. However the biological role of the adult CSF is poorly understood. Here, we perform mass spectrometry analysis on adult rat CSF and show that adult and embryonic CSF share a number of fundamental functions when proteins are compared on the basis of molecular function and biological process. The relative majority of proteins within the CSF are classified as regulatory molecules that include protease inhibitors. We show that both embryonic and adult CSF can inhibit the protease activity of purified Cathepsin B. In addition to regulatory molecules, other functional categories that are well represented are proteins involved in transfer and transport, immunity and defense, and signaling. We show that adult CSF promotes survival of embryonic explants and stimulates proliferation of both embryonic and adult neural progenitor cells, albeit to a lesser extent than embryonic CSF. Furthermore, adult CSF activates the IGF1 receptor and the AKT downstream signaling pathways. Taken together our results show that the CSF maintains fundamental functions throughout development and into the adult. Adult CSF contains signaling molecules that can support survival of explants without any exogenous factors, and proliferation of neural progenitor cells. This suggests that the adult CSF provides an endogenous niche that may help regulate stem cell self-renewal and differentiation and might play a role in neurodegeneration and aging.

INTRODUCTION

The adult cerebrospinal fluid is primarily produced by the active secretion from the choroid plexus in the lateral, third and fourth ventricles within the brain and circulates within the central nervous system[1, 2]. It is composed of a number of factors including ions, proteins, hormones, cholesterol, glucose, and metals[1, 2]. The adult CSF has several known functions including physical support and buoyancy to the brain, protection against changes in blood pressure, waste removal, provides nutrients, and transports of ions, metals and hormones[1, 2]. Recently it was shown that ciliary action of the ependymal cells lining the lateral ventricles creates a gradient of SLIT2 protein in the adult CSF that guided the migration of new neurons to the olfactory bulb suggesting that CSF factors might play other developmental roles as well[3].

Adult neural stem cells along the subventricular zone contact the cerebrospinal fluid CSF via a primary cilium[4, 5]. The adult neural stem cells are derived from embryonic progenitor radial glial cells which also contact the CSF throughout development[6]. Interestingly, all embryonic neural progenitor cells contact the CSF and differentiation into neurons or astrocytes is invariably associated with loss of CSF contact[7, 8]. The signaling molecules that regulate adult neural stem cells are poorly understood. Recently it was shown that Sonic hedgehog signaling is important to generate adult neural stem cells[9]. The niche or microenvironment in which a stem cell is located is essential to the maintenance and regulation of stem cell self-renewal and differentiation[4, 5]. One key component within the adult neural stem cell niche of the subventricular zone is the contact with the CSF via a primary cilium[4, 5]. However, the role of the adult CSF in stem cell proliferation and maintenance is unknown. Here, we

analyze the adult rat CSF proteome and determine many functional similarities between the adult and embryonic CSF. We show that both embryonic and adult CSF can promote survival and stimulate proliferation of neural progenitor cells, suggesting that the CSF may provide an endogenous niche for the proliferation and maintenance of neural stem cells.

METHODS

Isolation of CSF from rats

CSF was isolated from embryos as previously described[10]. CSF from adult rats was isolated using an insulin syringe 28 Gauge 1cc gently placed into the cisterna magna. There are approximately 180ul of CSF in an adult rat and using this method we consistently isolate approximately 120ul. Samples were centrifuged at 10,000*g* at 4°C for10 min to remove any contaminating cells. The samples used for analysis had no visible signs of contaminating neuroepithelial cells or red blood cells that could be detected under the microscope. Samples were stored at -80°C until further analysis.

In-Gel Digestion and Mass Spectrometry

Mass spectrometry performed as previously described in Chapter 2[11].

Cortical Explants, Embryonic Neurospheres, and Immunohistochemistry

Performed as previously described in Chapter 3[10].

Adult Neurospheres

3 mm coronal sections of adult rat brain were obtained and sections containing the subventricular zone (SVZ) surrounding the lateral ventricles were selected. SVZ areas were dissected in cold HBSS. Adult brain tissues were dissociated using the Papain

dissociation system (Worthington Biochem. Corp)). 100,000 cells were resuspended per well in a 24 well plate in Neurobasal medium containing B27 supplement, N2 supplement, penicillin/streptomycin, and 0.8 mM glutamine. Spheres are observed and dissociated after 7-9 days of incubation at 37C. Primary spheres were then re-suspended in media without EGF or FGF, dissociated into single cells, plated at a final density of 2,500 cells/cm^2, and cultured in various media conditions as described in text. Fresh media was supplemented on day 4 of incubation. Cells were fixed in 4% paraformaldehyde and stained for GLAST after 10 DIV.

Cortical Cell Cultures

Cultures of mixed cortical progenitor cells and neurons were prepared. Briefly, mouse embryonic E13.5 cortices were isolated and dissociated by Papain Dissociation System according to the manufacturer's instructions (Worthington Biochem. Corp). Cells were cultured in NBM supplemented with 1% penicillin-streptomycin, 1% glutamine, N2, and bFGF (10ng/ml). The following day, cells were deprived of growth factors for 6 hours, followed by a 5 minute pulse of ACSF, embryonic CSF, adult CSF, IGF1 (20ng/ml), or IGF2 (20ng/ml).

Cathepsin B Inhibition Assay

Assay was performed as recommended by manufacture instructions (EMDBiosciences). 25ul of purified cathepsin was added to 5ul of embryonic or adult CSF.

RESULTS

Proteomic analysis of adult CSF

Mass spectrometry analysis revealed 77 proteins with 2 or more unique peptides found in the adult Rat CSF (Appendix 1 Table 1.9). To understand the fundamental functional groups of proteins within the CSF conserved throughout development we compared the adult rat CSF proteome to a previous embryonic CSF proteomics analysis[11]. There were 59 proteins in the adult rat CSF proteome that have been identified in the embryonic CSF proteome (Appendix 1 Table 1.9)[11]. Similar to the embryonic proteome, the adult proteome contains many transport and carrier proteins -- including transferrin, albumin, transthyretin, ceruloplasmin, and apolipoproteins -- that are involved in lipid, metal ion, or vitamin transport through fluids or across cell membranes. Both the adult and embryonic CSF contain a number of protease inhibitors and complement proteins, which regulate the immune response and proteases.

In addition, a number of extracellular matrix molecules and glycoproteins were also identified in both the adult and embryonic CSF such as contactin-1, fibronectin, gelsolin, and clusterin. Contactin-1 has been shown to function as a ligand for Notch which promotes oligodendrocyte precursor differentiation[12]. Fibronectin is an extracellular matrix glycoprotein that binds to integrin receptors as well as extracellular matrix components such as collagen and proteoglycans. Binding of extracellular matrix molecules to integrin receptors is important for cell survival, cytoskeletal rearrangements, and cell motility. Another factor within the CSF is gelsolin. It is an actin binding protein that severs actin filaments and helps regulate cell motility and extracellular matrix remodeling[13, 14]. Gelsolin has also been shown to bind to the amyloid beta (Aβ) protein

which forms amyloid plaques in Alzheimer's disease. Gelsolin binding not only prevents amyloid plague formation by preventing Aβ fibrillization, but also solubilizes Aβ fibrils[15, 16]. Clusterin is a glycoprotein that inhibits apoptosis, and decreases oxidative stress. Clusterin has been shown to promote survival through the AKT pathway and is believed to bind to the megalin receptor[17].

In addition to the extracellular matrix proteins and glycoproteins, Amyloid Beta A4 Protein Precursor (APP) was also found in embryonic and adult rat CSF. Soluble forms of APP are found in the CSF throughout development and into adulthood and have been shown to stimulate proliferation of embryonic and adult neural stem cells[10, 18-20]. Therefore APP may be a key regulatory molecule within the CSF for maintaining neural stem cells throughout development.

Although over 75% of the proteins found in the adult CSF are also in the embryonic CSF, a number of proteins were found by mass spectrometry in adult CSF but were not detected in multiple embryonic samples. However, western blot analysis on embryonic CSF was not performed. One protein found in the adult CSF is the limbic system-associated membrane protein (LSAMP) which has been shown to regulate intracellular calcium signaling as well as promote neurite outgrowth[21, 22]. Secretogranin-1 was also identified in the adult CSF which is a putative neuroendocrine secretory factor that contains multiple neuropeptides. Although in our analyses, there are a few proteins in the adult CSF not identified in the embryonic CSF, the majority of the proteins found via mass spectrometry in the adult rat CSF are also present in the embryonic rat CSF suggesting that the common proteins represent fundamental functions of the CSF throughout life.

Informatics analysis of adult proteome

To elucidate the functions of the adult CSF on a systems level we used the PANTHER (Protein Analysis Through Evolutionary Relationships) protein ontology database to classify the proteins into distinct categories of molecular function and biological process[23]. Table 4.1 shows the percentage of proteins assigned to each functional category in the adult and embryonic rat CSF. Panther analysis of molecular function reveals that the majority of proteins found within the adult and embryonic rat CSF share similar functional categories (Table 4.1 and Figure 4.2). The comparison of relevant protein categories in each sample is shown in Figure 4.2.

Table 4.1. List of protein categories based on molecular function for adult and embryonic rat CSF.

Adult Rat CSF	Percent proteins in each category	Embryonic Rat CSF	Percent proteins in each category
Cell adhesion	14.3%	Cell adhesion	12.6%
Chaperone	1.4%	Chaperone	5.0%
Cytoskeletal	7.1%	Cytoskeletal	8.4%
Defense/Immunity	12.9%	Defense/Immunity	6.7%
Extracellular matrix	7.1%	Extracellular matrix	10.9%
Hydrolase	1.4%	Hydrolase	1.7%
Kinase	5.7%	Kinase	2.5%
Nucleic acid binding	1.4%	Nucleic acid binding	5.0%
Oxidoreductase	2.9%	Oxidoreductase	5.0%
Protease	8.6%	Protease	6.0%
Receptor	5.7%	Receptor	10.1%
Calcium binding	7.1%	Calcium binding	4.2%
Regulatory molecule	20.0%	Regulatory molecule	12.6%
Signaling molecule	11.4%	Signaling molecule	6.0%
Synthase and synthetase	1.4%	Synthase and synthetase	1.0%
Transfer/Carrier	10.0%	Transfer/Carrier	12.6%
Transporter	5.7%	Transporter	3.4%

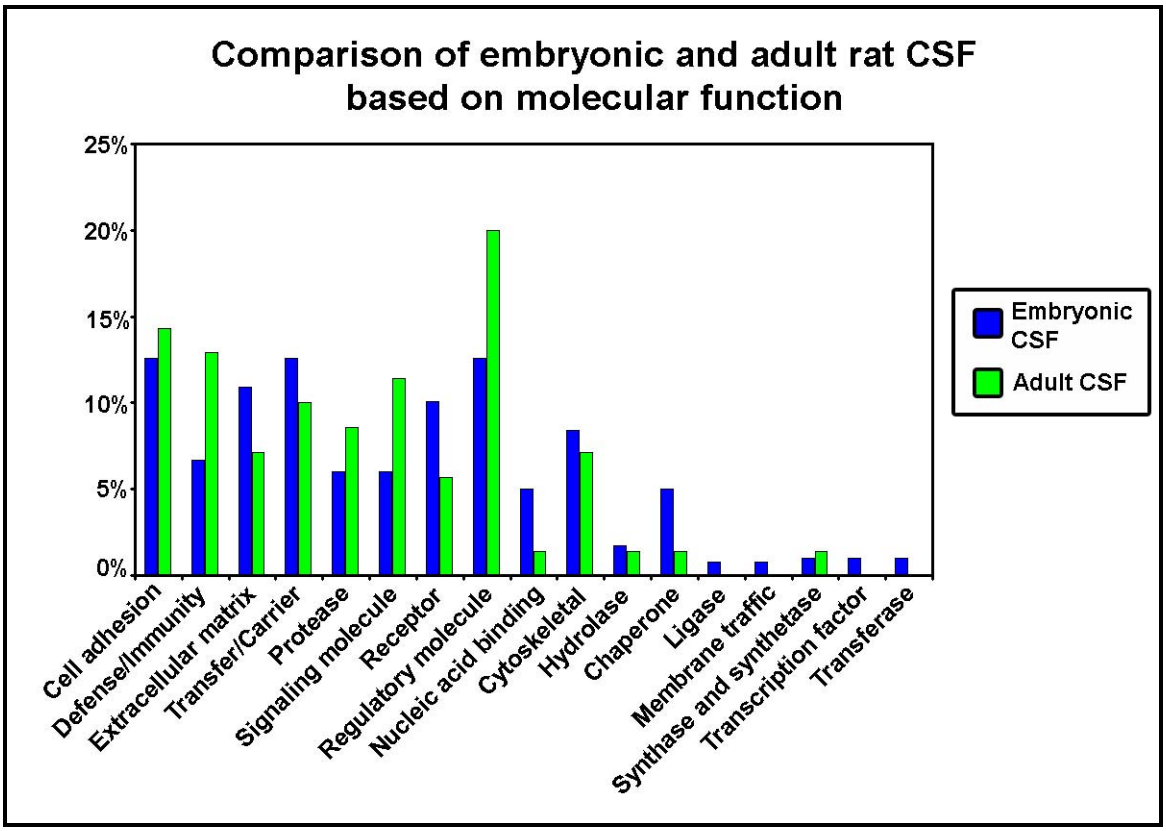

Figure 4.2. Comparison of proteins in embryonic and adult rat CSF proteome based on molecular function. Proteins present in embryonic and adult rat CSF were analyzed using the Panther gene ontology database and classified according to molecular function. Relative percentages from relevant categories are graphed. Chart includes protein category name and percentage is calculated from number of proteins assigned to each category over total number of proteins analyzed.

The adult and embryonic rat CSF proteome share a number of categories based on molecular function. The rat CSF proteome has a number of proteins involved in cell adhesion, defense and immunity, and signaling. It also contains transfer/carrier proteins important for transporting various hormones, lipids, and ions. One of the most abundant categories in both adult and embryonic CSF is for regulatory molecules. In the PANTHER database, regulatory molecules include proteins involved in kinase, phosphatase, and G-protein modulation, as well as enzyme regulation and protease

inhibition[23]. Surprisingly, the majority of the regulatory molecules present in both adult and embryonic rat CSF are protease inhibitors (Figure 4.3).

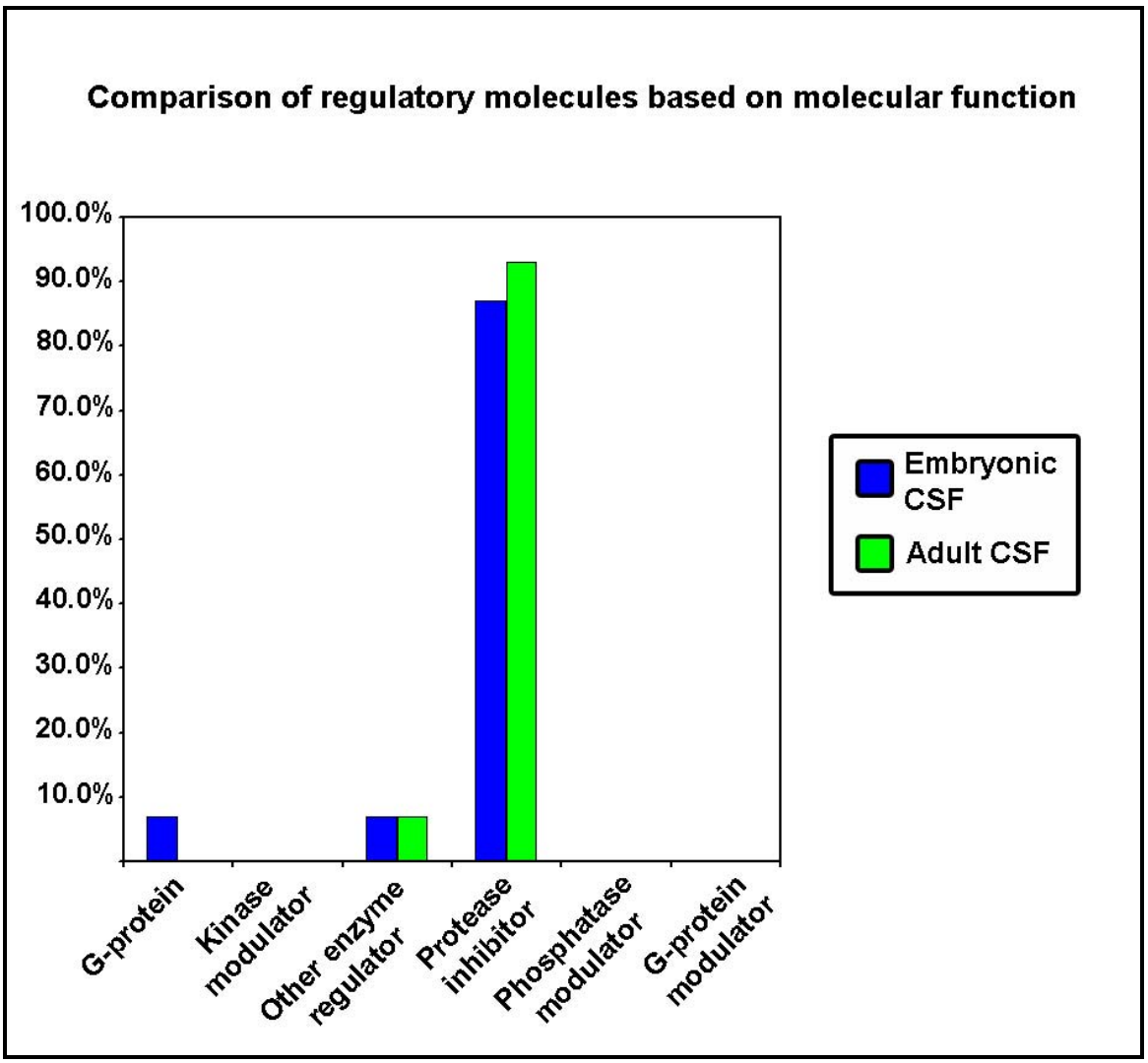

Figure 4.3. Subclassification of regulatory molecules based on molecular function. Regulatory molecules in the embryonic and adult CSF were subdivided based on molecular function. The majority of regulatory molecules in the CSF are protease inhibitors.

Protease inhibitors are important in a number of physiological processes to regulate the activity of endogenous proteases. Previous mass spectrometry analyses revealed the presence of Cystatin C in the CSF[11] and western blot analysis showed Cystatin C present in the CSF throughout development and into adulthood[10]. Cystatin C is a potent

Cathepsin B inhibitor shown to inhibit Aβ deposition in mouse models of Alzheimer's Disease[24, 25].

We therefore determined whether purified human Cathepsin B could be inhibited by protease inhibitors within the CSF. Using a fluorometric Cathepsin B assay measuring units of cleaved AMC, we show that both adult and embryonic CSF inhibits Cathepsin B activity in vitro (Figure 4.4).

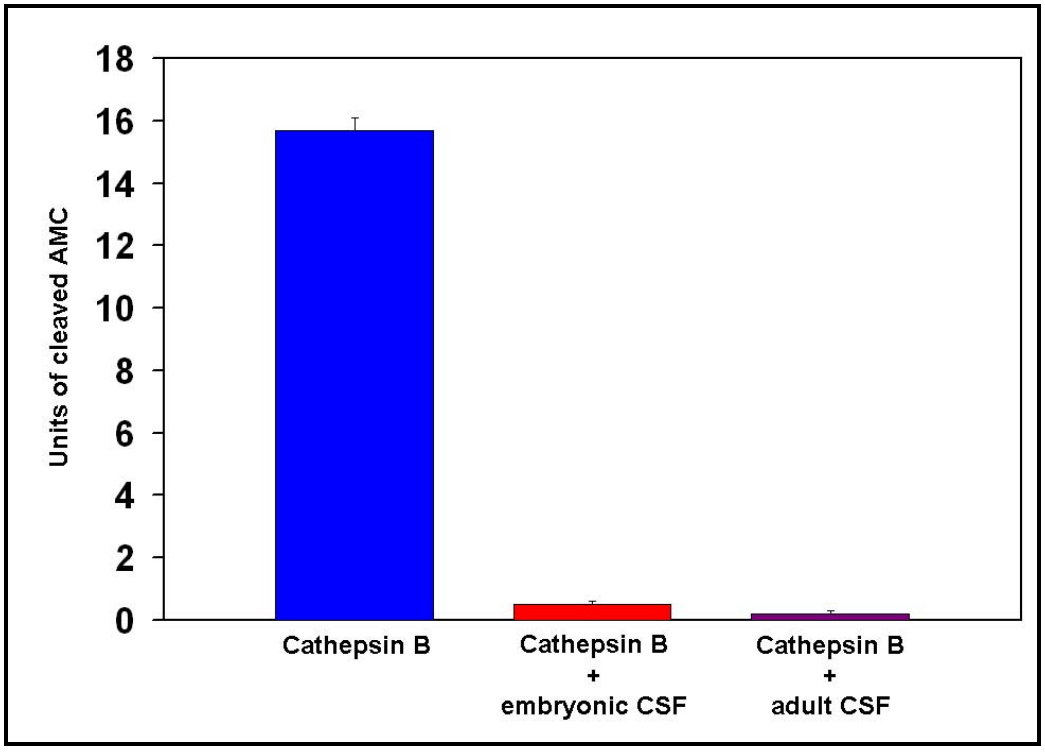

Figure 4.4. Embryonic and adult CSF inhibit Cathepsin B protease activity. Purified human Cathepsin B was incubated in a fluorometric assay measuring units of cleaved AMC, a Cathepsin B substrate. Data is presented as units of cleaved AMC for each assay ± SEM. Cathepsin B mean: 15.7 ± 0.15, Cathepsin B + embryonic CSF mean: 0.5 ± 0.01, Cathepsin B + adult CSF mean: 0.2 ± 0.01, n = 3, *t-test*, Cathepsin B vs. embryonic CSF $p<0.0001$, Cathepsin B vs. adult CSF $p<0.0001$.

Our data shows that protease inhibitors are a major active functional group within the embryonic and adult CSF. This implies that one of the functions of the CSF is to regulate protease activity within the extracellular environment of the developing and adult brain.

Panther analysis shows a strong similarity of adult and embryonic CSF proteins based on biological process. Table 4.2 shows the percentage of proteins assigned to each biological process category in the adult and embryonic rat CSF. The comparison of relevant protein categories in each sample is shown in Figure 4.2.

Table 4.2. List of protein categories based on biological process for adult and embryonic rat CSF.

Adult Rat CSF	Percent proteins in each category	Embryonic Rat CSF	Percent proteins in each category
Neuronal activities	1.4%	Neuronal activities	0.8%
Signal transduction	21.4%	Signal transduction	26.1%
Developmental processes	15.7%	Developmental processes	16.8%
Cell proliferation and differentiation	1.4%	Cell proliferation and differentiation	6.7%
Coenzyme and prosthetic group metabolism	1.4%	Coenzyme and prosthetic group metabolism	1.7%
Cell structure and motility	12.9%	Cell structure and motility	16.0%
Immunity and defense	25.7%	Immunity and defense	18.5%
Apoptosis	2.9%	Apoptosis	2.5%
Oncogenesis	2.2%	Oncogenesis	3.4%
Muscle contraction	2.9%	Muscle contraction	0.8%
Transport	11.4%	Transport	15.1%
Blood circulation and gas exchange	4.3%	Blood circulation and gas exchange	5.9%
Carbohydrate metabolism	2.9%	Carbohydrate metabolism	1.7%
Nucleoside, nucleotide and nucleic acid metabolism	0.0%	Nucleoside, nucleotide and nucleic acid metabolism	5.0%
Homeostasis	4.3%	Homeostasis	2.5%
Protein metabolism and modification	30.0%	Protein metabolism and modification	27.7%
Cell cycle	4.3%	Cell cycle	7.6%
Intracellular protein traffic	10.0%	Intracellular protein traffic	11.8%
Cell adhesion	14.3%	Cell adhesion	17.6%
Lipid, fatty acid and steroid metabolism	7.1%	Lipid, fatty acid and steroid metabolism	5.9%
Sensory perception	2.9%	Sensory perception	1.7%
Electron transport	1.4%	Electron transport	0.8%
Amino acid metabolism	0.6%	Amino acid metabolism	0.8%
Biological process unclassified	4.3%	Biological process unclassified	5.0%
Protein targeting and localization	1.4%	Protein targeting and localization	2.5%

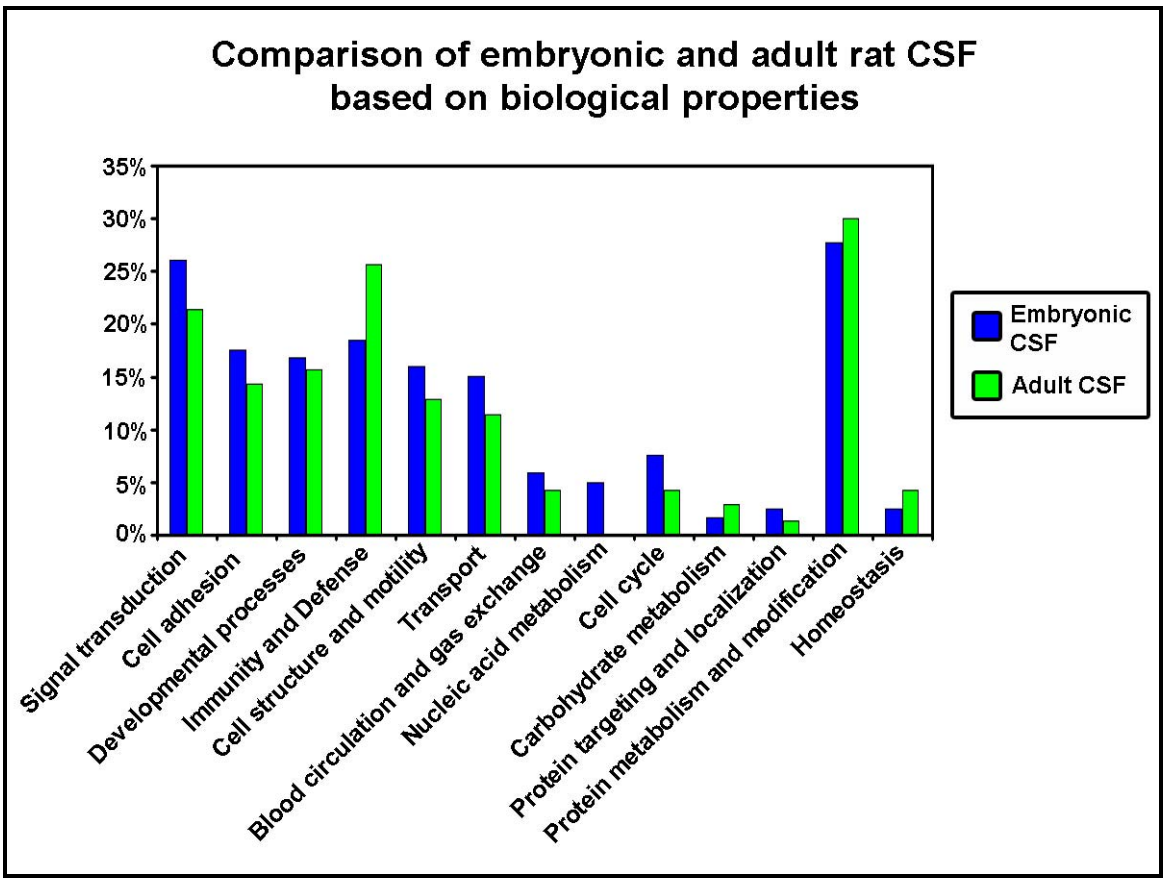

Figure 4.5. Comparison of proteins in embryonic and adult rat CSF proteome based on biological process. Proteins present in embryonic and adult rat CSF were analyzed using the Panther gene ontology database and classified according to biological process. Relative percentages from relevant categories are graphed. Chart includes protein category name and percentage is calculated from number of proteins assigned to each category over total number of proteins analyzed.

The three most abundant categories of proteins are similar in both the adult and embryonic CSF. Proteins involved in protein metabolism and modification comprise the most represented class of proteins based on biological process in both adult and embryonic CSF. Proteins within this biological class are the protein regulators such as the protease inhibitors. Proteins involved in immunity and defense, and signal transduction are also well represented. This data shows that proteins within the

embryonic and rat CSF share similar functional biological processes and most likely represent fundamental functions of the CSF.

Adult CSF supports cortical explant growth and neural stem cell proliferation

Because of the similarities in protein classes between the embryonic and adult CSF, we next determined whether the adult CSF could support embryonic cortical explant growth and survival, similar to embryonic CSF[10]. We have previously shown that E16 cortical explants survive and proliferate when cultured with 100% embryonic day 17 (E17) CSF and do not survive with 100% artificial CSF (ACSF)[10]. We compared growth and proliferation of E16 explants cultured in 100% E17 CSF to explants cultured in 100% adult CSF. E16 explants survive and proliferate when cultured in both E17 and adult CSF. However proliferation of neural progenitor cells is not as robust when explants are cultured in adult CSF, as indicated by staining with the monoclonal antibody to Vimentin 4A4, a marker for mitotically active neural progenitor cells[26] (Figure 4.6) (E17 mean: 37.1 ± 1.4; adult mean: 7.3 ± 0.6; n = 4; E17 vs. adult, $p<0.0001$).

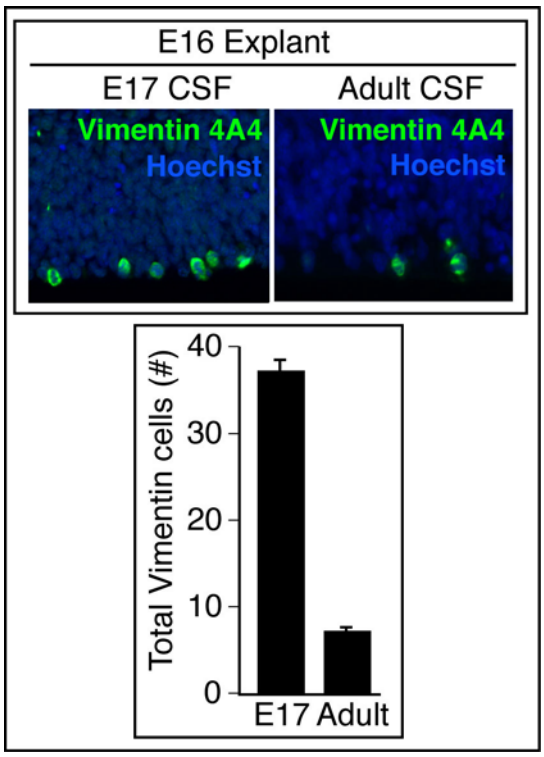

Figure 4.6. Adult CSF supports embryonic explant growth and proliferation. E16 explants cultured in 100% E17, or adult CSF for 24 hours, were stained with anti-Vimentin 4A4 (green) and Hoechst (blue). Quantification of Vimentin 4A4-positive cells per explant grown with E17 or adult CSF. The number of Vimentin 4A4-positive cells was significantly decreased in explants cultured with adult CSF compared to E17 CSF (E17 mean: 37.1 ± 1.4; adult mean: 7.3 ± 0.6; n = 4; *t-test*; E17 vs. adult, $p<0.0001$). The number of immuno-positive cells is represented as mean ± SEM.

We next determined whether adult CSF is sufficient to maintain and stimulate proliferation of embryonic neural stem cells. We used primary dissociated cortical progenitors cultured as "neurospheres", an in vitro experimental model for embryonic neural stem cells. Primary neurospheres derived from E14 rat embryos were dissociated, plated at clonal density, and cultured with E17 or adult CSF. Both E17 and adult CSF supported the generation of small neurospheres, composed primarily of GLAST positive cells[27, 28], for up to 10 days in vitro (DIV), in the complete absence of supplemental FGF and EGF that are normally essential to maintain them. Neurospheres failed to form in the presence of ACSF (ACSF mean: 8.3 ± 1.7; E17 mean: 274 ± 8; adult mean: 81 ± 8.8; n =

3; E17 vs. adult, $p<0.0001$) (Figure 4.7). Although neurospheres formed in the presence of adult CSF, some primary dissociated cortical progenitors had a variable response when cultured in adult CSF compared to embryonic CSF. A few cells appeared to begin to differentiate, adhere to the slide, and send out processes. However, the neurospheres generated in adult CSF retained responsiveness to FGF and EGF (data not shown), indicating that the CSF maintains a population of the stem cells in an uncommitted fate. This data suggests that both embryonic and adult CSF can generate and maintain neurospheres, although the embryonic CSF is more robust at forming embryonic neurospheres. The embryonic progenitor cells may be primed to respond better to the embryonic CSF conditions than to the adult CSF conditions.

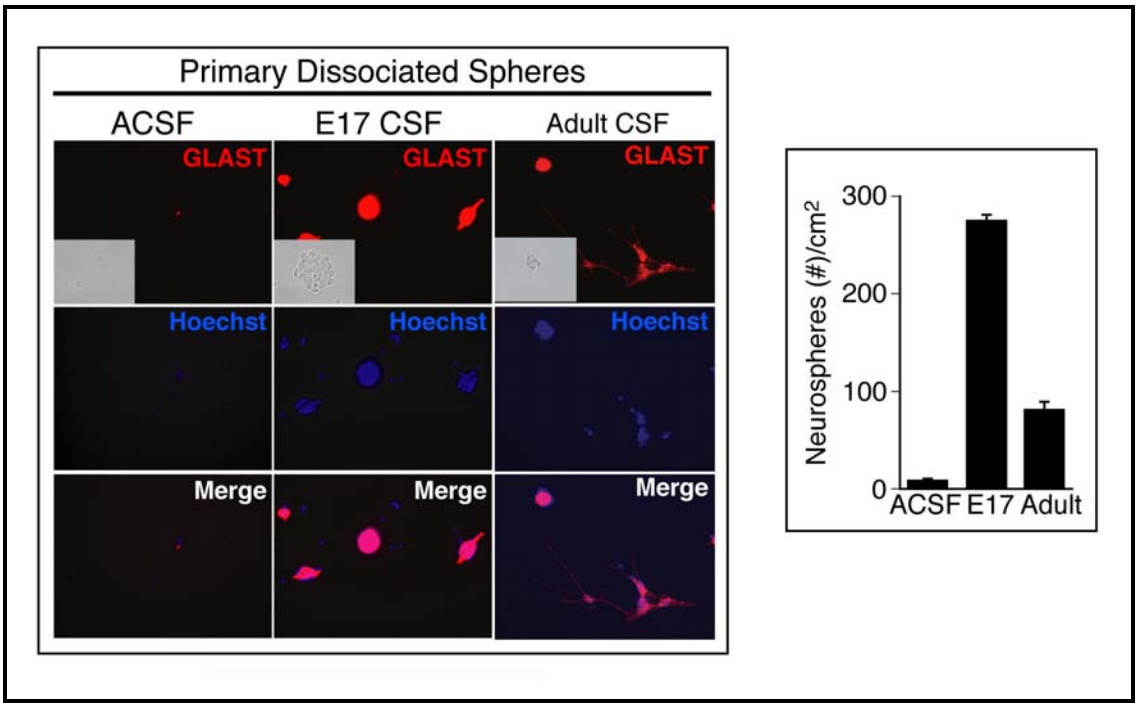

Figure 4.7. Adult CSF stimulates proliferation of embryonic neural progenitor cells. Single cells from dissociated primary neurospheres grown in: 20% ACSF, 20% E17 CSF, or 20% Adult CSF for 10 DIV and stained with anti-GLAST and Hoechst. Primary dissociated spheres grown in E17 and adult CSF proliferate and form spheres of slowly dividing GLAST positive cells. Quantification of average number of spheres per cm^2 formed in the various conditions at 10 DIV. Primary dissociated neurosphere cells generated spheres when cultured in adult CSF, albeit a lower number when compared with cells grown in E17 CSF. (ACSF mean: 8.3 ± 1.7; E17 mean: 274 ± 8; adult mean: 81 ± 8.8; n = 3; *t-test*; E17 vs. adult, $p<0.0001$). The number of immuno-positive spheres is represented as mean ± SEM.

We next determined whether CSF stimulates proliferation of adult neural stem cells. We used primary dissociated SVZ astrocytes cultured as "neurospheres", an in vitro experimental model for adult neural stem cells. Primary neurospheres derived from adult female rats were dissociated, plated at clonal density, and cultured with 20% ACSF, 20% E13, 20% E17, or 20% adult CSF. Although these are preliminary results, both embryonic and adult CSF supported the generation of small neurospheres, composed primarily of GFAP positive cells, for up to 10 days in vitro (DIV) (Figure 4.8). Interestingly, embryonic CSF stimulated proliferation of GFAP-positive adult neural

stem cells to a larger degree than stem cells grown in adult CSF. Taken together our results suggest that although the adult CSF can stimulate proliferation adult neural stem cells, embryonic CSF is more robust in stimulating proliferation of embryonic and adult cortical stem cells.

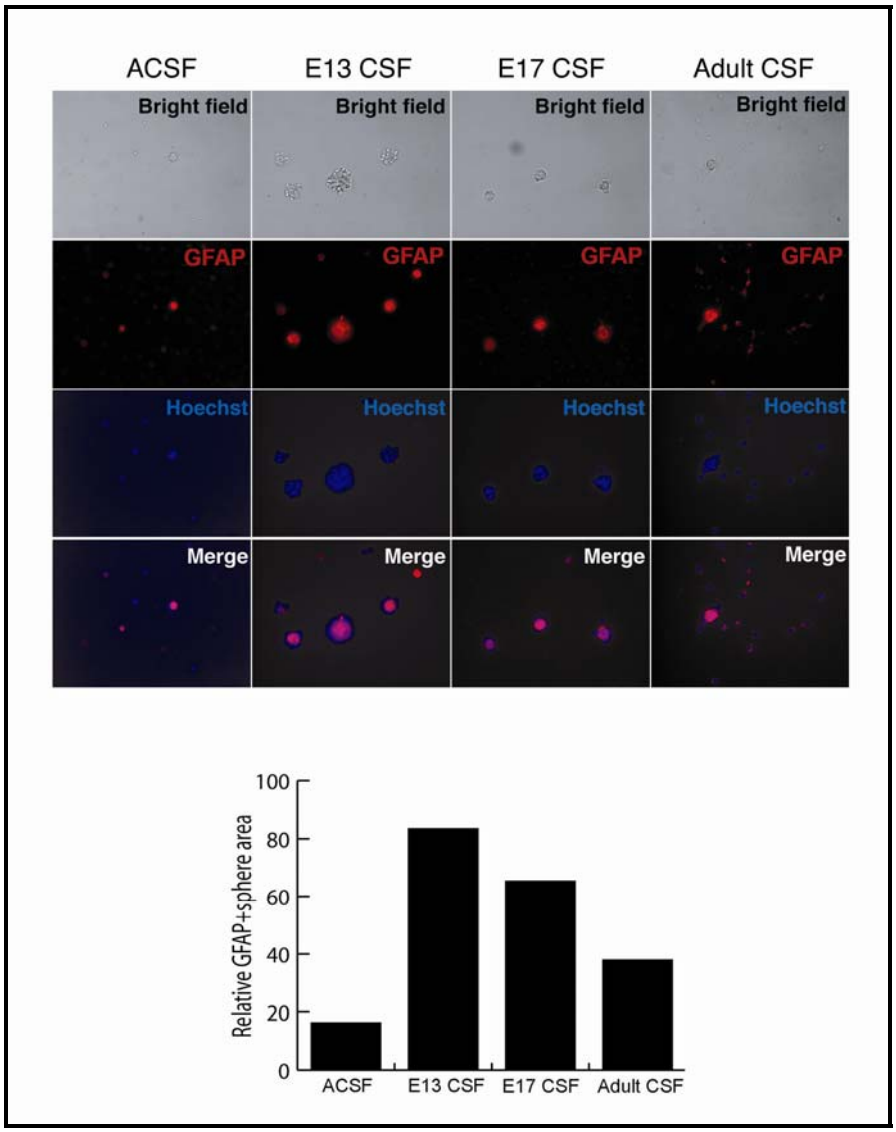

Figure 4.8. CSF stimulates proliferation of adult neural stem cells. Single cells from dissociated primary neurospheres grown in: 20% ACSF, 20% E13 CSF, 20% E17 CSF, or 20% Adult CSF, for 10 DIV and stained with anti-GFAP and Hoechst. Primary dissociated spheres grown in CSF proliferate and form spheres of slowly dividing GFAP positive cells. Quantification of size of GFAP+ sphere area per cm^2 formed in the various conditions at 10 DIV for n=1. Both embryonic and adult CSF generates spheres. Primary dissociated neurosphere cells generated larger spheres when cultured in embryonic CSF compared with cells grown in adult CSF.

Adult CSF activates the insulin signaling pathway

Previous western blot analysis revealed that adult CSF contains low levels of IGF2[10]. We therefore determined if IGF signaling within the adult CSF may be responsible for supporting cortical explant growth and neural progenitor cell proliferation. Indeed, similar to the embryonic CSF, adult CSF activated IGF signaling in primary cortical precursor cells and neurons via the IGF1 receptor, as reflected by induction of phosphorylated IGF1Rβ (p-IGF1Rβ) and the activation of the AKT signaling pathway, a downstream target of IGF signaling as well as other growth-factor-stimulated signaling cascades (Figure 4.9). Taken together our results show that CSF is capable of inducing the activation of IGF signaling.

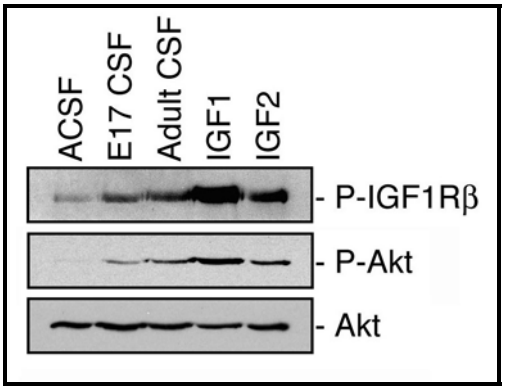

Figure 4.9. CSF activates insulin signaling pathway. Lysates of cortical cells treated with ACSF, E17 CSF, Adult CSF, IGF1, or IGF2 for 5 minutes were immunoblotted with antibodies to p-IGF1R, p-AKT, AKT.

DISCUSSION

Here we show that the embryonic and adult rat CSF proteome share many similarities in protein categories based on molecular function and biological properties. Their similarities suggest that CSF has certain fundamental functions throughout development involved in the transport and transfer of lipids, metals, and hormones, as well as a number of signaling and regulatory molecules that are essential irrespective of age.

Our data show that embryonic and adult CSF support cortical explant survival. We show that embryonic and adult CSF stimulate proliferation of embryonic and adult neural progenitor cells and can generate neurospheres, although the embryonic CSF is more robust at stimulating neural progenitor cell proliferation. Here we also show that adult CSF, similar to embryonic CSF, activates the insulin signaling pathway suggesting that CSF-borne insulin signaling may be a major regulator of survival and proliferation of progenitor cells.

During development there is expansion in number of the neural progenitor pool. If signaling factors are present that regulate proliferation of the neural progenitor cells, it is likely that such factors would be more abundantly expressed in the embryonic CSF than in the adult CSF. In fact both IGF2 and FGF2 are consistently and more abundantly present in the embryonic CSF. In the adult CSF variable amounts of both IGF2 and FGF2 are present (data not shown), suggesting that these factors may play a role in the proliferation and maintenance of neural stem cells.

Both embryonic and adult CSF stimulates the IGF signaling cascade. Initially we were surprised by these results as it appears that the adult CSF stimulates phosphorylation of the IGF1 receptor equal if not greater than the embryonic CSF, although we have not quantified this. In a preliminary analysis we stained for P-AKT activation in the mixed population of cells consisting of both progenitors and neurons. Surprisingly we found that the embryonic CSF preferentially and robustly activated P-AKT in Tuj1 negative cells (Tuj1 is a neural marker) and that the adult CSF preferentially activated P-AKT in Tuj1 positive cells. This suggests that Tuj1 negative cells, likely to be progenitor cells, are more responsive to signaling factors within the embryonic CSF than adult CSF, and that Tuj1 positive neurons are more responsive to signaling factors within the adult CSF than embryonic CSF, although this needs to be investigated further. One interesting possibility is that there might be modulation of the insulin signaling from the CSF potentially by insulin binding proteins that may also be differentially expressed throughout development. We are currently investigating this further.

In addition to insulin signaling, embryonic and adult CSF contains other factors that may be important for regulating the stem cell niche. Soluble forms of APP are present in the CSF that stimulate the proliferation of embryonic neural progenitor cells and adult neural stem cells[18, 19]. Soluble forms of APP have been shown to bind to EGF responsive neural stem cells and act as an EGF cofactor to stimulate proliferation[18]. Therefore, APP may also be an essential factor important for the maintenance of the adult neurogenic niche. Another factor shown to stimulate neurosphere formation in conjunction with FGF2 is cystatin C, which is abundant in both embryonic and adult

CSF[29]. Given the importance of Sonic hedgehog (Shh) signaling in generating neural adult stem cells, we assessed for the presence of Shh within the CSF and have not yet detected it with our methods. It may be in low abundance, undetectable by western blot, and therefore concentrating larger volumes of CSF may be necessary to detect it. However preliminary data using luciferase assays suggests that Shh signaling is present in the CSF and RT-PCR results suggests that Shh mRNA is expressed by the choroid plexus. Therefore the CSF may be a likely source for Shh signaling. Together our results suggest that the adult CSF provides an endogenous niche that may help regulate stem cell self-renewal and differentiation.

Interestingly the SVZ astrocytes, the neural adult stem cells which contact the CSF are histologically similar to astrocytes and are derived from the radial glial cells. Proteome transitions within the CSF from embryonic CSF to adult CSF may regulate the transition of embryonic progenitor cells to adult stem cells. Different factors or temporal changes in concentration may be responsible for regulating different pools of neural progenitor cells throughout development[30]. It is likely that multiple factors within the CSF regulate the proliferation and differentiation of neural progenitor cells and that the dynamism of protein expression within the CSF creates an endogenous environment for optimal development and stem cell maintenance.

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Chapter 5

Discussion

The CSF proteome and its developmental functions

To elucidate the function of a complex fluid, it is important to study the constituents of that fluid. Mass spectrometry analysis of the CSF offered a comprehensive view of the protein constituents within the CSF on a systems level. Mass spectrometry enabled us to begin to classify the embryonic and adult CSF proteome which may help in understanding the basic molecular mechanisms that are operating within the dynamic environment of the fluid bathing the central nervous system during development and into adulthood.

We have provided the first systematic glimpse of the embryonic human CSF proteome. We performed a comprehensive proteomics analysis comparing the human and rat embryonic CSF[1], as well as an analysis comparing the embryonic and adult rat CSF. Previous to the work conducted in this thesis, one analysis of the rat embryonic CSF had been performed and discovered only 31 proteins[2]. In our embryonic rat CSF analysis we identified between 249 and 423 proteins in four samples from three different time-points in cortical development with 137 proteins common to all four samples. Proteomics analysis of adult rat CSF identified 77 proteins, of which 59 had been identified in the embryonic CSF proteome. We determined that CSF is a complex fluid harboring a large number of functionally diverse proteins.

Through side-by-side comparisons, we found great similarity in the composition and biological function of proteins present in the CSF irrespective of age suggesting that the CSF has some fundamental characteristics that are maintained throughout the lifetime of the organism. It contains proteins involved in transport and metabolism of lipids, metals, vitamins, and hormones. The CSF also contains a number of extracellular matrix

proteins, cellular adhesion molecules, proteins involved in immunity and defense, and signaling molecules. The most common functional class of proteins in the CSF, based on molecular and biological processes are regulatory molecules, which includes protease inhibitors. We show that the protease inhibitors in the CSF inhibit the protease activity of purified Cathepsin B. Understanding the functional categories of proteins present in the CSF should lead to a greater understanding of the fundamental functions of the CSF to maintain tissue and fluid homeostasis throughout development. By cataloguing the CSF proteome at various times in development we hope to have generated a wealth of molecular information that may hopefully be used as a groundwork for targeted analyses into how the proteins within the CSF might function individually or together for proper brain development.

Differences in CSF composition with age

The embryonic CSF is a much more complex and diverse fluid than the adult CSF proteome which may suggest an active role for the embryonic CSF in brain development. There are a few potential reasons why the protein content of embryonic CSF is greater and more diverse than adult CSF. One potential explanation is that during development there may be greater numbers of cells undergoing apoptosis along the ventricular zone which might cause proteins to 'leak' into the CSF. We do not believe this to be the case because we do not visualize much cell death in the developing embryo, and because CSF samples where we have seen contamination with cellular debris contain proteins (such as mitochondrial proteins) that are not present in cleanly prepared embryonic samples. Another possibility is that the complexity of the embryonic CSF comes from immaturity

of the blood-brain or blood-CSF barrier. We consider this unlikely because tight junctions are present within the choroid plexus and endothelial cells early in development and passive transport does not readily occur[3-6]. Instead active transport and secretion by the choroid plexus occurs early in development via a transcellular mechanism[3-6]. Therefore, for these reasons we propose that the most likely explanation for the greater diversity of the embryonic CSF proteome is that its composition is precisely controlled, and its great protein diversity reflects additional functions – some not yet understood – in the developing brain. It is plausible that factors that are required in high concentrations early in development, during proliferation and growth, are not required once the brain has formed. We show that growth factors such as IGF2 and FGF2, antioxidants such as EC-SOD, and proteases such as Cathepsin B, that are abundant in the embryonic CSF are less abundant in the adult CSF. In addition, the embryonic CSF contains membrane bound particles that are believed to be released by proliferating cells[7]. Although they may influence brain development by carrying signaling factors or morphogens[8], our analysis of the contents of these particles has so far not identified them to contain any signaling factors, such as IGF2 or FGF2 (data not shown). This idea however should not be ruled out and further investigation into the role of these particles and their contents should be pursued, since similar particles have been shown to be important mediators of retinoic acid and Shh signaling in and around Hensen's node during early development[9]. The complexity of the embryonic CSF may therefore be due to the requirements of those proteins in brain development.

CSF as a neural stem cell niche

We show that CSF is sufficient to maintain and stimulate proliferation of cortical progenitor cells. We show that both the adult and embryonic CSF provides endogenous signals for the proliferation and maintenance of stem cells without requiring exogenous FGF or EGF. The maintenance of stem cells requires signals for proliferation, self-renewal, and when necessary, differentiation. Understanding the various signals required for proliferation and self renewal has been challenging. In an elegant study, Sally Temple's lab identified vascular endothelial cells as an essential source of secreted factors for stem cell self renewal[10]. They show that stem cells cultured in the presence of FGF2 proliferate and then begin to differentiate into neurons and glia[11]. When the stem cells are exposed to endothelial cells in the presence of FGF2, the stem cells proliferate and continue to self-renew[10]. This implies that multiple pathways may be present within a niche that govern proliferation and self-renewal, and that the signaling factors may also be different. By adding FGF2, the proliferative factor is added to the culture media, while the endothelial cells provide the signaling factor(s) essential for maintaining stem cell fate.

Our results suggest that the CSF may function as an endogenous stem cell niche within the organism. Embryonic progenitor cells contact the CSF throughout development and SVZ astroctyes contact the CSF in the adult[12]. CSF represents the fluid environment that contacts the neural stem cells throughout life[12]. Although we have not extensively characterized the source of CSF proteins, they may originate from a number of sources: some factors are directly produced and secreted by the epithelial cells of the choroid plexus. In contrast, other factors appear to cross the blood-CSF barrier and so

may originally be synthesized by the endothelial cells of the choroid plexus, or perhaps originating in the serum[13].

We have shown that a number of proliferative factors are present in the CSF. We show that IGF2 is present in the embryonic and adult CSF and stimulates progenitor cell proliferation. IGF2 is produced by the choroid plexus as well as by endothelial cells, and has been shown to cross the blood-CSF and blood-brain barrier[14, 15]. In addition, FGF2 is also present in the embryonic CSF[16, 17], has been occasionally identified in the adult CSF (data not shown), and is thought to cross the blood-CSF barrier in chick embryos[17]. We also show that the CSF contains sAPP, Cystatin C, PEDF and a suite of other signaling molecules known to affect progenitor cell proliferation[18-22]. Therefore, multiple factors within the CSF may be acting in combination to stimulate progenitor cell proliferation and self-renewal, creating a stem cell niche within the developing brain and in the adult.

CSF as a regulator of neurogenesis

Our data suggest that embryonic CSF may play a fundamental, dynamic, and instructive role in neurogenesis and brain development. We show that neural progenitor cell proliferation increases when explants or cells are cultured with E17 CSF compared with E13 CSF, P6 CSF or adult CSF. We also show that individual proteins within the CSF are dynamically expressed throughout development. The changing concentrations of CSF signaling factors with age suggest that the CSF may act as a global regulator of neurogenesis. For example, we found that IGF2 expression increases during development, is maximal during the peak of cortical neurogenesis in the rat brain (E15-E19), and declines as cortical neurogenesis nears completion around birth. Indeed, IGF2

stimulates the proliferation of cortical progenitors and may maintain them in an uncommitted state through development. Therefore, changing growth factor levels, such as IGF2, in the CSF strongly suggests a role for the CSF as a vehicle for orchestrating cortical neurogenesis. In addition, the presence of proliferation-inducing factors in the CSF suggests that an important aspect of neural differentiation may be the simple isolation of developing cells from the growth-promoting environment created by the CSF, by the withdrawal of the apical end foot from the ventricle, which invariably coincides with neural differentiation[23].

Additional factors within the CSF may also help promote neurogenesis. Lunatic Fringe (β-1,3-N-Acetylglucosaminyltransferase) has been identified in the CSF, and is a known modulator of Notch signaling[24, 25]. The activation of Notch is generally associated with suppression of neurogenesis and maintenance of progenitor cell fate[26], and suppression of Notch signaling is associated with differentiation. In somites, Lunatic fringe has been shown to have a cyclical expression pattern[27]. It may be possible that Lunatic fringe is expressed in a temporal gradient or in a cyclical pattern and may regulate Notch signaling to promote neurogenesis.

We have also identified two factors in the CSF that are members of the TGF-β superfamily, Growth and Differentiation Factor 3 (GDF3) and Growth and Differentiation Factor 8 (GDF8). Although, we could not reproducibly confirm the presence of these factors in the CSF using western blot, they may nonetheless be important mediators of neurogenesis present in low concentrations. GDF3 is a BMP inhibitor believed to have multiple actions including, maintenance of pluripotency in human ES cells, as well as in the Nodal signaling pathway for early endoderm

formation[28-30]. GDF8, also known as Myostatin, is a negative regulator of muscle growth released by muscles to regulate skeletal muscle mass[31]. Although we have not yet found reports of GDF8 knockout mice having brain defects, a factor released from the muscles in response to muscle development that helps regulate brain growth is a tantalizing possibility. A careful analysis of these factors in the CSF needs to be pursued to determine their levels of expression, any temporal variations, and possible functions.

Two other potential neurogenic factors identified by mass spectrometry which we also could not reproducibly confirm by western blot, are Fibroblast Growth Factor 15 (FGF15), and Hepatoma Derived Growth Factor (HDGF)[31, 32]. A recent study shows that FGF15 promotes differentiation of neurons and suppresses proliferation[32]. With factors such as FGF2 and FGF15 in the CSF, it is possible that the CSF may act as a signaling medium for other FGFs in development. HDGF is a growth factor which has been isolated from human hepatoma cell lines and shown to be expressed by endothelial cells[33]. HDGF was identified in an analysis of genes regulated by circadian rhythm in the liver [34]. HDGF may not have been reproducibly identified in the CSF because of a potential cyclical expression pattern. This suggests that pulsatile expression of factors within other organs such as the liver may create a pulsatile expression within the CSF. With examples such as FGF15, GDF8 and HDGF in the CSF, it may be possible therefore that growth factors derived from a number of sources, including other organs, may be released into the serum and cross the brain-CSF barrier to effect brain development.

In addition to specific factors within the CSF, we also show that total protein concentration within the CSF increases from E12 to P0 and then decreases into

adulthood. The increase in total protein concentration within the CSF coincides with cortical development in the rat and in other species[35]. The increasing concentration of proteins within the CSF may create an oncotic pressure that pulls fluid into the ventricles which provides a necessary driving force for the expansion of the ventricles and therefore for proper brain development and neurogenesis[36]. Thus, whether the CSF is providing specific growth factors to the developing neuroepithelium, or creating a fluid filled space generating an outward pressure to the developing tissue, its role as a regulator of neurogenesis is slowly being elucidated.

Age dependent differences in CSF signals

The results in this thesis suggest that age-dependent differences in CSF signals are both supportive and instructive for precursor proliferation in the developing cortex. We show that E17 CSF stimulates proliferation of neural progenitor cells both in explants and as neurospheres more robustly than E13 CSF, P6 CSF, or adult CSF. We propose a few likely possibilities for this observation. One possibility is that factors within the CSF stimulate proliferation of progenitor cells to maintain a pool of stem cells throughout development and into adulthood. The radial glial cell gives rise to adult neural stem cells and a certain population of stem cells needs to be retained within the stem cell pool to give rise to the adult SVZ astrocytes[37]. The CSF may therefore be instrumental in generating and maintaining a pool of progenitor cells to give rise to the adult neural stem cells.

A second possibility is that the factors within the CSF stimulate progenitor cells to increase the number of intermediate or basal progenitors for the increased demand of

neurogenesis during that time period[38]. Very little is still understood regarding what factors stimulate radial glial cells to give rise to basal progenitor cells[38, 39], but it is possible that temporal changes in growth factors or concentration changes of modulatory proteins such as Lunatic fringe within the CSF help regulate this process.

Another possibility is that the CSF may contain environmental signals that restrict the potency of neural progenitors. In elegant transplantation studies, McConnell et al. showed that the fate of an early progenitor from a young animal transplanted into an older host depended on the timing of the cell cycle of the transplanted cell[40]. Early progenitors isolated shortly before mitosis and transplanted into a later host retained the cell fate specifications of the early progenitor and migrated to deep cortical levels of the older host[40]. In contrast, early progenitors isolated earlier in the cell cycle during S-phase and transplanted into the older host mostly adapted to the new environment and migrated to superficial cortical levels[40]. However, progenitors isolated late in development and transplanted into a younger host did not respond to the environment of the younger host and mostly generated later born neurons[40]. In careful stepwise experiments, Desai and McConnell, showed that potency became restricted in a progressive manner[41]. Therefore, this suggests that both intrinsic and extrinsic mechanisms affect the fate of a progenitor cell, and that there is a progressive shift in potency throughout development[40, 41]. This progressive shift in progenitor fate determination to effect proper brain development may be the result of changes in signaling factors within the CSF, such as IGF2, which show a progressive increase in concentration through peak points in neurogenesis and then decrease into adulthood. Therefore, progenitor cells in E16 explants may be more stimulated to proliferate when cultured in E17 CSF than with E13 CSF because the E16

tissue is able to better interpret the proliferative cues from later CSF than from earlier CSF. The results obtained from the P6 and adult CSF suggests that the proliferative factors within the CSF have decreased in concentration.

A fourth possibility is that factors within the CSF collected from different time points stimulate different populations of multipotential stem cells. Different populations of multipotential stem cells that are lineage restricted have been isolated from multiple areas of the developing brain[42-45]. In vivo retroviral lineage studies have also shown distinct populations of progenitor cells[46-48]. In addition, progenitor cells cultured in vitro in the presence of proliferation inducing factors first give rise to neurons and then start to generate glia[11]. Experimentally, the potency of the progenitor cell can be shifted by changes in concentration of specific growth factors[11]. The progenitor cells generally fell into 3 classes, neuron only (neurogenic), neuron-glia (neurogliogenic), and glia only (gliogenic). Therefore, CSF isolated from rats at different times in development may be triggering proliferation of different populations of progenitor cells. For example, E13 CSF may stimulate proliferation of neurogenic progenitors, whereas E17 CSF may stimulate the proliferation of neurogenic, neurogliogenic, and gliogenic progenitors. P6 and adult CSF therefore may stimulate proliferation of gliogenic progenitors. Therefore, the stem cells cultured in E13 CSF, if allowed to differentiate, may give rise to a greater percentage of neurons than stem cells cultured in E17 CSF or P6 CSF. Conversely, stem cells cultured in the E17 or P6 CSF may give rise to more glia than stem cells cultured in E13 CSF.

It is clear that both extrinsic and intrinsic mechanisms regulate neurogenesis. The environmental mechanisms may be regulated by factors within the CSF. Changes in

concentration of growth factors over time create temporal gradients that may affect the stem cell potency and may prime the ability of the various progenitor cell populations to accurately interpret the signals that are present in the environment. In addition, multiple growth factors and other signaling molecules are most likely acting in concerted, sequential manners regulating progenitor cell proliferation and differentiation.

Further and future analysis of CSF

We have started to collect and maintain a library of embryonic human and rat CSF from different ages during development in an attempt to further explore the embryonic CSF proteome. Deeper probing and investigating of the factors within the CSF may lead to some promising discoveries. It is likely that some of the essential factors within the CSF important for its biological actions are factors that are present in low abundance. Due to the high concentrations of albumin, immunoglobulins, and alpha-fetoprotein in the embryonic CSF, it may be difficult to identify factors present at low abundance via mass spectrometry. Therefore, either more sensitive techniques could be used to investigate the presence of specific factors within the CSF or better methods could be used for removing the highly abundant proteins within the CSF. For discovery based approaches, mass spectrometry is one of the most sensitive methods today to identify proteins in complex mixtures[49, 50], however the abundance of other factors often can mask the low abundant ions within the mass spectrometry instrument. Western blot analysis can be used to assay for the presence of a specific factor that one may be interested in, though some low abundance factors may also be too scarce to find by

western blot, so that various methods of concentration can be used to concentrate proteins within the CSF.

We are continuing our analyses of the human embryonic CSF proteome by performing mass spectrometry of CS19-20 embryonic CSF to further our proteome catalogue from our previous analysis[1]. We have also started to analyze CS21, CS22, and CS23 embryonic CSF. At these ages the CSF can still be collected with relative precision and low amounts of contamination. In addition, there are more selective albumin and immunoglobulin depletion methods for human fluids than for rat. Therefore, we are planning to perform an albumin and immunoglobulin depletion on the embryonic CSF before running the sample through the mass spectrometry. It would be very interesting to determine if the changes in protein expression we find with the rat embryonic CSF are similar in the human embryonic CSF.

There are other methods of analysis that could be used to analyze the CSF further. One method is to perform a 2-D gel electrophoresis to separate the proteins in one dimension based on isoelectric point and a second dimension based on molecular weight[51]. This gives the proteins a greater separation than a 1-D gel so that differences between samples may be visualized using silver stain or fluorescence based approaches[51]. Another technique that can identify small molecules within the CSF such as steroids and hormones is the gas chromatography followed by tandem mass spectrometry (GC-MS/MS)[52]. Preliminary GC-MS/MS data from our analysis of adult rat CSF identified one molecule, dodecanoic acid (lauric acid), a fatty acid previously reported to be present in the adult human CSF[53]. Surprisingly, lauric acid, which is the main fatty acid also found in coconut oil[54], has been shown to stimulate the interaction between albumin and

various steroid hormones[55]. Therefore the presence of fatty acids and other non-proteinaceous molecules may provide important regulatory mechanisms for protein-protein interactions, protein-hormone interactions, and protein-receptor interactions.

CSF and aging

The CSF is an intimate fluid compartment in contact with the central nervous system. It provides essential ions, nutrients and growth factors to the tissue, as well as acting as a sink for toxins, drugs and various cellular metabolites[13]. In addition it provides essential regulatory activities such as antioxidants and protease inhibitors. During the aging process a number of mechanisms can affect the brain's internal environment. In rats it has been shown that the CSF turns over in 2 hours at three months of age and 8 hours at 30 months of age which was caused by a decrease in the production of the CSF[56]. In humans similar results have been obtained, but contradictory studies make it difficult to interpret[56, 57]. It has been suggested however that the turnover rate for humans may decrease from 4 times per day to 1 or 2 times per day with age[57]. The decreased production of CSF may be caused by a number of mechanisms, including choroid plexus degeneration, basement membrane thickening, decreased ion transport, and hormonal changes (vasopressin increases with age in the CSF causing decreased CSF secretion)[56, 58]. Therefore, with aging as CSF secretion is diminished, important signaling molecules such as IGF2, FGF2, soluble APP, Slit2, Cystatin C, and PEDF may be decreased in the CSF which may influence neuronal survival, as well as stem cell proliferation, differentiation and migration.

Decreased production of CSF in aging may be compounded by other factors as well, leading to the CSF collecting harmful waste products within the brain[56]. Aging tissue may be more resistant to draining the CSF due to the degeneration of the arachnoid granulations or decreased transporters on the choroid plexus that clear molecules from the ventricles[56, 59]. There may also be decreased ciliary movement along the ventricles of the brain causing decreased CSF circulation. In addition, aging causes increased free radical and reactive oxygen species within the CSF[13], and the normal mechanisms for clearing or neutralizing these compounds may be compromised. Therefore, CSF stagnation caused by decreased production and removal of CSF may cause an increase in metabolic waste products within the CSF and this may have deleterious effects on the neuronal tissues.

Given the embryonic role of CSF to regulate neurogenesis, it is intriguing to speculate that functional changes in the CSF with age may lead to decreased neurogenesis, and perhaps relating somehow to age-related memory impairment and dementia[60, 61]. This model would pre-suppose that embryonic and adult CSF have roles to promote increased neurogenesis in the adult brain. Preliminary results in chapter 4 of this thesis have shown that embryonic CSF stimulates adult stem cell proliferation in vitro. In an attempt to assess whether embryonic CSF can stimulate adult stem cell proliferation in vivo, we infused embryonic CSF into the lateral ventricles of an adult. In addition we have also infused purified IGF2 into the lateral ventricles to assess if IGF2 may play a role in adult stem cell proliferation. We are awaiting the results from our CSF replacement experiment.

CSF and neurodegeneration

In Alzheimer's disease (AD), CSF production is decreased and poor CSF circulation may contribute to disease pathology[62]. One major finding in AD is the presence of amyloid plaques deposited in the cortex[63-65]. The amyloid plaques contain Aβ peptides. The amyloidogenic Aβ peptides are formed by β-secretase and γ-secretase cleavage of the integral membrane glycoprotein APP[64-66]. APP which is cleaved by the α-secretase generates the non-amyloidogenic secreted soluble APP (sAPP) found in the CSF[22]. The Aβ peptides are known to multimerize and form fibrils which aggregate in various brain regions[64]. Increased levels of Aβ are associated with promoting amyloid plaque formation[65, 67]. Normally Aβ peptides created by the proteolysis of APP are rapidly cleared by the CSF[56, 57, 62, 68]. However, CSF stagnation and decreased CSF production with age may lead to an increase in Aβ peptides within the CSF that cannot be cleared or neutralized, and therefore, the Aβ peptides may have a stronger predisposition to form fibrils and later become plaques[56, 57, 62, 68, 69].

CSF contains a number of factors implicated in Alzheimer's disease. One factor in the CSF is Amyloid Beta A4 Protein Precursor (APP), which we identified in embryonic human and rat CSF as well as in adult CSF. sAPP is normally present in brain and soluble forms are known to circulate in adult CSF[70]. The soluble form of APP has been shown to stimulate proliferation of embryonic neural stem cells as well as adult neural progenitor cells from the subventricular zone[21, 22, 71]. Soluble isoforms of APP may play a role during development and in the adult and may be released in the extracellular space and taken up in the CSF in order to diffuse throughout the CSF to function at more distant sites. Interestingly, levels of non-amyloidogenic sAPP are

decreased in the CSF of AD patients[72]. Therefore, it is possible that decreased levels of sAPP, due to altered APP proteolysis, may lead to a decrease in neuronal proliferation and survival in AD.

Other proteins are also relatively abundant in the CSF and may be relevant to AD. Gelsolin solubilizes Aβ fibrils and prevents Aβ fibrillization, therefore decreasing the likelihood of plaque formation[73, 74]. Gelsolin also acts as a calcium-regulated actin binding protein that helps regulate cell motility and extracellular matrix remodeling, and enhances neurite extension in PC12 cells[75-77]. Apolipoproteins, also implicated in AD, include a large class of proteins found in the adult and embryonic CSF, which increase in complexity between embryonic chick CSF and rat CSF and are important for neural differentiation[2, 78]. Interestingly, Apolipoprotein E (ApoE) is one of the main lipid transporters found in the CSF that has been implicated in Aβ clearance, antioxidant activity, and neurite extension[79]. ApoE also functions to deliver lipids for neuronal regeneration and repair after injury[79].

Another common functional class of proteins in the CSF is protease inhibitors which may provide therapeutic value for neurodegenerative disease. Recently, Hook et al. showed that infusion of protease inhibitors into the ventricles reduced in vivo levels of Aβ and improved memory[80-82]. In addition, Cystatin C, a potent Cathepsin B inhibitor found in the CSF[1], had been shown to inhibit Aβ deposition in mouse models of Alzheimer's disease[83, 84]. Cathpesin B has been implicated in a number of different diseases and pathologies including Alzheimer's, cancer, arthritis, and airway disease. Cathepsin B has also been implicated to act as the β-secretase for the proteolytic processing of APP to generate the extracellular Aβ peptides[85]. Therefore, throughout life

the CSF may inhibit proteases released into the ECM by proliferating cells, dying cells, or as a natural mechanism of growth and plasticity. Overall, as the brain ages and potentially CSF secretion and flow are altered[62, 68], the CSF may become stagnant potentially resulting in a decrease in neurogenic factors, or regulatory enzymes and protease inhibitors, and an increase in toxic levels of metabolic by-products, all potentially leading to neurodegeneration and impaired memory[57, 62, 68].

Conclusion

Our findings have several important implications that may be relevant to biology in general. As we previously mentioned in the introduction, all epithelia develop in relation to fluids. The fluid environment that contacts a cell or tissue may potentially provide some information or instructions, especially when cells have primary cilia extending into that environment[86]. It is now believed that almost every cell has a primary cilium[87], and therefore every cell may be monitoring the extracellular environment for instructional cues to proliferate and expand, remain quiescent, differentiate, or even undergo apoptosis. The neuroepithelial cells, radial glial cells, and adult SVZ astrocytes are most likely constantly monitoring the environment through their primary cilia contacting the CSF to perceive signals from the external environment that can direct their fate and provide instructional cues for development. Therefore, since the CNS represents just one example of an epithelium that grows in relation to an extracellular fluid, our findings may generalize to other epithelia that are likely to develop using similar rules, with a major contributor of instructional signals coming from the fluid that bathes the epithelium. In addition, if a major component of a stem cell niche reflects secreted

factors acting at large distances from their sources, a deeper understanding of the proteomic composition of extracellular fluids may provide unexpected ways to regulate stem cell behavior.

In conclusion, embryonic and adult CSF components, which can potentially be dispersed over large areas, may be more significant and pervasive regulators of development, stem cell renewal, disease, neurodegeneration and behavior than previously thought. Cells lining the neural tube during development, or along the ventricles in the adult, could be responsive to factors released into the CSF immediately by changes in food consumption, exercise, mood, sex, sleep, etc. Therefore, the CSF may be a vehicle to provide immediate signaling to major control centers of the brain. As the physicians and philosophers surmised 2,000 years ago, maybe indeed the CSF acts as an agent for communication between body and mind, though perhaps not quite as a "spirit" traveling within our central nervous system. If appetite, behavior and especially sleep can be considered as factors that affect our state of consciousness and if CSF can indeed regulate the state of arousal[88-90], then the CSF may be the perfect vehicle to regulate our state of consciousness.

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Appendix 1

Human and Rat Proteome Tables

Table 1.1. Protein list of mass spectrometry analysis of Carnegie Stage 20 embryonic human CSF. A – represents number of unique peptides, B – represents number of total peptides.

A	B	Name of Protein	MW	Subcellular location	Function	Tissue Specificity	Notes	Found in Rat CSF
206	**584**	APOLIPOPROTEIN B-100 PRECURSOR	515563	Secreted	Lipid and fatty acid transport and metabolism	Plasma	Apo B-100 functions as a recognition signal for the cellular binding and internalization of LDL particles by the apoB/E receptor	Yes - all rat samples
43	**79**	ISOFORM 1 OF FIBRONECTIN PRECURSOR	262607	Secreted, extracellular space, extracellular matrix	Cell adhesion, cell motility, wound healing, and maintenance of cell shape	Plasma fibronectin made by liver and cellular fibronectin made by fibroblasts, epithelial and other cell types is deposited in the extracellular matrix	Integrin signaling pathway	Yes - all rat samples
42	**114**	ALPHA-2-MACROGLOBULIN PRECURSOR	163278	Secreted	Serine Protease Inhibitor	Plasma	Contrary to the rat protein, which is an acute phase protein, this protein is always present at high levels in circulation	Yes - all rat samples

27	**63**	SEROTRANSFERRIN PRECURSOR	77050	Secreted	Transport, Transfer/ Carrier	Plasma	Transport of iron from sites of absorption and heme degradation to those of storage and utilization. Serum transferrin may also play a role in stimulating cell proliferation	Yes - all rat samples
25	**91**	ALB (Albumin) PROTEIN	71705	Secreted	Transport, Transfer/ Carrier	Plasma	Serum albumin, the main plasma protein, has a good binding capacity for water, calcium, sodium, potassium, fatty acids, hormones, bilirubin and drugs. Its main function is the regulation of the colloidal osmotic pressure of blood	Yes - all rat samples
23	**34**	COMPLEMENT COMPONENT 3 PRECURSOR	187306	Secreted	Complement mediated immunity	Plasma	Plays a central role in the activation of the complement system	Yes - all rat samples

21	**87**	ALPHA-FETOPROTEIN PRECURSOR	68678	Secreted	Transport, Transfer/ Carrier	Plasma	Binds copper, nickel, and fatty acids as well as, and bilirubin less well than, serum albumin	Yes - all rat samples
19	**45**	INTER-ALPHA-TRYPSIN INHIBITOR HEAVY CHAIN H2 PRECURSOR	106436	Secreted	Serine Protease Inhibitor	Plasma, widely distributed	May act as a carrier of hyaluronan in serum or as a binding protein between hyaluronan and other matrix protein, including those on cell surfaces in tissues to regulate the localization, synthesis and degradation of hyaluronan which are essential to cells undergoing biological processes.	Yes - present in rat E14.5, E17.5 LV
14	**14**	FATTY ACID SYNTHASE	273400	Cytoplasm	Lipid and fatty acid biosynthesis	Ubiquitous. Prominent expression in brain, lung, and liver	Involved in catalyzing the formation of long chain fatty acids	Yes - all rat samples

14	**15**	ISOFORM 1 OF TENASCIN PRECURSOR	240866	Secreted, extracellular space, extracellular matrix	Cell adhesion, extracellular matrix glycoprotein-mediated signaling	Widely distributed	Extracellular matrix protein implicated in guidance of migrating neurons as well as axons during development, synaptic plasticity as well as neuronal regeneration. Ligand for integrin receptors.	Yes - all rat samples
13	**25**	INTER-ALPHA-TRYPSIN INHIBITOR HEAVY CHAIN H1 PRECURSOR	101389	Secreted	Protease Inhibitor	Plasma	See notes on INTER-ALPHA-TRYPSIN INHIBITOR HEAVY CHAIN H2 PRECURSOR above.	Similar to inter-alpha-inhibitor H4 heavy chain
12	**17**	COMPLEMENT C5 PRECURSOR	188331	Secreted	Complement mediated immunity	Plasma	Activation of C5 by a C5 convertase initiates the spontaneous assembly of the late complement components, C5-C9, into the membrane attack complex.	Yes - present in E17.5 LV
12	**19**	ISOFORM 1 OF FIBRINOGEN ALPHA CHAIN PRECURSOR	94973	Secreted	Blood clotting	Plasma	Monomers polymerize into fibrin and also acts as a cofactor in platelet aggregation.	Yes - all rat samples

11	**27**	ISOFORM GAMMA-B OF FIBRINOGEN GAMMA CHAIN PRECURSOR	51512	Secreted	Blood clotting	Plasma	Monomers polymerize into fibrin and also acts as a cofactor in platelet aggregation.	Yes - all rat samples
11	**12**	ALPHA 3 TYPE VI COLLAGEN ISOFORM 1 PRECURSOR	343669	Secreted, extracellular space, extracellular matrix	Cell adhesion - Cell structure	Widley distributed, expressed in muscles	Collagen VI acts as a cell-binding protein	Yes - present in rat E14.5, E17.5 LV
10	**19**	APOLIPOPROTEIN A-I PRECURSOR	30778	Secreted	Lipid and fatty acid transport and metabolism	Major protein of plasma HDL, also found in chylomicrons.	Participates in the reverse transport of cholesterol from tissues to the liver for excretion by promoting cholesterol efflux from tissues.	Yes - all rat samples
10	**13**	ISOFORM 1 OF GELSOLIN PRECURSOR	85698	Secreted	Actin remodeling - Cell structure	Plasma	Calcium-regulated, actin-modulating protein. It can promote the assembly of monomers into filaments as well as sever filaments already formed. May be involved in myelination.	Yes - all rat samples

10	**16**	PLASMA PROTEASE C1 INHIBITOR PRECURSOR	55154	Secreted	Serine Protease Inhibitor	Plasma	May regulate complement activation, blood coagulation, fibrinolysis and the generation of kinins.	Yes - all rat samples
10	**12**	COMPLEMENT C4-A PRECURSOR	192771	Secreted	Complement mediated immunity	Plasma	Inflammatory response	Yes - all rat samples
10	**10**	ISOFORM 1 OF ECTONUCLEOTIDE PYROPHOSPHATASE/PHOSPHODIESTERASE 2	99004	Membrane	Hydrolase	Predominantly expressed in brain, placenta, ovary, and small intestine.	Localized in secretory epithelial cells in the brain and the eye including choroid plexus epithelial cells, ciliary epithelial cells, iris pigment epithelial cells, and retinal pigment cells. Has a potent tumor cell motility-stimulating activity.	Yes - all rat samples
9	**16**	FIBRINOGEN BETA CHAIN PRECURSOR	55928	Secreted	Blood clotting	Plasma	Monomers polymerize into fibrin and also acts as a cofactor in platelet aggregation.	Yes - all rat samples

9	**22**	TRANSTHYRETIN PRECURSOR	15887	Secreted	Hormone transport	Most abundant in the choroid plexus. Also present in the liver	Thyroid hormone-binding protein. Probably transports thyroxine from the bloodstream to the brain.	Yes - all rat samples
8	**17**	ALPHA-1-ANTITRYPSIN PRECURSOR	46737	Secreted	Serine Protease Inhibitor	Plasma	Belongs to the serpin family	Yes - all rat samples
8	**21**	AMBP PROTEIN PRECURSOR	38999	Secreted	Serine Protease Inhibitor	Plasma, urine, and cerebrospinal fluid	It appears not only as a free monomer but also in complexes with IgA and albumin.	Yes - all rat samples
8	**11**	ISOFORM SHORT OF RECEPTOR-TYPE TYROSINE-PROTEIN PHOSPHATASE ZETA PRECURSOR	163444	Membrane	Cell surface receptor mediated signal transduction, transmembrane receptor protein tyrosine phosphatase activity	Central nervous system	May be involved in the regulation of specific developmental processes in the CNS	Yes - all rat samples
8	**8**	HYPOTHETICAL PROTEIN DKFZP761K0511 - heat shock 90kDa protein 1, beta	84843	Cytoplasm	Chaperone, protein folding, stress response	Ubiquitous	Belongs to the heat shock protein 90 family	Yes - all rat samples

8	**15**	PRO2275 - Serpin peptidase inhibitor, clade A (alpha-1 antiproteinase, antitrypsin), member 1	13097	Secreted	Serine Protease Inhibitor - Blood coagulation	Plasma	Belongs to the serpin family	
7	**9**	CERULOPLASMIN PRECURSOR	122205	Secreted	Transport, Transfer/ Carrier, Oxidoreductase	Plasma	It is involved in iron transport across the cell membrane, and metal ion oxidoreductase activity	Yes - similar to GPI anchored ceruloplamsin present in all rat samples
7	**8**	45 KDA PROTEIN - Homologous to Phospholipid transfer protein	44847	Secreted	Transport, Transfer Carries	Plasma, widely distributed	Involved in phospholipid transfer in the serum.	Yes - all rat samples
7	**10**	CADHERIN-2 PRECURSOR (Neuronal cadherin)	99851	Membrane	Cell adhesion	Widely distributed	May be involved in neuronal tissue recognition	Yes- neural cadherin precursor present in all rat samples
7	**7**	ISOFORM 1 OF DNA-DEPENDENT PROTEIN KINASE CATALYTIC SUBUNIT	469089	Nucleus	Serine/threonine-protein kinase	Ubiquitous	Molecular sensor for DNA damage	

7	**7**	HEAT SHOCK PROTEIN HSP 90-ALPHA 2	98113	Cytoplasm	Molecular chaperone, protein folding, stress response	Ubiquitous	Belongs to the heat shock protein 90 family	Yes - HSP 90 family present in all rat samples
7	**7**	MYOSIN-10	228939	Intracellular	Cell structure, cell motility	Brain	Actin binding motor protein	Yes - all rat samples
7	**16**	PREGNANCY ZONE PROTEIN PRECURSOR	163836	Secreted	Protease Inhibitor	Plasma	Belongs to the protease inhibitor I39 (alpha-2-macroglobulin) family	Yes - alpha-1-macroglobulin present in all rat samples
6	**10**	APOLIPOPROTEIN E PRECURSOR	36154	Secreted	Lipid and fatty acid transport and metabolism	Plasma	Mediates the binding, internalization, and catabolism of lipoprotein particles.	Yes - all rat samples
6	**6**	MICROTUBULE-ASSOCIATED PROTEIN 1B	270620	Intracellular	Cell structure	Brain	The function of brain MAPS is unknown. Phosphorylated MAP1B may play a role in the cytoskeletal changes that accompany neurite extension.	Yes - present in rat E12.5 LV, E17.5 LV
6	**6**	COMPLEMENT C2 PRECURSOR (FRAGMENT)	83268	Secreted	Serine protease, complement-mediated immunity	Plasma	Belongs to the peptidase S1 family.	Yes - all rat samples

6	**6**	LAMININ GAMMA-1 CHAIN PRECURSOR (Laminin B2 chain)	177607	Secreted, extracellular space, extracellular matrix	Extracellular matrix linker protein-mediated signaling	Basement membranes	Binds to cells and is thought to mediate the attachment, migration and organization of cells into tissues during embryonic development by interacting with other extracellular matrix components.	Yes - present in rat E12.5 LV, E14.5
6	**7**	ANGIOTENSINOGEN PRECURSOR	53154	Secreted	Serine Protease Inhibitor	Plasma	Belongs to the serpin family. Helps regulate volume and mineral balance of body fluids.	Yes - all rat samples
6	**7**	CADHERIN-5 PRECURSOR	87516	Membrane	Cell adhesion	Endothelial tissues and brain	Plays a role in endothelial adhesion.	Yes - all rat samples
6	**7**	BASEMENT MEMBRANE-SPECIFIC HEPARAN SULFATE PROTEOGLYCAN CORE PROTEIN PRECURSOR (Perlecan)	468825	Secreted, extracellular space, extracellular matrix	Cell adhesion	Widely distributed in various tissues	Integral component of basement membranes.	Yes - all rat samples
6	**10**	AGRIN PRECURSOR	214889	Secreted, extracellular space, extracellular matrix	Cell adhesion mediated signaling	Embryonic nervous system and muscle.	Component of the basal lamina that binds to laminin.	Yes - all rat samples

5	**7**	GALECTIN-3-BINDING PROTEIN PRECURSOR	65331	Secreted, extracellular space, extracellular matrix	Intergrin-mediated cell adhesion	Ubiquitous. Detected in body fluids such as semen, milk, serum, tears, saliva and urine.	May stimulate host defense against viruses and tumor cells.	
5	**5**	ISOFORM 2 OF INTER-ALPHA-TRYPSIN INHIBITOR HEAVY CHAIN H4 PRECURSOR	101242	Secreted	Protease Inhibitor	Plasma	May be involved in acute phase reactions.	Yes - all rat samples
5	**5**	MYOSIN-9	226401	Intracellular	Cytokinesis, cell shape, and specialized functions such as secretion and capping	In the kidney, expressed in the glomeruli. Also expressed in leukocytes.	Non-muscle myosin involved in a number of cellular functions.	Yes - present in 12.5LV, E14.5LV, E17.5LV
5	**7**	ALPHA-1B-GLYCOPROTEIN PRECURSOR	54273	Secreted	Function unknown	Plasma	Immunoglobulin domain glycoprotein	Yes - present in E12.5LV, E14.5
5	**5**	ISOFORM V0 OF VERSICAN CORE PROTEIN PRECURSOR	372820	Secreted, extracellular space, extracellular matrix	Extracellular matrix protein-mediated signaling, cell adhesion, cell motility	Brain	Also known as chondroitin sulfate proteoglycan core protein 2	Yes - all rat samples

5	**7**	ISOFORM B OF FIBULIN-1 PRECURSOR	77186	Secreted, extracellular space, extracellular matrix	Cell adhesion, cell motility	Widely expressed during embryonic development.	Incorporated into fibronectin-containing matrix fibers. May play a role in cell adhesion and migration along protein fibers within the extracellular matrix. Could play a significant role in modulating the neurotrophic activities of APP, particularly soluble APP.	Yes - all rat samples

5	**7**	PIGMENT EPITHELIUM-DERIVED FACTOR PRECURSOR (PEDF)	46342	Secreted	Serpin family member - neurotrophic properties, antiangiogenic	Retinal pigment epithelial cells, adult murine SVZ cells, and blood plasma	Pigment epithelium-derived factor, a neurotrophic protein, is a member serpin that has been shown to promote the survival and/or differentiation of rat cerebellar granule neurons and human retinoblastoma cells in vitro. Also PEDF was shown to prevent the death and atrophy of spinal motor neurons in the developing neonatal mouse after axotomy. PEDF is also secreted by retinal pigment epithelial cells into the interphotoreceptor matrix, where it acts on photoreceptor cells.	
5	**6**	ISOFORM 2 OF CADHERIN-11 PRECURSOR	76541	Membrane	Cell adhesion	Expressed mainly in brain but also found in other tissues. Expressed in neuroblasts	Also known as osteoblast-cadherin	Yes - all rat samples
5	**5**	HEMOGLOBIN SUBUNIT ZETA	15506	Intracellular	Oxygen Transport, Transfer - Carrier Protein	Red blood cells	The zeta chain is an alpha-type chain of mammalian embryonic hemoglobin, synthesized primarily in the yolk sac.	

5	**5**	ISOFORM 2 OF NEURAL CELL ADHESION MOLECULE L1-LIKE PROTEIN PRECURSOR	136654	Membrane	Extracellular matrix protein-mediated signaling, cell adhesion, cell motility	Expressed in the fetal and adult brain	Plays a role in nervous system development. Plays important roles in neurite outgrowth and neuronal survival.	
5	**6**	NESTIN	176706	Intracellular	Cell structure	CNS stem cells.	Upon terminal neural differentiation, nestin is down-regulated and replaced by neurofilaments.	Yes - present in E12.5 LV, E14.5 LV, E17.5 LV
5	**7**	ISOFORM 1 OF COMPLEMENT FACTOR B PRECURSOR (FRAGMENT)	85533	Secreted	Serine Protease - Complement Mediated Immunity	Plasma	Hydrolase, Peptidase	Yes - all rat samples
4	**5**	ISOFORM SHORT OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN U	88814	Nucleus. Cell surface	DNA and RNA binding and RNA processing.	Ubiquitous	Invovled in RNA splicing	Yes - all rat samples
4	**4**	CREATINE KINASE B-TYPE	42644	Membrane	Kinase, energy modulation	Ubiquitous	Plays a central role in tissues with variable energy demands.	Yes - all rat samples
4	**4**	HEAT SHOCK 70 KDA PROTEIN 4	94300	Intracellular - Cytoplasm	Heat shock, protein folding, stress response	Ubiquitous	Heat shock protein 70 family	Yes - all rat samples

4	**4**	ATP-DEPENDENT DNA HELICASE 2 SUBUNIT 2	82573	Nucleus	Single stranded ATP-dependent DNA helicase activity	Ubiquitous	Plays a role in chromosome translocation. Involved in DNA nonhomologous end joining required for double-strand break repair and V(D)J recombination.	
4	**4**	NCL (Nucleolin) PROTEIN	51641	Nucleus	Major nucleolar protein of growing eukaryotic cells. Nucleotide binding	Ubiquitous	It is thought to play a role in pre-rRNA transcription and ribosome assembly	Yes - present in E12.5 LV, E17.5 LV
4	**4**	ISOFORM 1 OF NUCLEAR AUTOANTIGENIC SPERM PROTEIN	85238	Intracellular - Nucleus, Cytoplasm	Nuclear-cytoplasmic shuttling	Testis and Sperm	Required for DNA replication, normal cell cycle progression and cell proliferation.	Yes - all rat samples
4	**10**	TRYPSIN PRECURSOR (EC 3.4.21.4)>PIR1:TRPGTR trypsin (EC 3.4.21.4)	26558	Secreted, extracellular space, extracellular matrix	Serine protease	Ubiquitous	Belongs to the peptidase S1 family	
4	**7**	ANTITHROMBIN III VARIANT	52692	Secreted	Serine Protease Inhibitor	Plasma	Regulates the blood coagulation cascade. Belongs to the serpin family.	

4	**9**	VITRONECTIN PRECURSOR	54306	Secreted, extracellular space, extracellular matrix	Cell adhesion	Plasma	Vitronectin is an abundant glycoprotein found in blood plasma and the extracellular matrix. It regulates proteolysis initiated by plasminogen activation. It is recognized by certain members of the integrin family and serves as a cell-to-substrate adhesion molecule.	
4	**4**	PROTEIN KINASE C-BINDING PROTEIN NELL2 PRECURSOR	91346	Secreted	Cell communication, Cell adhesion, Cell structure	Widely distributed	Regulation of growth and neurogenesis	Yes - all rat samples
4	**4**	NETRIN RECEPTOR DCC PRECURSOR	158457	Membrane	Ligand mediated signaling, cell adhesion	Axons of the central and peripheral nervous system and in differentiated cell types of the intestine	Axon guidance and neuronal growth cone growth	Yes - all rat samples

4	**4**	CONTACTIN-2 PRECURSOR	113393	Membrane; (attached to the neuronal membrane by a GPI-anchor and is also released from neurons)	Cell Adhesion - Neurogenesis	Highly expressed in brain	May play a role in the initial growth and guidance of axons. Belongs to the immunoglobulin superfamily.	Yes - all rat samples
4	**5**	ISOFORM 1 OF ATTRACTIN PRECURSOR	158537	Membrane	Protease involved in cell clustering during inflammatory response	Secreted by activated T lymphocytes. Also expressed in peripheral blood leukocytes, spleen, lymph node, tonsil, bone marrow and fetal liver.	May regulate chemotactic activity of chemokines. Has a critical role in normal myelination in the central nervous system.	Yes - all rat samples
4	**6**	FACTOR VII ACTIVE SITE MUTANT IMMUNOCONJUGATE	75553	Secreted	Serine Protease - Blood clotting	Plasma	Involved in blood coagulation, activated by Factor Xa	
4	**5**	QUIESCIN Q6 ISOFORM A	82578	Membrane	Oxidase	Widely distributed, expressed in heart, placenta, lung, liver, skeletal muscle, pancreas and very weakly in brain and kidney	May contribute to disulfide bond formation in a variety of secreted proteins. Induced in quiescent cells.	Yes - all rat samples

4	**7**	COLLAGEN ALPHA-1(III) CHAIN PRECURSOR	138555	Secreted, extracellular space, extracellular matrix	Cell adhesion - Cell structure	Widely distributed, highly expressed in skin, lungs, intestinal walls, and blood vessels	Present in most soft connective tissue	Yes - all rat samples
4	**6**	DESMOGLEIN 2	122294	Membrane	Cell adhesion	Widley distributed	Component of desmosomes	
4	**4**	FAR UPSTREAM ELEMENT-BINDING PROTEIN 2	72709	Intracellular - Nucleus, Cytoplasm	RNA binding, RNA processing and may play a role in mRNA trafficking	Detected in neural and non-neural cell lines.		Yes - present in E12.5 LV, E14.5 LV, E17.5 LV
4	**7**	HEPARIN COFACTOR 2 PRECURSOR	60178	Secreted	Thrombin inhibitor involved in blood clotting - Serine Protease Inhibitor	Expressed predominantly in liver.	Belongs to the serpin family.	Yes - present in E14.5 4thV, E17.5 LV
4	**4**	FILAMIN A, ALPHA	280018	Intracellular	Cell structure, cell motility	Ubiquitous	Actin binding protein	Yes - all rat samples
4	**4**	ISOFORM 1 OF CULLIN-ASSOCIATED NEDD8-DISSOCIATED PROTEIN 1	136376	Nucleus	Transcriptional Enhancer	Widely distributed, highly expressed in lung fibroblasts	Down-regulates ubiquitination of target proteins.	Yes - all rat samples

4	**5**	ISOFORM 1 OF NEOGENIN PRECURSOR	159959	Membrane	Cell adhesion	Widely expressed	May be involved as a regulatory protein in the transition of undifferentiated proliferating cells to their differentiated state. Belongs to the immunoglobulin superfamily.	Yes - all rat samples
4	**4**	PLASMINOGEN PRECURSOR	90569	Secreted	Protease	Present in plasma and many other extracellular fluids	Plasmin dissolves the fibrin of blood clots and acts as a proteolytic factor in a variety of other processes including embryonic development, tissue remodeling, tumor invasion, and inflammation.	Yes - all rat samples

3	**8**	PLASMA RETINOL-BINDING PROTEIN PRECURSOR	23010	Secreted	Vitamin/ Co-factor transport	Plasma	Delivers retinol from the liver stores to the peripheral tissues. In plasma, the RBP-retinol complex interacts with transthyretin, this prevents its loss by filtration through the kidney glomeruli.	Yes - all rat samples
3	**4**	APOLIPOPROTEIN A-IV PRECURSOR	45399	Secreted	Lipid and fatty acid transport and metabolism	Plasma	May have a role in chylomicrons and VLDL secretion and catabolism. Apoa-IV is a major component of HDL and chylomicrons.	Yes - all rat samples
3	**3**	EXPORTIN-1	123386	Intracellular - Nucleus, Cytoplasm	Nuclear export of cellular proteins and RNAs	Ubiquitous	Mediates nuclear export signal dependent protein transport	Yes - present in E12.5 LV, E14.5 LV, E17.5 LV
3	**3**	COLLAGEN ALPHA-1(V) CHAIN PRECURSOR	183560	Secreted, extracellular space, extracellular matrix	Cell adhesion - Cell structure	Ubiquitous	Component of connective tissue	Yes - all rat samples

3	**3**	LAMININ BETA-1 CHAIN PRECURSOR	198066	Secreted, extracellular space, extracellular matrix	Extracellular matrix linker protein-mediated signaling	Widely distributed in basement membranes	Is thought to mediate the attachment, migration and organization of cells into tissues during embryonic development by interacting with other extracellular matrix components.	Yes - all rat samples
3	**3**	IMPORTIN BETA-1 SUBUNIT	97170	Intracellular - Nucleus, Cytoplasm	Nuclear protein import	Ubiquitous	Import of proteins with nuclear localization signal	Yes - present in E12.5 LV, E14.5 LV, E17.5 LV
3	**3**	COFILIN-1	18371	Intracellular - Nucleus, Cytoplasm	Cell structure - cytoskeleton	Widely distributed in various tissues	Controls actin polymerization and depolymerization. A major component of intranuclear and cytoplasmic actin rods.	Yes - present in E12.5 LV, E14.5 LV, E17.5 LV
3	**3**	MYRISTOYLATED ALANINE-RICH C-KINASE SUBSTRATE	31423	Intracellular	Actin binding, actin cytoskeleton, cell structure	Ubiquitous	MARCKS is the most prominent cellular substrate for protein kinase C. MARCKS is a filamentous (F) actin cross-linking protein.	

3	**3**	UBIQUITIN-ACTIVATING ENZYME E1	117849	Intracellular	Protein modification	Ubiquitous	Involved with ubiquitin conjugation by activating ubiquitin	Yes - all rat samples
3	**3**	POLY [ADP-RIBOSE] POLYMERASE 1	112953	Nucleus	DNA repair	Ubiquitous	Involved in the base excision repair pathway	Yes - present in E12.5 LV, E17.5 LV
3	**3**	TRANSITIONAL ENDOPLASMIC RETICULUM ATPASE	89191	Intracellular - Nucleus, Cytoplasm	Protein targeting and localization, intracellular protein traffic	Ubiquitous	Necessary for the fragmentation of Golgi stacks during mitosis and for their reassembly after mitosis. Involved in the formation of the transitional endoplasmic reticulum.	Yes - all rat samples
3	**3**	TYPE 1 TUMOR NECROSIS FACTOR RECEPTOR SHEDDING AMINOPEPTIDASE REGULATOR ISOFORM A	107841	Secreted	Protease	Ubiquitous	May play a role in the inactivation of peptide hormones. May be involved in the regulation of blood pressure.	
3	**3**	COMPLEMENT C1R SUBCOMPONENT PRECURSOR	80174	Secreted	Protease - complement mediated immunity	Plasma	Classical pathway of the complement system	

3	**3**	ISOFORM 1 OF MULTIPLE EPIDERMAL GROWTH FACTOR-LIKE DOMAINS 8	254573	Membrane	Cell adhesion, cell structure	Widely distributed	Also known as Multiple EGF like domain protein 4	
3	**3**	GLYCERALDEHYDE-3-PHOSPHATE DEHYDROGENASE	35922	Cytoplasm	Glycolysis, carbohydrate degradation	Ubiquitous		Yes - present in E12.5 LV, E17.5 LV
3	**3**	ISOFORM B1 OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEINS A2/B1	37430	Nucleus	mRNA processing	Ubiquitous	Forms ribonucleosome complexes	Yes - present in E14.5 LV
3	**3**	CLUSTERIN PRECURSOR	52495	Secreted	Function unclear; has been implicated in apoptosis	Ubiquitous	Seems to be able to bind to cells, membranes and hydrophobic proteins. Has been implicated in membrane lipid recycling, in apoptotic cell death, and as a stress-induced secreted chaperone protein.	Yes - present in E14.5, E17.5 LV

3	**4**	127 KDA PROTEIN - RAN binding protein 5	126522	Intracellular - Nucleus, Cytoplasm	Nuclear-cytoplasmic transport	Ubiquitous	Involved in the import of proteins with the nuclear localization signal.	Yes - one isoform found in E12.5 LV, E14.5 LV, E17.5 LV, 2nd isoform found in E12.5 LV, E14.5 4thV, and E17.5 LV
3	**4**	HEAT SHOCK PROTEIN 86 (FRAGMENT)	35674	Cytoplasm	Molecular chaperone, protein folding, stress response	Ubiquitous	Heat shock protein family	Yes - all rat samples
3	**5**	ALPHA-2-HS-GLYCOPROTEIN PRECURSOR	39325	Secreted, extracellular space, extracellular matrix	Cysteine protease inhibitor	Synthesized in liver and concentrated in bone. Secreted in plasma.	Extracellular matrix glycoprotein involved in skeletal development	Yes - present in E14.5, E17.5 LV
3	**3**	GAMMA-G GLOBIN (FRAGMENT)	16969	Intracellular	Oxygen Transport, Transfer - Carrier Protein	Red blood cells	Belongs to the globin family	

3	**3**	PROTHROMBIN PRECURSOR (FRAGMENT)	70037	Secreted	Blood clotting	Expressed by the liver and secreted in plasma	Thrombin, converts fibrinogen to fibrin and activates factors V, VII, VIII, XIII, and, in complex with thrombomodulin.	Yes - present in E14.5 4thV, E17.5 LV
3	**3**	ALPHA-MANNOSIDASE 2	131084	Golgi apparatus	Glycosidase	Ubiquitous	Involved in N-glycosylation	Yes - all rat samples
3	**3**	ISOFORM 1 OF ROUNDABOUT HOMOLOG 1 PRECURSOR	180930	Membrane	Axon guidance receptor	Widely expressed	Receptor for SLIT1 and SLIT2 which are thought to act as molecular guidance cue in cellular migration, including axonal navigation at the ventral midline of the neural tube and projection of axons to different regions during neuronal development.	Yes - present in E14.5 4thV
3	**3**	ISOFORM 1 OF PERIOSTIN PRECURSOR	93314	Secreted, extracellular space, extracellular matrix	Cell adhesion, cell structure, cell motility	Widely expressed with highest levels in aorta, stomach, lower gastrointestinal tract, placenta, uterus and breast.	Binds to heparin. Induces cell attachment and spreading and plays a role in cell adhesion	Yes - present in E14.5

3	**3**	CARBOXYPEPTIDASE N SUBUNIT 2 PRECURSOR	60615	Secreted	Enzyme regulator, protein stabilization	Plasma	Binds to catalytic subunit, stabilizes it and keeps it in circulation	
3	**3**	PUROMYCIN-SENSITIVE AMINOPEPTIDASE	103276	Intracellular - Nucleus, Cytoplasm	Protease	Widely distributed	Involved in proteolytic events essential for cell growth and viability. May act as regulator of neuropeptide activity.	Yes - all rat samples
3	**3**	ACTIN, AORTIC SMOOTH MUSCLE	42009	Cytoplasm	Cell motility	Widely distributed	Actins are highly conserved proteins that are involved in various types of cell motility and are ubiquitously expressed in all eukaryotic cells	
3	**3**	COLLAGEN ALPHA-1(I) CHAIN PRECURSOR	138883	Secreted, extracellular space, extracellular matrix	Cell adhesion - Cell structure	Forms the fibrils of tendon, ligaments and bones	Component of connective tissue	Yes - all rat samples
3	**3**	MEPRIN A SUBUNIT ALPHA PRECURSOR	84368	Membrane	Protease	Widely distributed, highly expressed in gut	Cell surface endopeptidase	
3	**13**	PROTEIN TYROSINE PHOSPHATASE, RECEPTOR-TYPE, ZETA1 PRECURSOR	254587	Membrane	Transmembrane receptor protein	Specifically expressed in the central nervous system	May be involved in the regulation of specific developmental processes in the CNS	

3	**4**	120 KDA PROTEIN - Importin 7	119702	Intracellular - Nucleus, Cytoplasm	Nuclear-cytoplasmic transport	Ubiquitous	Involved in the import of proteins with the nuclear localization signal.	Yes - present in E12.5 LV, E17.5 LV
3	**3**	DNA-BINDING PROTEIN TAXREB107	32891	Intracellular	Protein biosynthesis - Ribonucleoprotein	Ubiquitous		
3	**3**	TRIPARTITE MOTIF-CONTAINING 28 PROTEIN	88550	Nucleus	Transcriptional Regulation	Ubiquitous	Acts as a transcriptional corepressor	Yes - present in E12.5 LV, E14.5 LV
3	**3**	AMYLOID-LIKE PROTEIN 1 PRECURSOR	72176	Cell membrane, Cytoplasm	May play a role in postsynaptic function	Cerebral cortex	Can regulate neurite outgrowth through binding to components of the extracellular matrix.	Yes - present in E14.5 4thV, E17.5 LV
3	**4**	ISOFORM 1 OF COLLAGEN ALPHA-1(IX) CHAIN PRECURSOR	91855	Secreted, extracellular space, extracellular matrix	Extracellular matrix structural constituent	Structural component of hyaline cartilage and vitreous of the eye	Component of connective tissue	
3	**3**	NIDOGEN-2 PRECURSOR	151395	Secreted, extracellular space, extracellular matrix	Cell adhesion	Heart, placenta and bone	Cell adhesion glycoprotein which is widely distributed in basement membranes	Yes - all rat samples
3	**3**	VASORIN PRECURSOR	71713	Membrane	Inhibitor of TGF-beta signaling	Aorta, kidney, placenta, brain, heart, liver, lung and skeletal muscle.	Modulates the arterial response to injury	

3	**3**	ISOFORM 1 OF HEAT SHOCK COGNATE 71 KDA PROTEIN	70898	Cytoplasm	Chaperone	Ubiquitous	Belongs to the heat shock protein 70 family	Yes - present in E12.5 LV, E14.5 LV, E17.5 LV
3	**3**	ISOFORM 1 OF NEURONAL CELL ADHESION MOLECULE PRECURSOR	144074	Membrane	Cell adhesion, involved in neuron-neuron adhesion	Widely distributed, highly expressed in brain	Belongs to the immunoglobulin super family	Yes - all rat samples
2	**2**	PHOSPHATIDYLETHANOLAMINE-BINDING PROTEIN 1	20926	Cytoplasm	Serine Protease Inhibitor	Ubiquitous	Serine protease inhibitor which inhibits thrombin, neuropsin and chymotrypsin.	Yes - present in E17.5 LV
2	**4**	IGKV1-5 (Immunoglobulin kappa variable 1-5) PROTEIN	26234	Membrane	MHC class I protein complex	Unknown	Antigen processing and presentation of peptides	
2	**2**	ALPHA-2-ANTIPLASMIN PRECURSOR	55064	Secreted	Serine Protease Inhibitor - Blood coagulation	Plasma	Belongs to the serpin family	Yes - all rat samples
2	**2**	ISOFORM 2A OF DESMOCOLLIN-2 PRECURSOR	99962	Membrane	Cell adhesion	Expressed in epithelia, myocardium and lymph nodes	Component of intercellular desmosome junctions.	

2	**2**	DNA REPLICATION LICENSING FACTOR MCM2	101896	Nucleus	DNA binding, cell cycle progression	Ubiquitous	Acts as a factor that allows the DNA to undergo a single round of replication per cell cycle. Required for the entry in S phase and for cell division	Yes - present in E12.5 LV, E17.5 LV
2	**2**	PENTRAXIN-RELATED PROTEIN PTX3 PRECURSOR	42020	Secreted	Inflammatory response	Widely distributed, highly expressed in connective tissue	Plays a role in the regulation of innate resistance to pathogens, and inflammatory reactions.	
2	**2**	ISOFORM A22 OF NEUROPILIN-2 PRECURSOR	104831	Membrane	Vascular endothelial growth factor receptor activity - involved in axon guidance	Widely distributed	High affinity receptor for semaphorins 3C, 3F, VEGF-165 and VEGF-145 isoforms of VEGF, and the PLGF-2 isoform of PGF	Yes - present in E14.5 4thV
2	**4**	LUMICAN PRECURSOR	38429	Secreted, extracellular space, extracellular matrix	ECM structural component	Widely distributed, highly expressed in cornea	Binds to laminin	Yes - all rat samples
2	**2**	ISOFORM HMW OF KININOGEN-1 PRECURSOR	71945	Secreted, extracellular space, extracellular matrix	Cysteine protease inhibitor	Plasma	Bradykinin is released from kininogen by plasma kallikrein. Plays an important role in blood coagulation.	Yes - all rat samples

2	**2**	ISOFORM 1 OF EXPORTIN-2	110417	Intracellular - Nucleus, Cytoplasm	Nuclear-cytoplasmic shuttling	Ubiquitous	Export receptor for importin-alpha.	
2	**2**	ISOFORM 2 OF NUCLEOPHOSMIN	29465	Nucleus, nucleolus	rRNA metabolism	Ubiquitous	Associated with nucleolar ribonucleoprotein structures and bind single-stranded nucleic acids. It may function in the assembly and/or transport of ribosome	
2	**2**	ALCADEIN BETA	107033	Membrane	Cell adhesion	Widely distributed, expressed highly in brain	Calcium ion binding	
2	**2**	14-3-3 PROTEIN THETA	27764	Cytoplasm	Chaperone, signal transduction	Widely distributed, expressed highly in brain, heart and pancreas	Adapter protein implicated in the regulation of a large spectrum of both general and specialized signaling pathways.	Yes - present in E12.5 LV, E14.5 LV, E17.5 LV
2	**2**	60S RIBOSOMAL PROTEIN L4	47566	Cytoplasm	Protein biosynthesis	Ubiqutous	Cytosolic large ribosomal subunit	Yes - present in E12.5 LV, E14.5 LV
2	**2**	72 KDA TYPE IV COLLAGENASE PRECURSOR	73882	Secreted, extracellular space, extracellular matrix	Hydrolase, proteolysis	Fibroblasts	Cleaves gelatin and collagen	

2	**2**	HYPOTHETICAL PROTEIN LOC345651	42003	Unknown	Unknown	Unknown	Unknown	
2	**2**	COLLAGEN ALPHA-2(IV) CHAIN PRECURSOR	167535	Secreted, extracellular space, extracellular matrix	Extracellular matrix structural constituent	Widely distributed	Type IV collagen is the major structural component of glomerular basement membranes, forming a meshwork together with laminins, proteoglycans and entactin/nidogen.	Yes - present in E12.5 LV, E14.5
2	**2**	ISOFORM GTBP-ALT OF DNA MISMATCH REPAIR PROTEIN MSH6	120563	Nucleus	DNA mismatch repair	Ubiquitous	Restores repair of base-base and single-nucleotide insertion-deletion mismatches.	
2	**2**	ENDOPLASMIN PRECURSOR	92469	Endoplasmic reticulum	Chaperone, protein folding	Widely distributed	Molecular chaperone that functions in the processing and transport of secreted proteins	Yes - all rat samples (TUMOR REJECTION ANTIGEN GP96)

2	**2**	ISOFORM APP770 OF AMYLOID BETA A4 PROTEIN PRECURSOR (FRAGMENT)	86943	Membrane. After alpha-secretase cleavage, soluble APP is released into the extracellular space and the C-terminal is internalized to endosomes and lysosomes.	Cell surface receptor involved in neurite growth, neuronal adhesion and axonogenesis.	Expressed in all fetal tissues examined with highest levels in brain, kidney, heart and spleen.	During neuronal differentiation, the Thr-743 phosphorylated form is located mainly in growth cones, moderately in neurites and sparingly in the cell body. Defects in APP are a cause of autosomal dominant Alzheimer disease.	Yes - present in E12.5 LV, E14.5 4thV, E17.5 LV
2	**2**	HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN A1 ISOFORM B	38747	Intracellular - Nucleus, Cytoplasm	Component of ribonucleosomes. Nuclear mRNA splicing	Ubiquitous	Involved in the packaging of pre-mRNA into hnRNP particles, transport of poly(A) mRNA from the nucleus to the cytoplasm and may modulate splice site selection.	Yes - present in E12.5 LV
2	**2**	ISOFORM 1 OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN K	50976	Intracellular - Nucleus, Cytoplasm	RNA processing	Ubiquitous	One of the major pre-mRNA-binding proteins. Binds tenaciously to poly(C) sequences.	

2	**2**	ADP-RIBOSYLATION FACTOR 1	20566	Membrane - Golgi	Protein trafficking	Ubiquitous	Modulates vesicle budding and uncoating within the Golgi complex.	
2	**2**	CYSTATIN C PRECURSOR	15799	Secreted, extracellular space, extracellular matrix	Cysteine protease inhibitor	Widely distributed, highly expressed in epididymis, vas deferens, brain, thymus, and ovary	Important regulator of cysteine proteases in a number of physiologic functions	Yes - all rat samples
2	**2**	TUBULIN BETA-2C CHAIN	49831	Intracellular	Cell structure, cell mobility, chromosome segregation, intracellular protein traffic	Widely distributed	Tubulin is the major constituent of microtubules	Yes - all rat samples
2	**2**	COLLAGEN ALPHA-2(I) CHAIN PRECURSOR	129412	Secreted, extracellular space, extracellular matrix	Cell adhesion - Cell structure	Forms the fibrils of tendon, ligaments and bones	Involved in skeletal development	Yes - all rat samples
2	**4**	IGLC1 PROTEIN	24793	Membrane	Immune response antigen binding	Ubiquitous	MHC class I protein complex antigen processing and presentation.	
2	**2**	60S RIBOSOMAL PROTEIN L7A	29864	Cytoplasm	Protein biosynthesis	Ubiquitous	Cytosolic large ribosomal subunit	Yes - present in E12.5 LV, E17.5 LV

2	**2**	LAMININ ALPHA 2 SUBUNIT PRECURSOR	343905	Secreted, extracellular space, extracellular matrix	Extracellular matrix linker protein-mediated signaling	Placenta, striated muscle, peripheral nerve, cardiac muscle, pancreas, lung, spleen, kidney, adrenal gland, skin, testis, meninges, choroid plexus, and some other regions of the brain	Laminin is thought to mediate the attachment, migration and organization of cells into tissues during embryonic development by interacting with other extracellular matrix components.	
2	**3**	HISTIDINE-RICH GLYCOPROTEIN PRECURSOR	59578	Secreted	Function unknown	Expressed by the liver and secreted in plasma	It binds heme, dyes and divalent metal ions. It can inhibit rosette formation and is known to interact with heparin, thrombospondin, and the lysine-binding site of plasminogen. On the basis of its homology with HMW kininogen, the His-rich region of this protein may mediate the contact activation phase of intrinsic blood coagulation cascade.	Yes - present in E12.5 LV, E14.5 LV

2	**2**	GTP-BINDING NUCLEAR PROTEIN RAN	24292	Intracellular - Nucleus, Cytoplasm	Nuclear-cytoplasmic shuttling	Ubiquitous	Required for the import of protein into the nucleus and also for RNA export.	Yes - all rat samples
2	**2**	HEMOGLOBIN SUBUNIT ALPHA	15126	Intracellular	Oxygen Transport, Transfer - Carrier Protein	Red blood cells	Involved in oxygen transport from the lung to the various peripheral tissues	Yes - present in E12.5 LV, E17.5 LV
2	**2**	HEMOGLOBIN SUBUNIT BETA	15867	Intracellular	Oxygen Transport, Transfer - Carrier Protein	Red blood cells	Involved in oxygen transport from the lung to the various peripheral tissues	Yes - present in E17.5 LV
2	**2**	ISOFORM 1 OF COMPLEMENT FACTOR H PRECURSOR	139070	Secreted	Complement activation	Expressed by the liver and secreted in plasma	Involved in the regulation of complement activation	Yes - all rat samples
2	**2**	COATOMER SUBUNIT BETA	107139	Cytoplasm. Golgi apparatus	Vesicle mediated transport	Ubiquitous	Coatomer complex is required for budding from Golgi membranes, and is essential for the retrograde Golgi-to-ER transport of dilysine-tagged proteins.	Yes - present in E12.5 LV, E17.5 LV
2	**2**	ISOFORM 1 OF CLATHRIN HEAVY CHAIN 2	187030	Cytoplasmic vesicle; cytoplasmic vesicle membrane	Receptor-mediated endocytosis	Ubiquitous	Involved in the formation of clathrin coated vesicles during vesicle endocytosis	Yes - all rat samples

2	**2**	COMPLEMENT C1S SUBCOMPONENT PRECURSOR	76684	Secreted	Serine protease	Plasma	Immune response - Complement activation	Yes - present in E17.5 LV
2	**2**	GOLGI PHOSPHOPROTEIN 2	46273	Golgi apparatus	Function unknown	Widely expressed	Cellular response protein to viral infection	
2	**2**	ELONGATION FACTOR 2	95207	Cytoplasm	Protein biosynthesis	Ubiquitous	Promotes translocation of protein chain from A site to P site on ribosome	Yes - all rat samples
2	**2**	TUBULIN ALPHA-1 CHAIN	49924	Intracellular	Cell structure, cell mobility, intracellular protein traffic	Widely distributed	Tubulin is the major constituent of microtubules	Yes - all rat samples
2	**2**	22 KDA PROTEIN	22066	Unknown	Unknown	Unknown	Unknown	
2	**2**	ISOFORM LONG OF UBIQUITIN CARBOXYL-TERMINAL HYDROLASE 5	95786	Intracellular - Lysosome	Protease	Ubiquitous	Cleaves linear and branched multiubiquitin polymers with a marked preference for branched polymers.	Yes - present in E14.5 LV, E17.5 LV
2	**2**	CYTOSKELETON-ASSOCIATED PROTEIN 5	225509	Intracellular - centrosome	Centrosome organization and biogenesis, and establishment and maintenance of microtubule cytoskeleton polarity	Skeletal muscle, brain, heart, placenta, lung, liver, kidney and pancreas	Plays a major role in organizing spindle poles	

2	**7**	ALB PROTEIN	45160	Secreted	Transport, Transfer/ Carrier	Plasma	Serum albumin, the main protein of plasma, has a good binding capacity for water, Ca(2+), Na(+), K(+), fatty acids, hormones, bilirubin and drugs. Its main function is the regulation of the colloidal osmotic pressure of blood.	Yes - all rat samples
2	**3**	ISOFORM 1 OF CADHERIN-6 PRECURSOR	88309	Membrane	Cell adhesion	Highly expressed in ovary, brain, cerebellum, and kidney	Also known as Kidney cadherin	Yes - all rat samples
2	**2**	ISOFORM LONG OF SPLICING FACTOR, PROLINE- AND GLUTAMINE-RICH	76149	Nucleus	mRNA processing	Ubiquitous	DNA- and RNA binding protein, involved in several nuclear processes. Essential pre-mRNA splicing factor required early in spliceosome formation.	

2	**2**	VON WILLEBRAND FACTOR PRECURSOR	309299	Secreted	Cell adhesion - Blood clotting	Plasma	Important in the maintenance of hemostasis, it promotes adhesion of platelets to the sites of vascular injury. Also acts as a chaperone for coagulation factor VIII, delivering it to the site of injury, stabilizing its heterodimeric structure and protecting it from premature clearance from plasma.	Yes - all rat samples
2	**3**	ISOFORM 1 OF ALPHA-1-ANTICHYMOTRYPSIN PRECURSOR	47651	Secreted	Serine protease inhibitor	Plasma	Belongs to the serpin family	
2	**2**	GLUTATHIONE S-TRANSFERASE P	23225	Cytoplasm	Transferase	Ubiquitous	Involved in detoxifing compounds by linking glutathione to hydrophobic substances	Yes - present in E12.5 LV
2	**2**	DNA REPLICATION LICENSING FACTOR MCM4	96558	Nucleus	Involved in the control of DNA replication	Ubiquitous	Involved in chromatin binding	

2	**8**	ISOFORM C OF FIBULIN-1 PRECURSOR	74462	Secreted, extracellular space, extracellular matrix	Cell adhesion mediated signaling	Widely expressed during embryonic development	Involved in a number of various ECM related functions during development including cell adhesion, migration, and ecm architecture. Binds to laminin and nidogen (both found in the CSF).	Yes - all rat samples
2	**3**	ISOFORM LONG OF COLLAGEN ALPHA-1(XII) CHAIN PRECURSOR	333194	Secreted, extracellular space, extracellular matrix	Cell adhesion - Cell structure	Widely distributed	Component of connective tissue	
2	**3**	TRANSMEMBRANE PROTEIN 132A ISOFORM B	110110	Membrane	Integral to membrane	Unknown	Unknown	
2	**2**	EXTRACELLULAR MATRIX PROTEIN 1 PRECURSOR	60674	Secreted, extracellular space, extracellular matrix	Signal transduction activity	Widely distributed	Positive regulation of I-kappaB kinase/NF-kappaB cascade	
2	**2**	COMPLEMENT COMPONENT C6 PRECURSOR	105752	Secreted	Immune response - complement pathway	Plasma	Involved in the formation of the lytic complex, which inserts into plasma membranes and causes cells to lyse.	Yes - present in E17.5 LV

2	**2**	RECEPTOR-TYPE TYROSINE-PROTEIN PHOSPHATASE F PRECURSOR	211845	Membrane	Transmembrane receptor protein involved in cell adhesion	Widely distributed	Signaling molecule invovled in cell growth and differentiation	Yes-LAR RECEPTOR-LINKED TYROSINE PHOSPHATASE present in all rat samples
2	**2**	CADHERIN EGF LAG SEVEN-PASS G-TYPE RECEPTOR 2 PRECURSOR	317453	Membrane	G-protein coupled receptor protein signaling pathway	Highest expression in brain and testis	May have an important role in cell/cell signaling during nervous system formation	Yes - present in E12.5 LV, E14.5 LV
2	**2**	60S RIBOSOMAL PROTEIN L8	27893	Cytoplasm	Protein Biosynthesis	Ubiquitous	Ribosomal structural protein	Yes - present in E12.5 LV, E14.5 4thV
2	**2**	KINESIN HEAVY CHAIN	109685	Intracellular	Microtubule motor activity	Ubiquitous	Microtubule-dependent motor required for normal distribution of mitochondria and lysosomes	Yes - present in E17.5 LV
2	**2**	14-3-3 PROTEIN EPSILON	29174	Cytoplasm	Chaperone, signal transduction - intracellular signaling cascade	Ubiquitous	Adapter protein implicated in the regulation of a large spectrum of both general and specialized signaling pathway	Yes - all rat samples

2	**4**	FLJ00385 PROTEIN (FRAGMENT)	56111	Membrane	Unknown	Unknown	IgG like protein	
2	**2**	MATRIN-3	94623	Nucleus	Function unclear	Ubiquitous	May play a role in trascription, nuclear structure, or nuclear retention of defective RNAs	Yes - present in E12.5 LV, E17.5 LV
2	**2**	ISOFORM DPI OF DESMOPLAKIN	331776	Membrane	Cell adhesion, cell junctions	Isoform DPI is a constituent of all desmosomes	Major high molecular weight protein of desmosomes	Yes - present in E12.5 LV, E17.5 LV
2	**2**	ALPHA-1-ACID GLYCOPROTEIN 2 PRECURSOR	23603	Secreted	Immune response - acute phase	Plasma	Appears to function in modulating the activity of the immune system during the acute-phase reaction	
2	**2**	EUKARYOTIC INITIATION FACTOR 4A-I	46154	Intracellular	Protein biosynthesis	Ubiquitous	Required for mRNA binding to ribosome	
2	**2**	LACTATE DEHYDROGENASE A	36689	Cytoplasm	Anaerobic glycolysis	Widely distributed, highly expressed in muscle tissue	Catalyzes the conversion of lactate and NAD to pyruvate and NADH	Yes - present in E12.5 LV, E14.5
2	**2**	ISOFORM 1 OF PLEXIN DOMAIN-CONTAINING PROTEIN 2 PRECURSOR	59583	Membrane	Cell surface endothelial marker	Endothelial cells	May play a role in tumor angiogenesis	

2	**2**	PEROXIREDOXIN-6	24904	Cytoplasm	Oxidoreductase, Peroxidase	Ubiquitous	Involved in redox regulation of the cell in response to oxidative stress.	
2	**2**	NEUROCAN CORE PROTEIN PRECURSOR	142973	Secreted, extracellular space, extracellular matrix	Extracellular matrix protein-mediated signaling, cell adhesion, cell motility	Brain	May modulate neuronal adhesion and neurite growth during development by binding to neural cell adhesion molecules.	Yes - present in E14.5 4thV, E17.5 LV
2	**2**	ISOFORM 1 OF CONTACTIN-1 PRECURSOR	113320	Membrane	Cell adhesion	Widely distributed, highly expressed in brain	Mediates cell surface interactions during nervous system development. Involved in the formation of axon-glial junctions in myelinated peripheral nerves and in the signaling between axons and myelinating glial cells. Participates in oligodendrocytes generation by acting as a ligand of NOTCH1.	Yes - present in E17.5 LV

2	**2**	LEUCINE-RICH REPEAT-CONTAINING PROTEIN 15 PRECURSOR	64396	Membrane	Unknown	Brain and placenta	Unknown	

Table 1.2. Protein list from mass spectrometry CS19 human CSF

Unique peptides	Total peptides	Protein matches for CS19 human CSF
194	**571**	Homo sapiens (Human) APOLIPOPROTEIN B-100 PRECURSOR. [MASS=515563
120	**176**	Homo sapiens (Human) DYNEIN HEAVY CHAIN, CYTOSOLIC. [MASS=532408
68	**168**	Homo sapiens (Human) MICROTUBULE-ASSOCIATED PROTEIN 1B. [MASS=270620
53	**58**	Homo sapiens (Human) MYOSIN-10. [MASS=228939
52	**66**	Homo sapiens (Human) FILAMIN A, ALPHA. [MASS=280018
48	**54**	Homo sapiens (Human) ISOFORM 1 OF SPECTRIN ALPHA CHAIN, BRAIN. [MASS=284539
39	**72**	Homo sapiens (Human) FATTY ACID SYNTHASE. [MASS=273400
36	**73**	Homo sapiens (Human) VIMENTIN. [MASS=53520
36	**36**	Homo sapiens (Human) ISOFORM LONG OF SPECTRIN BETA CHAIN, BRAIN 1. [MASS=274631
36	**72**	Homo sapiens (Human) NESTIN. [MASS=176706
35	**172**	Homo sapiens (Human) ALB PROTEIN. [MASS=71705
34	**127**	Homo sapiens (Human) SEROTRANSFERRIN PRECURSOR. [MASS=77050
31	**41**	Homo sapiens (Human) Heat shock 70kDa protein 5. [MASS=72422
31	**45**	Homo sapiens (Human) ISOFORM 1 OF FIBRONECTIN PRECURSOR. [MASS=262607
30	**36**	Homo sapiens (Human) MOESIN. [MASS=67689
29	**84**	Homo sapiens (Human) HYPOTHETICAL PROTEIN DKFZP761K0511. [MASS=84843
28	**58**	Homo sapiens (Human) ISOFORM 1 OF HEAT SHOCK COGNATE 71 KDA PROTEIN. [MASS=70898
27	**46**	Homo sapiens (Human) ELONGATION FACTOR 2. [MASS=95207
27	**30**	Homo sapiens (Human) PRE-MRNA-PROCESSING-SPLICING FACTOR 8. [MASS=273600
26	**44**	Homo sapiens (Human) APOLIPOPROTEIN A-IV PRECURSOR. [MASS=45399
26	**102**	Homo sapiens (Human) GLYCERALDEHYDE-3-PHOSPHATE DEHYDROGENASE. [MASS=35922
26	**29**	Homo sapiens (Human) ISOFORM 1 OF DNA-DEPENDENT PROTEIN KINASE CATALYTIC SUBUNIT. [MASS=469089
25	**109**	Homo sapiens (Human) TUBULIN BETA-2C CHAIN. [MASS=49831
25	**41**	Homo sapiens (Human) CLATHRIN HEAVY CHAIN 1. [MASS=191615
24	**27**	Homo sapiens (Human) MYOSIN-9. [MASS=226401
23	**30**	Homo sapiens (Human) T-COMPLEX PROTEIN 1 SUBUNIT BETA. [MASS=57357
23	**31**	Homo sapiens (Human) ENDOPLASMIN PRECURSOR. [MASS=92469
23	**35**	Homo sapiens (Human) ISOFORM 1 OF CULLIN-ASSOCIATED NEDD8-DISSOCIATED PROTEIN 1. [MASS=136376
23	**23**	Homo sapiens (Human) ISOFORM 2 OF MICROTUBULE-ACTIN CROSSLINKING FACTOR 1, ISOFORMS 1/2/3/5. [MASS=620418
23	**28**	Homo sapiens (Human) ISOFORM 2 OF HECT, UBA AND WWE DOMAIN-CONTAINING PROTEIN 1. [MASS=480198
22	**77**	Homo sapiens (Human) CREATINE KINASE B-TYPE. [MASS=42644

22	**26**	Homo sapiens (Human) KINESIN HEAVY CHAIN. [MASS=109685
22	**34**	Homo sapiens (Human) IMPORTIN BETA-1 SUBUNIT. [MASS=97170
22	**31**	Homo sapiens (Human) DNA REPLICATION LICENSING FACTOR MCM2. [MASS=101896
22	**24**	Homo sapiens (Human) STRUCTURAL MAINTENANCE OF CHROMOSOME 3. [MASS=141542
22	**42**	Homo sapiens (Human) APOLIPOPROTEIN A-I PRECURSOR. [MASS=30778
21	**44**	Homo sapiens (Human) ISOFORM M1 OF PYRUVATE KINASE ISOZYMES M1/M2. [MASS=57931
21	**35**	Homo sapiens (Human) DPYSL3 PROTEIN. [MASS=73910
21	**34**	Homo sapiens (Human) RAN BINDING PROTEIN 5. [MASS=125545
21	**35**	Homo sapiens (Human) TRANSITIONAL ENDOPLASMIC RETICULUM ATPASE. [MASS=89191
21	**167**	Homo sapiens (Human) ALPHA-FETOPROTEIN PRECURSOR. [MASS=68678
20	**26**	Homo sapiens (Human) DIHYDROPYRIMIDINASE-RELATED PROTEIN 1. [MASS=62184
20	**27**	Homo sapiens (Human) ATP-DEPENDENT RNA HELICASE A. [MASS=140881
20	**30**	Homo sapiens (Human) MATRIN-3. [MASS=94623
19	**35**	Homo sapiens (Human) RAB GDP DISSOCIATION INHIBITOR ALPHA. [MASS=50583
19	**24**	Homo sapiens (Human) APOLIPOPROTEIN E PRECURSOR. [MASS=36154
19	**20**	Homo sapiens (Human) C-1-TETRAHYDROFOLATE SYNTHASE, CYTOPLASMIC. [MASS=101428
19	**29**	Homo sapiens (Human) ISOFORM LONG OF SPLICING FACTOR, PROLINE- AND GLUTAMINE-RICH. [MASS=76149
19	**35**	Homo sapiens (Human) ATP-DEPENDENT DNA HELICASE 2 SUBUNIT 2. [MASS=82573
19	**23**	Homo sapiens (Human) ISOFORM 1 OF MICROTUBULE-ASSOCIATED PROTEIN 2. [MASS=199539
19	**22**	Homo sapiens (Human) PROTEIN DISULFIDE-ISOMERASE A4 PRECURSOR. [MASS=72932
18	**38**	Homo sapiens (Human) FIBRINOGEN BETA CHAIN PRECURSOR. [MASS=55928
18	**23**	Homo sapiens (Human) PHOSPHOGLYCERATE KINASE 1. [MASS=44483
18	**18**	Homo sapiens (Human) DNA REPLICATION LICENSING FACTOR MCM6. [MASS=92889
18	**37**	Homo sapiens (Human) ISOFORM 1 OF NUCLEAR AUTOANTIGENIC SPERM PROTEIN. [MASS=85238
18	**38**	Homo sapiens (Human) TRIPARTITE MOTIF-CONTAINING 28 PROTEIN. [MASS=88550
18	**20**	Homo sapiens (Human) ISOFORM 1 OF GENERAL TRANSCRIPTION FACTOR II-I. [MASS=112416
18	**35**	Homo sapiens (Human) NCL PROTEIN. [MASS=51641
18	**31**	Homo sapiens (Human) INTER-ALPHA-TRYPSIN INHIBITOR HEAVY CHAIN H2 PRECURSOR. [MASS=106436
18	**29**	Homo sapiens (Human) ISOFORM 5 OF INTERLEUKIN ENHANCER-BINDING FACTOR 3. [MASS=74607
17	**30**	Homo sapiens (Human) HEAT SHOCK 70 KDA PROTEIN 4. [MASS=94300

17	**19**	Homo sapiens (Human) LUPUS LA PROTEIN. [MASS=46837
17	**89**	Homo sapiens (Human) TUBULIN ALPHA-1 CHAIN. [MASS=49924
17	**24**	Homo sapiens (Human) POLY [ADP-RIBOSE] POLYMERASE 1. [MASS=112953
17	**18**	Homo sapiens (Human) LEUCYL-TRNA SYNTHETASE, CYTOPLASMIC. [MASS=134466
17	**21**	Homo sapiens (Human) PUROMYCIN-SENSITIVE AMINOPEPTIDASE. [MASS=103276
17	**17**	Homo sapiens (Human) ISOFORM 1 OF STRUCTURAL MAINTENANCE OF CHROMOSOME 2-LIKE 1 PROTEIN. [MASS=135781
16	**126**	Homo sapiens (Human) ALPHA-1-ANTITRYPSIN PRECURSOR. [MASS=46737
16	**19**	Homo sapiens (Human) EUKARYOTIC INITIATION FACTOR 4A-I. [MASS=46154
16	**20**	Homo sapiens (Human) T-COMPLEX PROTEIN 1 SUBUNIT ETA. [MASS=59367
16	**21**	Homo sapiens (Human) ISOCITRATE DEHYDROGENASE [NADP] CYTOPLASMIC. [MASS=46659
16	**17**	Homo sapiens (Human) KINESIN HEAVY CHAIN ISOFORM 5C. [MASS=109495
16	**35**	Homo sapiens (Human) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN U. [MASS=88814
16	**18**	Homo sapiens (Human) SPLICING FACTOR 3B SUBUNIT 1. [MASS=145815
16	**18**	Homo sapiens (Human) 26S PROTEASOME NON-ATPASE REGULATORY SUBUNIT 2. [MASS=100200
16	**17**	Homo sapiens (Human) CHAPERONIN CONTAINING TCP1, SUBUNIT 8. [MASS=59779
15	**17**	Homo sapiens (Human) ATP-CITRATE SYNTHASE. [MASS=120825
15	**53**	Homo sapiens (Human) ISOFORM GAMMA-B OF FIBRINOGEN GAMMA CHAIN PRECURSOR. [MASS=51512
15	**18**	Homo sapiens (Human) ISOFORM 1 OF EXPORTIN-2. [MASS=110417
15	**22**	Homo sapiens (Human) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN M ISOFORM A. [MASS=77516
15	**22**	Homo sapiens (Human) ISOFORM 2 OF FAR UPSTREAM ELEMENT-BINDING PROTEIN 1. [MASS=68605
15	**18**	Homo sapiens (Human) SPLICING FACTOR 3 SUBUNIT 1. [MASS=88886
15	**43**	Homo sapiens (Human) HEAT SHOCK PROTEIN HSP 90-ALPHA 2. [MASS=98113
15	**23**	Homo sapiens (Human) 14-3-3 PROTEIN EPSILON. [MASS=29174
15	**15**	Homo sapiens (Human) ISOFORM 1 OF VINCULIN. [MASS=116591
15	**18**	Homo sapiens (Human) ALANYL-TRNA SYNTHETASE. [MASS=106801
14	**18**	Homo sapiens (Human) DNA REPLICATION LICENSING FACTOR MCM4. [MASS=96558
14	**14**	Homo sapiens (Human) ISOFORM 1 OF SPECTRIN BETA CHAIN, BRAIN 2. [MASS=271295
14	**21**	Homo sapiens (Human) FAR UPSTREAM ELEMENT-BINDING PROTEIN 2. [MASS=72709
14	**14**	Homo sapiens (Human) PROTEIN DISULFIDE-ISOMERASE A3 PRECURSOR. [MASS=56782
14	**19**	Homo sapiens (Human) RAB GDP DISSOCIATION INHIBITOR BETA. [MASS=50663
14	**21**	Homo sapiens (Human) DEAH (ASP-GLU-ALA-HIS) BOX POLYPEPTIDE 15. [MASS=92829

14	**22**	Homo sapiens (Human) LACTATE DEHYDROGENASE A. [MASS=36689
14	**22**	Homo sapiens (Human) EUKARYOTIC TRANSLATION INITIATION FACTOR 3 SUBUNIT 10. [MASS=166569
14	**21**	Homo sapiens (Human) ISOFORM BETA OF HEAT-SHOCK PROTEIN 105 KDA. [MASS=92116
14	**25**	Homo sapiens (Human) ISOFORM 1 OF POLYADENYLATE-BINDING PROTEIN 1. [MASS=70671
13	**19**	Homo sapiens (Human) 6-PHOSPHOGLUCONATE DEHYDROGENASE, DECARBOXYLATING. [MASS=53009
13	**30**	Homo sapiens (Human) ISOFORM 1 OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN K. [MASS=50976
13	**14**	Homo sapiens (Human) DREBRIN. [MASS=71294
13	**14**	Homo sapiens (Human) EXPORTIN-1. [MASS=123386
13	**13**	Homo sapiens (Human) SMARCA4 ISOFORM 2. [MASS=188149
13	**15**	Homo sapiens (Human) HYDROXYMETHYLGLUTARYL-COA SYNTHASE, CYTOPLASMIC. [MASS=57294
13	**16**	Homo sapiens (Human) RIBONUCLEOSIDE-DIPHOSPHATE REDUCTASE LARGE SUBUNIT. [MASS=90070
13	**28**	Homo sapiens (Human) HNRPA2B1 PROTEIN. [MASS=28412
13	**45**	Homo sapiens (Human) ENOLASE 1. [MASS=47169
13	**15**	Homo sapiens (Human) ALPHA-ACTININ-1. [MASS=103058
13	**29**	Homo sapiens (Human) DIHYDROPYRIMIDINASE-LIKE 2. [MASS=67017
13	**15**	Homo sapiens (Human) DIHYDROPYRIMIDINASE-RELATED PROTEIN 4. [MASS=61878
13	**20**	Homo sapiens (Human) INSULIN-LIKE GROWTH FACTOR 2 MRNA BINDING PROTEIN 1. [MASS=63481
13	**17**	Homo sapiens (Human) ISOFORM 2 OF NEUTRAL ALPHA-GLUCOSIDASE AB PRECURSOR. [MASS=109438
13	**13**	Homo sapiens (Human) ISOFORM P150 OF DYNACTIN-1. [MASS=141695
13	**14**	Homo sapiens (Human) SPLICING FACTOR 3B SUBUNIT 2. [MASS=100228
13	**25**	Homo sapiens (Human) HEMOGLOBIN SUBUNIT EPSILON. [MASS=16072
13	**17**	Homo sapiens (Human) DNA REPLICATION LICENSING FACTOR MCM5. [MASS=82286
13	**18**	Homo sapiens (Human) FASCIN. [MASS=54399
13	**15**	Homo sapiens (Human) GLUTAMYL-PROLYL TRNA SYNTHETASE. [MASS=170591
13	**14**	Homo sapiens (Human) DNA REPLICATION LICENSING FACTOR MCM3. [MASS=90981
12	**25**	Homo sapiens (Human) UBIQUITIN-ACTIVATING ENZYME E1. [MASS=117849
12	**68**	Homo sapiens (Human) TRANSTHYRETIN PRECURSOR. [MASS=15887
12	**18**	Homo sapiens (Human) SPLICING FACTOR 3B SUBUNIT 3. [MASS=135592
12	**13**	Homo sapiens (Human) PHOSPHOFRUCTOKINASE, MUSCLE. [MASS=85183
12	**41**	Homo sapiens (Human) TUBULIN BETA-3 CHAIN. [MASS=50433
12	**12**	Homo sapiens (Human) ALPHA-ACTININ-4. [MASS=104854
12	**15**	Homo sapiens (Human) ISOFORM 1 OF GELSOLIN PRECURSOR. [MASS=85698

12	**14**	Homo sapiens (Human) MULTIFUNCTIONAL PROTEIN ADE2. [MASS=49679
12	**15**	Homo sapiens (Human) DIHYDROPYRIMIDINASE-RELATED PROTEIN 5. [MASS=61421
12	**22**	Homo sapiens (Human) ANNEXIN A5. [MASS=35806
12	**25**	Homo sapiens (Human) L-LACTATE DEHYDROGENASE B CHAIN. [MASS=36507
12	**16**	Homo sapiens (Human) CALNEXIN PRECURSOR. [MASS=67568
12	**23**	Homo sapiens (Human) ISOFORM 1 OF FIBRINOGEN ALPHA CHAIN PRECURSOR. [MASS=94973
12	**18**	Homo sapiens (Human) NON-POU DOMAIN-CONTAINING OCTAMER-BINDING PROTEIN. [MASS=54232
12	**13**	Homo sapiens (Human) 116 KDA U5 SMALL NUCLEAR RIBONUCLEOPROTEIN COMPONENT. [MASS=109436
12	**15**	Homo sapiens (Human) STRESS-INDUCED-PHOSPHOPROTEIN 1. [MASS=62639
12	**12**	Homo sapiens (Human) COATOMER SUBUNIT ALPHA. [MASS=138332
11	**14**	Homo sapiens (Human) T-COMPLEX PROTEIN 1 SUBUNIT DELTA. [MASS=57793
11	**17**	Homo sapiens (Human) ISOFORM 1 OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN D0. [MASS=38434
11	**12**	Homo sapiens (Human) CDNA FLJ45525 FIS, CLONE BRTHA2026311, HIGHLY SIMILAR TO PROTEIN DISULFIDE ISOMERASE A6. [MASS=53929
11	**12**	Homo sapiens (Human) ATP-DEPENDENT RNA HELICASE DDX3X. [MASS=73112
11	**13**	Homo sapiens (Human) 26S PROTEASE REGULATORY SUBUNIT 6A. [MASS=49204
11	**15**	Homo sapiens (Human) GLYCOGEN PHOSPHORYLASE, BRAIN FORM. [MASS=96565
11	**12**	Homo sapiens (Human) PROTEASOME 26S NON-ATPASE SUBUNIT 11 VARIANT (FRAGMENT). [MASS=47535
11	**11**	Homo sapiens (Human) DNA DAMAGE-BINDING PROTEIN 1. [MASS=126968
11	**11**	Homo sapiens (Human) RAS GTPASE-ACTIVATING-LIKE PROTEIN IQGAP1. [MASS=189252
11	**15**	Homo sapiens (Human) STAPHYLOCOCCAL NUCLEASE DOMAIN-CONTAINING PROTEIN 1. [MASS=101997
11	**23**	Homo sapiens (Human) UBIQUITIN-ACTIVATING ENZYME E1. [MASS=56852
11	**12**	Homo sapiens (Human) ISOFORM 2 OF PROTEIN KIAA1967. [MASS=103030
11	**11**	Homo sapiens (Human) ISOFORM 2 OF MICROTUBULE-ASSOCIATED PROTEIN 4. [MASS=102906
11	**14**	Homo sapiens (Human) ISOFORM GTBP-ALT OF DNA MISMATCH REPAIR PROTEIN MSH6. [MASS=120563
11	**14**	Homo sapiens (Human) 150 KDA OXYGEN-REGULATED PROTEIN PRECURSOR. [MASS=111335
11	**11**	Homo sapiens (Human) TALDO1 PROTEIN. [MASS=35329
11	**24**	Homo sapiens (Human) STATHMIN. [MASS=17171
11	**11**	Homo sapiens (Human) ISOFORM 1 OF CHROMODOMAIN HELICASE-DNA-BINDING PROTEIN 4. [MASS=217991
10	**11**	Homo sapiens (Human) RUVB-LIKE 2. [MASS=51025

10	**14**	Homo sapiens (Human) PLASMA PROTEASE C1 INHIBITOR PRECURSOR. [MASS=55154
10	**34**	Homo sapiens (Human) HEAT SHOCK PROTEIN HSP 90-ALPHA 2. [MASS=98113
10	**10**	Homo sapiens (Human) PIGMENT EPITHELIUM-DERIVED FACTOR PRECURSOR. [MASS=46342
10	**11**	Homo sapiens (Human) ISOFORM LONG OF UBIQUITIN CARBOXYL-TERMINAL HYDROLASE 5. [MASS=95786
10	**47**	Homo sapiens (Human) PRO2275. [MASS=13097
10	**12**	Homo sapiens (Human) T-COMPLEX PROTEIN 1 SUBUNIT ZETA. [MASS=57893
10	**36**	Homo sapiens (Human) MYRISTOYLATED ALANINE-RICH C-KINASE SUBSTRATE. [MASS=31423
10	**10**	Homo sapiens (Human) TALIN-1. [MASS=269767
10	**11**	Homo sapiens (Human) VACUOLAR PROTEIN SORTING 35. [MASS=91707
10	**12**	Homo sapiens (Human) T-COMPLEX PROTEIN 1 SUBUNIT EPSILON. [MASS=59671
10	**11**	Homo sapiens (Human) ISOFORM 3 OF POLYPYRIMIDINE TRACT-BINDING PROTEIN 2. [MASS=58084
10	**10**	Homo sapiens (Human) ISOFORM 1 OF REGULATOR OF NONSENSE TRANSCRIPTS 1. [MASS=124345
10	**10**	Homo sapiens (Human) UBIQUITIN-LIKE 1-ACTIVATING ENZYME E1B. [MASS=71224
10	**16**	Homo sapiens (Human) ISOFORM 1 OF CLATHRIN HEAVY CHAIN 2. [MASS=187030
10	**12**	Homo sapiens (Human) SEPTIN-7. [MASS=50809
10	**14**	Homo sapiens (Human) ADENYLYL CYCLASE-ASSOCIATED PROTEIN 1. [MASS=51542
10	**10**	Homo sapiens (Human) VALYL-TRNA SYNTHETASE. [MASS=140476
10	**11**	Homo sapiens (Human) DNA MISMATCH REPAIR PROTEIN MSH2. [MASS=104743
10	**28**	Homo sapiens (Human) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN R. [MASS=70943
10	**19**	Homo sapiens (Human) FRUCTOSE-BISPHOSPHATE ALDOLASE A. [MASS=39289
10	**15**	Homo sapiens (Human) THREONYL-TRNA SYNTHETASE, CYTOPLASMIC. [MASS=83435
10	**11**	Homo sapiens (Human) STRESS-70 PROTEIN, MITOCHONDRIAL PRECURSOR. [MASS=73680
10	**11**	Homo sapiens (Human) ELONGATION FACTOR 1-DELTA. [MASS=30991
10	**11**	Homo sapiens (Human) CYTOSKELETON-ASSOCIATED PROTEIN 5. [MASS=225509
10	**11**	Homo sapiens (Human) CALRETICULIN PRECURSOR. [MASS=48142
10	**13**	Homo sapiens (Human) PHOSPHORIBOSYLFORMYLGLYCINAMIDINE SYNTHASE. [MASS=144664
10	**11**	Homo sapiens (Human) ISOFORM 4 OF TUBULIN-SPECIFIC CHAPERONE D. [MASS=138597
10	**13**	Homo sapiens (Human) ISOFORM B OF ARSENITE-RESISTANCE PROTEIN 2. [MASS=100276
10	**10**	Homo sapiens (Human) ISOFORM 2 OF STRUCTURAL MAINTENANCE OF CHROMOSOMES 4-LIKE 1 PROTEIN. [MASS=140278
10	**13**	Homo sapiens (Human) ISOFORM 1 OF RETICULON-4. [MASS=130102

10	**45**	Homo sapiens (Human) HEMOGLOBIN SUBUNIT ZETA. [MASS=15506
10	**11**	Homo sapiens (Human) HSPC117 PROTEIN. [MASS=55210
10	**10**	Homo sapiens (Human) ISOFORM 1 OF SQUAMOUS CELL CARCINOMA ANTIGEN RECOGNIZED BY T-CELLS 3. [MASS=109935
10	**14**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S4, X ISOFORM. [MASS=29467
10	**10**	Homo sapiens (Human) TRANSKETOLASE. [MASS=67878
9	**13**	Homo sapiens (Human) ISOFORM 2 OF NUCLEOPHOSMIN. [MASS=29465
9	**10**	Homo sapiens (Human) UNCHARACTERIZED PROTEIN C20ORF77. [MASS=36900
9	**9**	Homo sapiens (Human) T-COMPLEX PROTEIN 1 SUBUNIT ALPHA. [MASS=60344
9	**10**	Homo sapiens (Human) INTERLEUKIN ENHANCER-BINDING FACTOR 2. [MASS=43062
9	**10**	Homo sapiens (Human) 26S PROTEASE REGULATORY SUBUNIT 8. [MASS=45626
9	**11**	Homo sapiens (Human) ISOFORM 1 OF DNA REPLICATION LICENSING FACTOR MCM7. [MASS=81308
9	**19**	Homo sapiens (Human) GAMMA-ENOLASE. [MASS=47137
9	**11**	Homo sapiens (Human) HYPOTHETICAL PROTEIN DKFZP451D234. [MASS=109187
9	**23**	Homo sapiens (Human) TUBULIN, BETA 2. [MASS=49907
9	**11**	Homo sapiens (Human) ISOFORM 1 OF PROTEIN ARGININE N-METHYLTRANSFERASE 1. [MASS=41486
9	**12**	Homo sapiens (Human) VILLIN 2. [MASS=69413
9	**11**	Homo sapiens (Human) RADIXIN. [MASS=68564
9	**11**	Homo sapiens (Human) ISOFORM 2 OF SWI/SNF-RELATED MATRIX-ASSOCIATED ACTIN-DEPENDENT REGULATOR OF CHROMATIN SUBFAMILY C MEMBER 2. [MASS=124841
9	**9**	Homo sapiens (Human) ASPARTYL-TRNA SYNTHETASE. [MASS=57136
9	**12**	Homo sapiens (Human) D-3-PHOSPHOGLYCERATE DEHYDROGENASE. [MASS=56519
9	**9**	Homo sapiens (Human) CAD PROTEIN. [MASS=242984
9	**9**	Homo sapiens (Human) CTP SYNTHASE 1. [MASS=66690
9	**9**	Homo sapiens (Human) SERINE-THREONINE KINASE RECEPTOR-ASSOCIATED PROTEIN. [MASS=38438
9	**11**	Homo sapiens (Human) ADENOSYLHOMOCYSTEINASE. [MASS=47585
9	**11**	Homo sapiens (Human) ELONGATION FACTOR 1-GAMMA. [MASS=49988
9	**20**	Homo sapiens (Human) CDNA FLJ45706 FIS, CLONE FEBRA2028457, HIGHLY SIMILAR TO NUCLEOLIN. [MASS=65962
9	**10**	Homo sapiens (Human) CHAPERONIN CONTAINING TCP1, SUBUNIT 3 ISOFORM B. [MASS=60463
9	**12**	Homo sapiens (Human) ENO1P PROTEIN. [MASS=42342
9	**9**	Homo sapiens (Human) PREDICTED: SIMILAR TO HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN U. [MASS=101752
9	**11**	Homo sapiens (Human) ISOFORM SHORT OF RECEPTOR-TYPE TYROSINE-PROTEIN PHOSPHATASE ZETA PRECURSOR. [MASS=163444
9	**11**	Homo sapiens (Human) 26S PROTEASE REGULATORY SUBUNIT 7. [MASS=48503

9	**10**	Homo sapiens (Human) PROTEIN DISULFIDE-ISOMERASE PRECURSOR. [MASS=57116
9	**11**	Homo sapiens (Human) FACT COMPLEX SUBUNIT SPT16. [MASS=119914
9	**14**	Homo sapiens (Human) LUMICAN PRECURSOR. [MASS=38429
9	**10**	Homo sapiens (Human) PROLIFERATION-ASSOCIATED PROTEIN 2G4. [MASS=43656
9	**10**	Homo sapiens (Human) IARS PROTEIN. [MASS=120627
9	**10**	Homo sapiens (Human) U5 SMALL NUCLEAR RIBONUCLEOPROTEIN 200 KDA HELICASE. [MASS=244508
9	**9**	Homo sapiens (Human) UBIQUITIN CARBOXYL-TERMINAL HYDROLASE 7. [MASS=128272
9	**10**	Homo sapiens (Human) INTER-ALPHA-TRYPSIN INHIBITOR HEAVY CHAIN H1 PRECURSOR. [MASS=101389
9	**12**	Homo sapiens (Human) ATP-DEPENDENT RNA HELICASE DDX1. [MASS=82432
9	**13**	Homo sapiens (Human) ISOFORM 1 OF PROBABLE ATP-DEPENDENT RNA HELICASE DDX17. [MASS=72371
9	**10**	Homo sapiens (Human) RNA-BINDING PROTEIN 12. [MASS=97395
9	**9**	Homo sapiens (Human) TRANSPORTIN 1. [MASS=102355
9	**9**	Homo sapiens (Human) GTP-BINDING NUCLEAR PROTEIN RAN. [MASS=24292
9	**9**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S18. [MASS=17719
9	**30**	Homo sapiens (Human) ACTIN, AORTIC SMOOTH MUSCLE. [MASS=42009
9	**10**	Homo sapiens (Human) EUKARYOTIC TRANSLATION INITIATION FACTOR 4 GAMMA 2. [MASS=102362
9	**12**	Homo sapiens (Human) SPLICING FACTOR, ARGININE/SERINE-RICH 1. [MASS=27745
9	**9**	Homo sapiens (Human) PEROXIREDOXIN-1. [MASS=22110
8	**10**	Homo sapiens (Human) GLUTATHIONE S-TRANSFERASE P. [MASS=23225
8	**31**	Homo sapiens (Human) ACTIN, CYTOPLASMIC 1. [MASS=41737
8	**9**	Homo sapiens (Human) HEAT SHOCK 70 KDA PROTEIN 1L. [MASS=70375
8	**12**	Homo sapiens (Human) COFILIN-1. [MASS=18371
8	**13**	Homo sapiens (Human) ANGIOTENSINOGEN PRECURSOR. [MASS=53154
8	**10**	Homo sapiens (Human) GLUCOSE-6-PHOSPHATE ISOMERASE. [MASS=63016
8	**51**	Homo sapiens (Human) TUBULIN BETA-2 CHAIN. [MASS=49671
8	**12**	Homo sapiens (Human) ISOFORM 1 OF CYTOSOLIC ACYL COENZYME A THIOESTER HYDROLASE. [MASS=41796
8	**10**	Homo sapiens (Human) HEAT SHOCK 70 KDA PROTEIN 1. [MASS=70052
8	**9**	Homo sapiens (Human) 26S PROTEASOME NON-ATPASE REGULATORY SUBUNIT 12. [MASS=52773
8	**23**	Homo sapiens (Human) GAMMA-G GLOBIN (FRAGMENT). [MASS=16969
8	**9**	Homo sapiens (Human) 14-3-3 PROTEIN THETA. [MASS=27764
8	**8**	Homo sapiens (Human) MALATE DEHYDROGENASE, MITOCHONDRIAL PRECURSOR. [MASS=35531
8	**9**	Homo sapiens (Human) A-KINASE ANCHOR PROTEIN 12 ISOFORM 2. [MASS=181690

8	**8**	Homo sapiens (Human) LIVER PHOSPHOFRUCTOKINASE ISOFORM A. [MASS=90577
8	**14**	Homo sapiens (Human) 14-3-3 PROTEIN ZETA/DELTA. [MASS=27745
8	**10**	Homo sapiens (Human) ATP-DEPENDENT RNA HELICASE A. [MASS=140881
8	**15**	Homo sapiens (Human) ISOFORM C1 OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEINS C1/C2. [MASS=32338
8	**8**	Homo sapiens (Human) NUCLEOSIDE DIPHOSPHATE KINASE A. [MASS=17149
8	**8**	Homo sapiens (Human) TRIPEPTIDYL-PEPTIDASE 2. [MASS=138219
8	**11**	Homo sapiens (Human) RCTPI1 (FRAGMENT). [MASS=26943
8	**11**	Homo sapiens (Human) ISOFORM 1 OF POLYPYRIMIDINE TRACT-BINDING PROTEIN 1. [MASS=57221
8	**11**	Homo sapiens (Human) CELLULAR RETINOIC ACID-BINDING PROTEIN 1. [MASS=15434
8	**8**	Homo sapiens (Human) MALATE DEHYDROGENASE, CYTOPLASMIC. [MASS=36295
8	**10**	Homo sapiens (Human) ESTERASE D. [MASS=31463
8	**15**	Homo sapiens (Human) ISOFORM 1 OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN Q. [MASS=69603
8	**12**	Homo sapiens (Human) ISOFORM SHORT OF RNA-BINDING PROTEIN FUS. [MASS=53355
8	**9**	Homo sapiens (Human) F-ACTIN CAPPING PROTEIN ALPHA-1 SUBUNIT. [MASS=32792
8	**10**	Homo sapiens (Human) PROBABLE ATP-DEPENDENT RNA HELICASE DDX48. [MASS=46740
8	**10**	Homo sapiens (Human) INORGANIC PYROPHOSPHATASE. [MASS=32660
8	**21**	Homo sapiens (Human) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN A0. [MASS=30841
8	**9**	Homo sapiens (Human) ISOFORM 1 OF GLUCOSAMINE--FRUCTOSE-6-PHOSPHATE AMINOTRANSFERASE [ISOMERIZING] 1. [MASS=78806
8	**10**	Homo sapiens (Human) ELAV. [MASS=42417
8	**8**	Homo sapiens (Human) CDNA FLJ33352 FIS, CLONE BRACE2005087, WEAKLY SIMILAR TO PRE-MRNA SPLICING HELICASE BRR2. [MASS=71472
8	**8**	Homo sapiens (Human) PREDICTED: SIMILAR TO ATP-DEPENDENT DNA HELICASE II, 70 KDA SUBUNIT (LUPUS KU AUTOANTIGEN PROTEIN P70) (KU70) (70 KDA SUBUNIT OF KU ANTIGEN) (THYROID-LUPUS AUTOANTIGEN) (TLAA) (CTC BOX BINDING FACTOR 75 KDA SUBUNIT) (CTCBF) (CTC75) ISOFORM 1. [MASS=54430
8	**11**	Homo sapiens (Human) IMPORTIN-7. [MASS=119517
8	**8**	Homo sapiens (Human) ISOFORM 1 OF CULLIN-3. [MASS=88930
8	**8**	Homo sapiens (Human) 26S PROTEASOME NON-ATPASE REGULATORY SUBUNIT 6. [MASS=45531
8	**9**	Homo sapiens (Human) PROTEIN PHOSPHATASE 2C ISOFORM GAMMA. [MASS=59272
8	**24**	Homo sapiens (Human) HYPOTHETICAL PROTEIN LOC345651. [MASS=42003
8	**9**	Homo sapiens (Human) 26S PROTEASOME NON-ATPASE REGULATORY SUBUNIT 3. [MASS=60978
8	**10**	Homo sapiens (Human) ISOFORM 1 OF EUKARYOTIC TRANSLATION INITIATION FACTOR 3 SUBUNIT 9. [MASS=92492

8	**9**	Homo sapiens (Human) 60S ACIDIC RIBOSOMAL PROTEIN P0. [MASS=34274
8	**8**	Homo sapiens (Human) FACT COMPLEX SUBUNIT SSRP1. [MASS=81075
8	**12**	Homo sapiens (Human) NUCLEOSOME ASSEMBLY PROTEIN 1-LIKE 4. [MASS=43011
8	**12**	Homo sapiens (Human) ISOFORM BETA-2 OF DNA TOPOISOMERASE 2-BETA. [MASS=183267
8	**9**	Homo sapiens (Human) GARS PROTEIN. [MASS=84648
8	**8**	Homo sapiens (Human) STRUCTURAL MAINTENANCE OF CHROMOSOME 1-LIKE 1 PROTEIN. [MASS=143233
8	**8**	Homo sapiens (Human) DNA-DIRECTED RNA POLYMERASE II 140 KDA POLYPEPTIDE. [MASS=133897
8	**24**	Homo sapiens (Human) NESTIN. [MASS=177439
8	**8**	Homo sapiens (Human) PREDICTED: SIMILAR TO PEPTIDYLPROLYL ISOMERASE A ISOFORM 1. [MASS=24517
8	**11**	Homo sapiens (Human) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN D-LIKE. [MASS=46438
8	**10**	Homo sapiens (Human) ISOFORM 2C OF CYTOPLASMIC DYNEIN 1 INTERMEDIATE CHAIN 2. [MASS=68426
7	**7**	Homo sapiens (Human) CSNK2A1 PROTEIN. [MASS=45909
7	**7**	Homo sapiens (Human) PEROXIREDOXIN-6. [MASS=24904
7	**9**	Homo sapiens (Human) HIGH MOBILITY GROUP PROTEIN 1-LIKE 10. [MASS=24218
7	**10**	Homo sapiens (Human) CALMODULIN. [MASS=16706
7	**9**	Homo sapiens (Human) NUCLEOSOME ASSEMBLY PROTEIN 1-LIKE 1. [MASS=45374
7	**10**	Homo sapiens (Human) IMPORTIN-9. [MASS=115832
7	**13**	Homo sapiens (Human) ISOFORM 1 OF PROTEIN SET. [MASS=33489
7	**11**	Homo sapiens (Human) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN H1. [MASS=49229
7	**9**	Homo sapiens (Human) SEPTIN-2. [MASS=41487
7	**7**	Homo sapiens (Human) ATAXIN-10. [MASS=53489
7	**7**	Homo sapiens (Human) COATOMER SUBUNIT BETA. [MASS=107139
7	**9**	Homo sapiens (Human) ISOFORM 2 OF DNA REPLICATION LICENSING FACTOR MCM7. [MASS=44649
7	**7**	Homo sapiens (Human) IRON-RESPONSIVE ELEMENT-BINDING PROTEIN 1. [MASS=98399
7	**10**	Homo sapiens (Human) TYROSINE 3-MONOOXYGENASE/TRYPTOPHAN 5-MONOOXYGENASE ACTIVATION PROTEIN, BETA POLYPEPTIDE. [MASS=28082
7	**9**	Homo sapiens (Human) 26S PROTEASE REGULATORY SUBUNIT S10B. [MASS=44173
7	**8**	Homo sapiens (Human) HYPOTHETICAL PROTEIN DKFZP781K0743. [MASS=105850
7	**8**	Homo sapiens (Human) UBIQUITIN CARBOXYL-TERMINAL HYDROLASE ISOZYME L1. [MASS=24824
7	**9**	Homo sapiens (Human) ISOFORM 1 OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN U-LIKE PROTEIN 1. [MASS=95739
7	**8**	Homo sapiens (Human) TUBULIN--TYROSINE LIGASE-LIKE PROTEIN 12. [MASS=74404
7	**7**	Homo sapiens (Human) ISOFORM 2 OF NUCLEAR MITOTIC APPARATUS PROTEIN 1. [MASS=236531

7	**8**	Homo sapiens (Human) ALPHA ISOFORM OF REGULATORY SUBUNIT A, PROTEIN PHOSPHATASE 2. [MASS=65309
7	**8**	Homo sapiens (Human) ISOFORM 4 OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN A/B. [MASS=31233
7	**8**	Homo sapiens (Human) CCR4-NOT TRANSCRIPTION COMPLEX, SUBUNIT 1 ISOFORM A. [MASS=266939
7	**8**	Homo sapiens (Human) PROFILIN-1. [MASS=14923
7	**11**	Homo sapiens (Human) PROLIFERATING CELL NUCLEAR ANTIGEN. [MASS=28769
7	**7**	Homo sapiens (Human) METHIONYL-TRNA SYNTHETASE. [MASS=101116
7	**8**	Homo sapiens (Human) UBIQUITIN-LIKE 1-ACTIVATING ENZYME E1A. [MASS=38450
7	**8**	Homo sapiens (Human) ALCOHOL DEHYDROGENASE. [MASS=36442
7	**7**	Homo sapiens (Human) ADP-RIBOSYLATION FACTOR 1. [MASS=20566
7	**9**	Homo sapiens (Human) THIOREDOXIN-LIKE PROTEIN 1. [MASS=32120
7	**11**	Homo sapiens (Human) ISOFORM 1 OF 26S PROTEASOME NON-ATPASE REGULATORY SUBUNIT 1. [MASS=105836
7	**7**	Homo sapiens (Human) EUKARYOTIC TRANSLATION INITIATION FACTOR 3 SUBUNIT 8. [MASS=105344
7	**7**	Homo sapiens (Human) VESICLE-FUSING ATPASE. [MASS=82654
7	**8**	Homo sapiens (Human) Complement component 3 precursor. [MASS=187306
7	**7**	Homo sapiens (Human) EUKARYOTIC TRANSLATION INITIATION FACTOR 3 SUBUNIT 6. [MASS=52221
7	**8**	Homo sapiens (Human) ATP-DEPENDENT DNA HELICASE 2 SUBUNIT 1. [MASS=69712
7	**7**	Homo sapiens (Human) ISOFORM 1 OF HOST CELL FACTOR. [MASS=208842
7	**7**	Homo sapiens (Human) METASTASIS-ASSOCIATED PROTEIN MTA2. [MASS=75023
7	**7**	Homo sapiens (Human) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN L ISOFORM A. [MASS=64133
7	**8**	Homo sapiens (Human) 26S PROTEASE REGULATORY SUBUNIT 4. [MASS=49185
7	**8**	Homo sapiens (Human) UDP-GLUCOSE CERAMIDE GLUCOSYLTRANSFERASE-LIKE 1 ISOFORM 1. [MASS=177190
7	**7**	Homo sapiens (Human) EUKARYOTIC TRANSLATION INITIATION FACTOR 5B. [MASS=138800
7	**7**	Homo sapiens (Human) ISOFORM V0 OF VERSICAN CORE PROTEIN PRECURSOR. [MASS=372820
7	**26**	Homo sapiens (Human) TUBULIN BETA-1 CHAIN. [MASS=50327
7	**7**	Homo sapiens (Human) ISOFORM 1 OF FILAMIN-B. [MASS=278195
7	**7**	Homo sapiens (Human) CONTACTIN-2 PRECURSOR. [MASS=113393
7	**7**	Homo sapiens (Human) UBIQUITIN SPECIFIC PROTEASE 9, X-LINKED ISOFORM 4. [MASS=290497
6	**11**	Homo sapiens (Human) ISOFORM 1 OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN A3. [MASS=39595
6	**11**	Homo sapiens (Human) HEMOGLOBIN SUBUNIT ALPHA. [MASS=15126
6	**8**	Homo sapiens (Human) ASTROCYTIC PHOSPHOPROTEIN PEA-15. [MASS=15040
6	**6**	Homo sapiens (Human) 26S PROTEASOME NON-ATPASE REGULATORY SUBUNIT 7. [MASS=37025

6	**7**	Homo sapiens (Human) PROTEASOME SUBUNIT BETA TYPE 1. [MASS=26489
6	**6**	Homo sapiens (Human) ALPHA-CENTRACTIN. [MASS=42614
6	**10**	Homo sapiens (Human) ISOFORM 1 OF PLASMINOGEN ACTIVATOR INHIBITOR 1 RNA-BINDING PROTEIN. [MASS=44965
6	**7**	Homo sapiens (Human) CALPONIN-3. [MASS=36414
6	**7**	Homo sapiens (Human) PROTEASOME SUBUNIT ALPHA TYPE 2. [MASS=25767
6	**8**	Homo sapiens (Human) PHOSPHATIDYLETHANOLAMINE-BINDING PROTEIN 1. [MASS=20926
6	**6**	Homo sapiens (Human) METHIONINE ADENOSYLTRANSFERASE II, BETA ISOFORM 1. [MASS=37552
6	**12**	Homo sapiens (Human) VITRONECTIN PRECURSOR. [MASS=54306
6	**7**	Homo sapiens (Human) PHOSPHORIBOSYL PYROPHOSPHATE SYNTHETASE-ASSOCIATED PROTEIN 2. [MASS=40926
6	**6**	Homo sapiens (Human) CONDENSIN COMPLEX SUBUNIT 3. [MASS=114334
6	**10**	Homo sapiens (Human) PEROXIREDOXIN-2. [MASS=21761
6	**12**	Homo sapiens (Human) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN A1 ISOFORM B. [MASS=38747
6	**8**	Homo sapiens (Human) RHO GDP-DISSOCIATION INHIBITOR 1. [MASS=23076
6	**6**	Homo sapiens (Human) ISOFORM 1 OF DIPEPTIDYL-PEPTIDASE 3. [MASS=82589
6	**6**	Homo sapiens (Human) ISOFORM 1 OF ACTIN-LIKE PROTEIN 6A. [MASS=47461
6	**6**	Homo sapiens (Human) ISOFORM 2 OF NSFL1 COFACTOR P47. [MASS=37325
6	**6**	Homo sapiens (Human) EUKARYOTIC TRANSLATION INITIATION FACTOR 4 GAMMA, 1 ISOFORM 2. [MASS=166589
6	**53**	Homo sapiens (Human) ELONGATION FACTOR 1-ALPHA 2. [MASS=50470
6	**8**	Homo sapiens (Human) HYPOTHETICAL PROTEIN DKFZP564E242. [MASS=31424
6	**6**	Homo sapiens (Human) 3-MERCAPTOPYRUVATE SULFURTRANSFERASE. [MASS=33047
6	**7**	Homo sapiens (Human) CLUSTERIN PRECURSOR. [MASS=52495
6	**6**	Homo sapiens (Human) REPLICATION PROTEIN A 70 KDA DNA-BINDING SUBUNIT. [MASS=68138
6	**7**	Homo sapiens (Human) DYNACTIN 2. [MASS=44820
6	**7**	Homo sapiens (Human) THIOREDOXIN-LIKE PROTEIN 2. [MASS=37432
6	**6**	Homo sapiens (Human) ISOFORM 2 OF CADHERIN-11 PRECURSOR. [MASS=76541
6	**9**	Homo sapiens (Human) S-ADENOSYLMETHIONINE SYNTHETASE ISOFORM TYPE-2. [MASS=43661
6	**7**	Homo sapiens (Human) ISOFORM 1 OF ELAV-LIKE PROTEIN 3. [MASS=39547
6	**6**	Homo sapiens (Human) SIMILAR TO ANNEXIN A2 ISOFORM 1. [MASS=38659
6	**8**	Homo sapiens (Human) ASPARTATE AMINOTRANSFERASE, CYTOPLASMIC. [MASS=46116
6	**7**	Homo sapiens (Human) NUCLEAR MIGRATION PROTEIN NUDC. [MASS=38243
6	**7**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S19. [MASS=15929

6	**6**	Homo sapiens (Human) RNA BINDING PROTEIN (FRAGMENT). [MASS=32550
6	**6**	Homo sapiens (Human) ISOFORM 1 OF DNA. [MASS=189566
6	**9**	Homo sapiens (Human) ISOFORM 2 OF SERINE/THREONINE-PROTEIN KINASE DCAMKL1. [MASS=82224
6	**6**	Homo sapiens (Human) PROTEIN TRANSPORT PROTEIN SEC23A. [MASS=86147
6	**10**	Homo sapiens (Human) 60S RIBOSOMAL PROTEIN L4. [MASS=47566
6	**7**	Homo sapiens (Human) PROTEASOME 26S NON-ATPASE SUBUNIT 13 ISOFORM 2. [MASS=39871
6	**6**	Homo sapiens (Human) ISOFORM 4 OF AFADIN. [MASS=206804
6	**16**	Homo sapiens (Human) DIHYDROPYRIMIDINASE-RELATED PROTEIN 2. [MASS=62294
6	**6**	Homo sapiens (Human) WUGSC:H_RG054D04.1 PROTEIN. [MASS=29037
6	**7**	Homo sapiens (Human) VACUOLAR ATP SYNTHASE CATALYTIC SUBUNIT A, UBIQUITOUS ISOFORM. [MASS=68304
6	**6**	Homo sapiens (Human) MGEA5 PROTEIN. [MASS=95331
6	**7**	Homo sapiens (Human) GLUCOSIDASE 2 SUBUNIT BETA PRECURSOR. [MASS=59296
6	**6**	Homo sapiens (Human) CYSTEINYL-TRNA SYNTHETASE ISOFORM C. [MASS=94638
6	**9**	Homo sapiens (Human) BIFUNCTIONAL PURINE BIOSYNTHESIS PROTEIN PURH. [MASS=64616
6	**6**	Homo sapiens (Human) HSC70-INTERACTING PROTEIN. [MASS=41332
6	**7**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S3. [MASS=26688
6	**9**	Homo sapiens (Human) GALECTIN-3-BINDING PROTEIN PRECURSOR. [MASS=65331
6	**6**	Homo sapiens (Human) ISOFORM 1 OF COMPLEMENT FACTOR B PRECURSOR (FRAGMENT). [MASS=85533
6	**6**	Homo sapiens (Human) ISOFORM 1 OF POLYADENYLATE-BINDING PROTEIN 4. [MASS=70783
6	**6**	Homo sapiens (Human) SPERMIDINE SYNTHASE. [MASS=33825
6	**7**	Homo sapiens (Human) PROTEIN DJ-1. [MASS=19891
6	**8**	Homo sapiens (Human) ISOFORM 1 OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN H3. [MASS=36926
6	**8**	Homo sapiens (Human) RAB1A, MEMBER RAS ONCOGENE FAMILY. [MASS=22678
6	**6**	Homo sapiens (Human) WD40 PROTEIN. [MASS=35079
6	**11**	Homo sapiens (Human) ISOFORM B1 OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEINS A2/B1. [MASS=37430
6	**7**	Homo sapiens (Human) RUVB-LIKE 1. [MASS=50228
6	**10**	Homo sapiens (Human) RNA BINDING MOTIF PROTEIN, X-LINKED-LIKE 1. [MASS=42142
6	**7**	Homo sapiens (Human) PHOSPHOGLYCERATE MUTASE 2. [MASS=28635
6	**7**	Homo sapiens (Human) DNA POLYMERASE DELTA CATALYTIC SUBUNIT. [MASS=123631
6	**6**	Homo sapiens (Human) SF3B3 PROTEIN. [MASS=30210
6	**6**	Homo sapiens (Human) RETINOBLASTOMA-ASSOCIATED FACTOR 600. [MASS=185447
5	**35**	TRYPSIN PRECURSOR (EC 3.4.21.4)>PIR1:TRPGTR trypsin (EC 3.4.21.4)
5	**8**	Homo sapiens (Human) TUBULIN BETA-4 CHAIN. [MASS=49586

5	**18**	Homo sapiens (Human) PROTHYMOSIN ALPHA. [MASS=12203
5	**6**	Homo sapiens (Human) 26S PROTEASOME NON-ATPASE REGULATORY SUBUNIT 14. [MASS=34577
5	**7**	Homo sapiens (Human) GLYOXYLATE REDUCTASE/HYDROXYPYRUVATE REDUCTASE. [MASS=35668
5	**7**	Homo sapiens (Human) DNA-(APURINIC OR APYRIMIDINIC SITE) LYASE. [MASS=35423
5	**6**	Homo sapiens (Human) ISOFORM 2 OF GUANINE NUCLEOTIDE-BINDING PROTEIN G(I), ALPHA-2 SUBUNIT. [MASS=38473
5	**5**	Homo sapiens (Human) ISOFORM 1 OF PROTEIN 4.1. [MASS=97017
5	**7**	Homo sapiens (Human) ADP-SUGAR PYROPHOSPHATASE. [MASS=24328
5	**6**	Homo sapiens (Human) HISTONE H2B TYPE 2-E. [MASS=13789
5	**10**	Homo sapiens (Human) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN F. [MASS=45672
5	**9**	Homo sapiens (Human) PREDICTED: SIMILAR TO HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN A3 ISOFORM 1. [MASS=31312
5	**9**	Homo sapiens (Human) NG,NG-DIMETHYLARGININE DIMETHYLAMINOHYDROLASE 2. [MASS=29644
5	**5**	Homo sapiens (Human) SERYL-TRNA SYNTHETASE. [MASS=58646
5	**5**	Homo sapiens (Human) NUCLEASE SENSITIVE ELEMENT-BINDING PROTEIN 1. [MASS=35793
5	**10**	Homo sapiens (Human) ISOFORM 1 OF CLEAVAGE AND POLYADENYLATION SPECIFICITY FACTOR 6. [MASS=59210
5	**7**	Homo sapiens (Human) POLY(RC)-BINDING PROTEIN 1. [MASS=37498
5	**7**	Homo sapiens (Human) ISOFORM B OF FIBULIN-1 PRECURSOR. [MASS=77186
5	**5**	Homo sapiens (Human) FK506-BINDING PROTEIN 3. [MASS=25177
5	**5**	Homo sapiens (Human) CTTN PROTEIN. [MASS=70959
5	**14**	Homo sapiens (Human) PREDICTED: SIMILAR TO HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN A1. [MASS=32163
5	**5**	Homo sapiens (Human) PRE-MRNA-SPLICING FACTOR 19. [MASS=55181
5	**7**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S15. [MASS=16909
5	**6**	Homo sapiens (Human) GLUTAMINYL-TRNA SYNTHETASE. [MASS=87799
5	**5**	Homo sapiens (Human) PROTEIN RCC2. [MASS=56085
5	**8**	Homo sapiens (Human) DOUBLECORTEX\; LISSENCEPHALY, X-LINKED. [MASS=49847
5	**5**	Homo sapiens (Human) ISOFORM B OF MANNOSE-6-PHOSPHATE RECEPTOR-BINDING PROTEIN 1. [MASS=47047
5	**6**	Homo sapiens (Human) COATOMER SUBUNIT BETA'. [MASS=102356
5	**7**	Homo sapiens (Human) HEPATOMA-DERIVED GROWTH FACTOR. [MASS=26788
5	**7**	Homo sapiens (Human) ELAV-LIKE PROTEIN 1. [MASS=36092
5	**5**	Homo sapiens (Human) PP856. [MASS=43833
5	**7**	Homo sapiens (Human) RAS-RELATED PROTEIN RAB-2A. [MASS=23546
5	**6**	Homo sapiens (Human) ISOFORM 2 OF PROTEIN ENABLED HOMOLOG. [MASS=63924
5	**7**	Homo sapiens (Human) ISOFORM 1 OF BETA-CATENIN. [MASS=85497
5	**5**	Homo sapiens (Human) AP-2 COMPLEX SUBUNIT ALPHA-2. [MASS=104150
5	**20**	Homo sapiens (Human) EEF1A1 PROTEIN. [MASS=47869

5	**7**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S17. [MASS=15419
5	**6**	Homo sapiens (Human) 14-3-3 PROTEIN GAMMA. [MASS=28171
5	**5**	Homo sapiens (Human) RAS-GTPASE-ACTIVATING PROTEIN-BINDING PROTEIN 1. [MASS=52164
5	**11**	Homo sapiens (Human) POLY(RC)-BINDING PROTEIN 2 ISOFORM B. [MASS=38222
5	**5**	Homo sapiens (Human) EXPORTIN-T. [MASS=109964
5	**6**	Homo sapiens (Human) EUKARYOTIC TRANSLATION INITIATION FACTOR 2C 1. [MASS=97214
5	**5**	Homo sapiens (Human) PREDICTED: STRUCTURAL MAINTENANCE OF CHROMOSOMES FLEXIBLE HINGE DOMAIN CONTAINING 1. [MASS=220242
5	**13**	Homo sapiens (Human) PREGNANCY ZONE PROTEIN PRECURSOR. [MASS=163836
5	**6**	Homo sapiens (Human) ISOFORM 1 OF LIM AND SH3 DOMAIN PROTEIN 1. [MASS=29717
5	**16**	Homo sapiens (Human) SIMILAR TO NESTIN. [MASS=175922
5	**5**	Homo sapiens (Human) ISOFORM 1 OF FILAMIN-C. [MASS=291293
5	**6**	Homo sapiens (Human) MICROTUBULE-ASSOCIATED PROTEIN RP/EB FAMILY MEMBER 1. [MASS=29868
5	**5**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S13. [MASS=17091
5	**5**	Homo sapiens (Human) MITOGEN-ACTIVATED PROTEIN KINASE 1. [MASS=41259
5	**5**	Homo sapiens (Human) UDP-GLUCOSE 6-DEHYDROGENASE. [MASS=55024
5	**9**	Homo sapiens (Human) PROBABLE ATP-DEPENDENT RNA HELICASE DDX5. [MASS=69148
5	**5**	Homo sapiens (Human) ISOFORM 1 OF SLIT-ROBO RHO GTPASE-ACTIVATING PROTEIN 3. [MASS=124504
5	**5**	Homo sapiens (Human) HSP90 CO-CHAPERONE CDC37. [MASS=44468
5	**8**	Homo sapiens (Human) AMBP PROTEIN PRECURSOR. [MASS=38999
5	**5**	Homo sapiens (Human) CGI-150 PROTEIN. [MASS=55012
5	**6**	Homo sapiens (Human) PRE-MRNA-PROCESSING FACTOR 6 HOMOLOG. [MASS=106925
5	**5**	Homo sapiens (Human) TAR DNA-BINDING PROTEIN 43. [MASS=44740
5	**6**	Homo sapiens (Human) ISOFORM 1 OF KH DOMAIN-CONTAINING, RNA-BINDING, SIGNAL TRANSDUCTION- ASSOCIATED PROTEIN 1. [MASS=48227
5	**5**	Homo sapiens (Human) HYPOTHETICAL PROTEIN DKFZP451P021. [MASS=117896
5	**7**	Homo sapiens (Human) KH-TYPE SPLICING REGULATORY PROTEIN. [MASS=73115
5	**5**	Homo sapiens (Human) ISOCITRATE DEHYDROGENASE [NADP], MITOCHONDRIAL PRECURSOR. [MASS=50909
5	**5**	Homo sapiens (Human) 182 KDA TANKYRASE 1-BINDING PROTEIN. [MASS=181816
5	**5**	Homo sapiens (Human) CONDENSIN COMPLEX SUBUNIT 1. [MASS=157169
5	**7**	Homo sapiens (Human) ISOFORM 1 OF ACIDIC LEUCINE-RICH NUCLEAR PHOSPHOPROTEIN 32 FAMILY MEMBER B. [MASS=28788
5	**5**	Homo sapiens (Human) SMALL NUCLEAR RIBONUCLEOPROTEIN SM D2. [MASS=13527
5	**5**	Homo sapiens (Human) FUSE-BINDING PROTEIN-INTERACTING REPRESSOR ISOFORM A. [MASS=59875

5	**6**	Homo sapiens (Human) COP9 SIGNALOSOME COMPLEX SUBUNIT 6. [MASS=36163
5	**5**	Homo sapiens (Human) ACETYL-COA CARBOXYLASE 1. [MASS=265040
5	**5**	Homo sapiens (Human) ISOFORM 2 OF SUPPRESSOR OF G2 ALLELE OF SKP1 HOMOLOG. [MASS=37673
5	**5**	Homo sapiens (Human) ISOFORM 5 OF DYNAMIN-1-LIKE PROTEIN. [MASS=79123
5	**5**	Homo sapiens (Human) 60S RIBOSOMAL PROTEIN L5. [MASS=34231
5	**6**	Homo sapiens (Human) PREDICTED: SIMILAR TO RIBOSOMAL PROTEIN L13 ISOFORM 1. [MASS=24280
5	**5**	Homo sapiens (Human) INOSINE-5'-MONOPHOSPHATE DEHYDROGENASE 2. [MASS=55805
5	**5**	Homo sapiens (Human) ISOFORM 1 OF PHOSPHOSERINE AMINOTRANSFERASE. [MASS=40423
5	**9**	Homo sapiens (Human) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN C-LIKE 1. [MASS=32142
5	**6**	Homo sapiens (Human) UBIQUITIN-CONJUGATING ENZYME E2 N. [MASS=17138
5	**5**	Homo sapiens (Human) PROTEIN KINASE C-BINDING PROTEIN NELL2 PRECURSOR. [MASS=91346
5	**5**	Homo sapiens (Human) ISOFORM 1 OF DYNAMIN-2. [MASS=98064
5	**5**	Homo sapiens (Human) NEURONAL PROTEIN NP25. [MASS=24893
5	**5**	Homo sapiens (Human) SMALL GLUTAMINE-RICH TETRATRICOPEPTIDE REPEAT-CONTAINING PROTEIN A. [MASS=34063
4	**4**	Homo sapiens (Human) PROLYL ENDOPEPTIDASE. [MASS=80764
4	**6**	Homo sapiens (Human) 60S ACIDIC RIBOSOMAL PROTEIN P2. [MASS=11665
4	**4**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S7. [MASS=22127
4	**6**	Homo sapiens (Human) ISOFORM 1 OF DNA-BINDING PROTEIN A. [MASS=40090
4	**6**	Homo sapiens (Human) ISOFORM EWS-B OF RNA-BINDING PROTEIN EWS. [MASS=61217
4	**4**	Homo sapiens (Human) THYMIDYLATE SYNTHASE. [MASS=31759
4	**5**	Homo sapiens (Human) NASCENT POLYPEPTIDE-ASSOCIATED COMPLEX SUBUNIT ALPHA. [MASS=23384
4	**5**	Homo sapiens (Human) HISTIDINE-RICH GLYCOPROTEIN PRECURSOR. [MASS=59578
4	**4**	Homo sapiens (Human) ISOFORM 1 OF PROTEASOME SUBUNIT ALPHA TYPE 7. [MASS=27887
4	**4**	Homo sapiens (Human) 1-PHOSPHATIDYLINOSITOL-4,5-BISPHOSPHATE PHOSPHODIESTERASE GAMMA 1. [MASS=148532
4	**4**	Homo sapiens (Human) SPLICEOSOME RNA HELICASE BAT1. [MASS=48991
4	**5**	Homo sapiens (Human) PREDICTED: SIMILAR TO PHOSPHOGLYCERATE MUTASE 1 (PHOSPHOGLYCERATE MUTASE ISOZYME B) (PGAM-B) (BPG-DEPENDENT PGAM 1) ISOFORM 1. [MASS=28850
4	**4**	Homo sapiens (Human) CRK-LIKE PROTEIN. [MASS=33777
4	**5**	Homo sapiens (Human) RNA-BINDING PROTEIN MUSASHI HOMOLOG 1. [MASS=39125
4	**4**	Homo sapiens (Human) FLAP ENDONUCLEASE 1. [MASS=42593

4	**5**	Homo sapiens (Human) ISOFORM C OF FIBULIN-1 PRECURSOR. [MASS=74462
4	**39**	Homo sapiens (Human) TUBA6 PROTEIN. [MASS=37021
4	**5**	Homo sapiens (Human) BA395L14.12. [MASS=28403
4	**4**	Homo sapiens (Human) ISOFORM SHORT OF TATA-BINDING PROTEIN-ASSOCIATED FACTOR 2N. [MASS=61558
4	**5**	Homo sapiens (Human) LUNG CANCER ONCOGENE 7. [MASS=37889
4	**4**	Homo sapiens (Human) DNAJ HOMOLOG SUBFAMILY A MEMBER 1. [MASS=44868
4	**5**	Homo sapiens (Human) CLASS III ALCOHOL DEHYDROGENASE 5 CHI SUBUNIT. [MASS=41601
4	**5**	Homo sapiens (Human) DYNC1H1 PROTEIN. [MASS=22182
4	**4**	Homo sapiens (Human) ISOFORM 2 OF SERINE/THREONINE-PROTEIN KINASE PAK 1. [MASS=61632
4	**5**	Homo sapiens (Human) 60S RIBOSOMAL PROTEIN L21. [MASS=18434
4	**7**	Homo sapiens (Human) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN U ISOFORM A. [MASS=90584
4	**4**	Homo sapiens (Human) HISTONE H4. [MASS=11236
4	**4**	Homo sapiens (Human) SCC-112 PROTEIN. [MASS=150830
4	**4**	Homo sapiens (Human) WW DOMAIN-BINDING PROTEIN 11. [MASS=69998
4	**5**	Homo sapiens (Human) ISOFORM 2 OF PUTATIVE GTP-BINDING PROTEIN PTD004. [MASS=27584
4	**4**	Homo sapiens (Human) PLATELET-ACTIVATING FACTOR ACETYLHYDROLASE, ISOFORM IB, ALPHA SUBUNIT. [MASS=46638
4	**4**	Homo sapiens (Human) ISOFORM II OF UBIQUITIN-PROTEIN LIGASE E3A. [MASS=100646
4	**4**	Homo sapiens (Human) BRAIN ACID SOLUBLE PROTEIN 1. [MASS=22562
4	**7**	Homo sapiens (Human) ACTIN-LIKE PROTEIN 2. [MASS=44761
4	**5**	Homo sapiens (Human) EUKARYOTIC TRANSLATION INITIATION FACTOR 5. [MASS=49223
4	**4**	Homo sapiens (Human) 14-3-3 PROTEIN ETA. [MASS=28088
4	**4**	Homo sapiens (Human) EUKARYOTIC TRANSLATION INITIATION FACTOR 2 SUBUNIT 1. [MASS=35981
4	**5**	Homo sapiens (Human) ISOFORM DELTA-1 OF SERINE/THREONINE-PROTEIN PHOSPHATASE 2A 56 KDA REGULATORY SUBUNIT DELTA ISOFORM. [MASS=69992
4	**4**	Homo sapiens (Human) UBIQUITIN CARBOXYL-TERMINAL HYDROLASE 10. [MASS=87692
4	**5**	Homo sapiens (Human) PDCD6IP PROTEIN. [MASS=96818
4	**4**	Homo sapiens (Human) PROTEIN FAM98B. [MASS=37191
4	**5**	Homo sapiens (Human) ISOFORM 1 OF 40S RIBOSOMAL PROTEIN S24. [MASS=15423
4	**5**	Homo sapiens (Human) ADENYLOSUCCINATE SYNTHETASE ISOZYME 2. [MASS=50097
4	**4**	Homo sapiens (Human) ISOFORM 1 OF MICROTUBULE-ASSOCIATED PROTEIN RP/EB FAMILY MEMBER 2. [MASS=37031
4	**4**	Homo sapiens (Human) EXPORTIN-7. [MASS=123776
4	**4**	Homo sapiens (Human) PHOSPHOLIPASE A-2-ACTIVATING PROTEIN. [MASS=87157
4	**6**	Homo sapiens (Human) ISOFORM 1 OF PHOSPHOLIPID TRANSFER PROTEIN PRECURSOR. [MASS=54739

4	**4**	Homo sapiens (Human) CERULOPLASMIN PRECURSOR. [MASS=122205
4	**5**	Homo sapiens (Human) RAS-RELATED PROTEIN RAB-7. [MASS=23490
4	**7**	Homo sapiens (Human) SERINE/THREONINE-PROTEIN PHOSPHATASE 2A CATALYTIC SUBUNIT ALPHA ISOFORM. [MASS=35594
4	**4**	Homo sapiens (Human) ISOFORM 1 OF DOUBLE-STRAND BREAK REPAIR PROTEIN MRE11A. [MASS=80593
4	**6**	Homo sapiens (Human) ADENYLATE KINASE ISOENZYME 1. [MASS=21635
4	**5**	Homo sapiens (Human) GPI-ANCHORED PROTEIN P137. [MASS=72752
4	**6**	Homo sapiens (Human) ALPHA-2-ANTIPLASMIN PRECURSOR. [MASS=55064
4	**5**	Homo sapiens (Human) PLASMA RETINOL-BINDING PROTEIN PRECURSOR. [MASS=23010
4	**4**	Homo sapiens (Human) ISOFORM 4 OF SAPS DOMAIN FAMILY MEMBER 3. [MASS=88952
4	**5**	Homo sapiens (Human) AP-1 COMPLEX SUBUNIT MU-1. [MASS=48456
4	**4**	Homo sapiens (Human) ALPHA-SOLUBLE NSF ATTACHMENT PROTEIN. [MASS=33247
4	**4**	Homo sapiens (Human) EUKARYOTIC TRANSLATION INITIATION FACTOR 4 GAMMA, 1 ISOFORM 4. [MASS=154805
4	**4**	Homo sapiens (Human) PROTEASOME SUBUNIT ALPHA TYPE 6. [MASS=27399
4	**4**	Homo sapiens (Human) QUINONE OXIDOREDUCTASE. [MASS=35207
4	**4**	Homo sapiens (Human) SPLICING FACTOR 3A SUBUNIT 3. [MASS=58849
4	**4**	Homo sapiens (Human) GMP SYNTHASE. [MASS=76715
4	**4**	Homo sapiens (Human) ISOFORM 2 OF NMDA RECEPTOR-REGULATED PROTEIN 1. [MASS=61602
4	**4**	Homo sapiens (Human) EUKARYOTIC TRANSLATION INITIATION FACTOR 3 SUBUNIT 2. [MASS=36502
4	**5**	Homo sapiens (Human) PROTEIN C14ORF166. [MASS=28068
4	**7**	Homo sapiens (Human) FARNESYL DIPHOSPHATE SYNTHASE. [MASS=48275
4	**5**	Homo sapiens (Human) COATOMER SUBUNIT GAMMA-2. [MASS=97622
4	**4**	Homo sapiens (Human) FIBRILLARIN. [MASS=33784
4	**4**	Homo sapiens (Human) NUCLEAR CAP-BINDING PROTEIN SUBUNIT 1. [MASS=91839
4	**4**	Homo sapiens (Human) PROTEASOME SUBUNIT BETA TYPE 4 PRECURSOR. [MASS=29192
4	**4**	Homo sapiens (Human) CALCIUM-BINDING PROTEIN 39. [MASS=39869
4	**4**	Homo sapiens (Human) PHENYLALANYL-TRNA SYNTHETASE BETA CHAIN. [MASS=66130
4	**4**	Homo sapiens (Human) PROTEIN FAM49B. [MASS=36748
4	**4**	Homo sapiens (Human) 47 KDA HEAT SHOCK PROTEIN PRECURSOR. [MASS=46267
4	**5**	Homo sapiens (Human) PEPTIDYLPROLYL ISOMERASE B PRECURSOR. [MASS=23743
4	**4**	Homo sapiens (Human) ISOFORM 1 OF EXPORTIN-5. [MASS=136311
4	**4**	Homo sapiens (Human) CADHERIN-2 PRECURSOR. [MASS=99851
4	**4**	Homo sapiens (Human) ISOFORM 3 OF DREBRIN-LIKE PROTEIN. [MASS=49042

4	**5**	Homo sapiens (Human) 16 KDA PROTEIN. [MASS=16122
4	**4**	Homo sapiens (Human) PROBABLE ATP-DEPENDENT RNA HELICASE DDX23. [MASS=95647
4	**4**	Homo sapiens (Human) CORONIN-1C. [MASS=53249
4	**4**	Homo sapiens (Human) SIGNAL RECOGNITION PARTICLE 14 KDA PROTEIN. [MASS=14544
4	**4**	Homo sapiens (Human) TROPOMYOSIN 1 ALPHA CHAIN ISOFORM 2. [MASS=32678
4	**4**	Homo sapiens (Human) VON HIPPEL-LINDAU BINDING PROTEIN 1. [MASS=26535
4	**7**	Homo sapiens (Human) ACETYL-COA ACETYLTRANSFERASE, CYTOSOLIC. [MASS=41351
4	**5**	Homo sapiens (Human) 60S RIBOSOMAL PROTEIN L19. [MASS=23466
4	**8**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S2. [MASS=31324
4	**5**	Homo sapiens (Human) ISOFORM 1 OF MELANOMA-ASSOCIATED ANTIGEN D2. [MASS=64954
4	**7**	Homo sapiens (Human) 60S RIBOSOMAL PROTEIN L3. [MASS=45978
4	**18**	Homo sapiens (Human) UBIQUITIN AND RIBOSOMAL PROTEIN S27A PRECURSOR. [MASS=17965
4	**4**	Homo sapiens (Human) PREDICTED: SIMILAR TO RAN-SPECIFIC GTPASE-ACTIVATING PROTEIN. [MASS=35024
4	**5**	Homo sapiens (Human) SEPTIN 9. [MASS=63633
4	**4**	Homo sapiens (Human) SPERMATID PERINUCLEAR RNA-BINDING PROTEIN. [MASS=73765
4	**5**	Homo sapiens (Human) PROBABLE ATP-DEPENDENT RNA HELICASE DDX46. [MASS=117461
4	**4**	Homo sapiens (Human) RAS-RELATED PROTEIN RAB-14. [MASS=23766
4	**6**	Homo sapiens (Human) MARCKS-RELATED PROTEIN. [MASS=19398
4	**4**	Homo sapiens (Human) GCN1-LIKE PROTEIN 1. [MASS=292930
4	**4**	Homo sapiens (Human) KINESIN LIGHT CHAIN 1 ISOFORM 2. [MASS=65310
4	**4**	Homo sapiens (Human) ISOFORM 2 OF AT-RICH INTERACTIVE DOMAIN-CONTAINING PROTEIN 1A. [MASS=218335
4	**5**	Homo sapiens (Human) TROPOMYOSIN 4. [MASS=28522
4	**4**	Homo sapiens (Human) EARLY ENDOSOME ANTIGEN 1. [MASS=162466
4	**6**	Homo sapiens (Human) RETICULOCALBIN-1 PRECURSOR. [MASS=38890
4	**4**	Homo sapiens (Human) ISOFORM 1 OF APOPTOSIS INHIBITOR 5. [MASS=57561
4	**4**	Homo sapiens (Human) ISOFORM 1 OF FOCAL ADHESION KINASE 1. [MASS=119233
4	**7**	Homo sapiens (Human) TUBULIN-SPECIFIC CHAPERONE B. [MASS=27326
4	**4**	Homo sapiens (Human) HSPC121. [MASS=44423
4	**6**	Homo sapiens (Human) SEPTIN-11. [MASS=49267
4	**6**	Homo sapiens (Human) NEUROCAN CORE PROTEIN PRECURSOR. [MASS=142973
4	**4**	Homo sapiens (Human) LYSYL-TRNA SYNTHETASE. [MASS=68048
4	**5**	Homo sapiens (Human) 6-PHOSPHOGLUCONOLACTONASE. [MASS=27547
4	**7**	Homo sapiens (Human) SPLICING FACTOR, ARGININE/SERINE-RICH 2. [MASS=25345

4	**4**	Homo sapiens (Human) 60S RIBOSOMAL PROTEIN L7A. [MASS=29864
4	**6**	Homo sapiens (Human) GUANINE NUCLEOTIDE-BINDING PROTEIN G(I)/G(S)/G(T) SUBUNIT BETA 2. [MASS=37200
4	**4**	Homo sapiens (Human) ISOFORM LONG OF 60 KDA SS-A/RO RIBONUCLEOPROTEIN. [MASS=60671
4	**4**	Homo sapiens (Human) SUPERKILLER VIRALICIDIC ACTIVITY 2-LIKE 2. [MASS=117805
4	**5**	Homo sapiens (Human) ISOFORM LONG OF TRIFUNCTIONAL PURINE BIOSYNTHETIC PROTEIN ADENOSINE-3. [MASS=107767
4	**4**	Homo sapiens (Human) HEPARIN COFACTOR 2 PRECURSOR. [MASS=60178
4	**5**	Homo sapiens (Human) APOLIPOPROTEIN A-II PRECURSOR. [MASS=11175
4	**4**	Homo sapiens (Human) MYOSIN-11. [MASS=227339
4	**7**	Homo sapiens (Human) HISTONE H1.2. [MASS=21234
4	**8**	Homo sapiens (Human) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN G. [MASS=42332
4	**5**	Homo sapiens (Human) GLUCOSAMINE-6-PHOSPHATE ISOMERASE. [MASS=32669
4	**4**	Homo sapiens (Human) DNA LIGASE 1. [MASS=101736
4	**4**	Homo sapiens (Human) 60S RIBOSOMAL PROTEIN L18A. [MASS=20762
4	**5**	Homo sapiens (Human) CLEAVAGE AND POLYADENYLATION SPECIFICITY FACTOR 73 KDA SUBUNIT. [MASS=77486
3	**3**	Homo sapiens (Human) PROTEASOME ACTIVATOR COMPLEX SUBUNIT 1. [MASS=28723
3	**3**	Homo sapiens (Human) ACYLAMINO-ACID-RELEASING ENZYME. [MASS=81225
3	**5**	Homo sapiens (Human) 60 KDA HEAT SHOCK PROTEIN, MITOCHONDRIAL PRECURSOR. [MASS=61055
3	**3**	Homo sapiens (Human) THO COMPLEX SUBUNIT 4. [MASS=27558
3	**3**	Homo sapiens (Human) SMALL NUCLEAR RIBONUCLEOPROTEIN SM D1. [MASS=13282
3	**3**	Homo sapiens (Human) FRUCTOSE-BISPHOSPHATE ALDOLASE C. [MASS=39325
3	**14**	Homo sapiens (Human) ALPHA-2-HS-GLYCOPROTEIN PRECURSOR. [MASS=39325
3	**4**	Homo sapiens (Human) IMPORTIN ALPHA-4 SUBUNIT. [MASS=57887
3	**5**	Homo sapiens (Human) GTP BINDING PROTEIN 1. [MASS=72454
3	**3**	Homo sapiens (Human) ISOFORM 1 OF DAZ-ASSOCIATED PROTEIN 1. [MASS=43383
3	**3**	Homo sapiens (Human) VACUOLAR PROTEIN SORTING 26A. [MASS=38170
3	**3**	Homo sapiens (Human) CYTOPLASMIC FMR1 INTERACTING PROTEIN 1 ISOFORM A. [MASS=145182
3	**3**	Homo sapiens (Human) ATP SYNTHASE SUBUNIT ALPHA, MITOCHONDRIAL PRECURSOR. [MASS=59751
3	**4**	Homo sapiens (Human) ACONITATE HYDRATASE, MITOCHONDRIAL PRECURSOR. [MASS=85425
3	**6**	Homo sapiens (Human) LUNG CANCER ONCOGENE 7. [MASS=37889
3	**4**	Homo sapiens (Human) F-ACTIN CAPPING PROTEIN ALPHA-2 SUBUNIT. [MASS=32818
3	**4**	Homo sapiens (Human) ISOFORM DUT-M OF DEOXYURIDINE 5'-TRIPHOSPHATE NUCLEOTIDOHYDROLASE, MITOCHONDRIAL PRECURSOR. [MASS=26706

3	**6**	Homo sapiens (Human) ISOFORM 1 OF ALPHA-ADDUCIN. [MASS=80955
3	**3**	Homo sapiens (Human) ISOFORM 1 OF PROTEIN PHOSPHATASE 1 REGULATORY SUBUNIT 7. [MASS=41564
3	**3**	Homo sapiens (Human) BM-010. [MASS=36153
3	**3**	Homo sapiens (Human) PROTEIN TYROSINE PHOSPHATASE, RECEPTOR-TYPE, ZETA1 PRECURSOR. [MASS=254587
3	**3**	Homo sapiens (Human) ISOFORM 3 OF UDP-N-ACETYLGLUCOSAMINE--PEPTIDE N-ACETYLGLUCOSAMINYLTRANSFERASE 110 KDA SUBUNIT. [MASS=116925
3	**3**	Homo sapiens (Human) HIV TAT SPECIFIC FACTOR 1. [MASS=85853
3	**4**	Homo sapiens (Human) UV EXCISION REPAIR PROTEIN RAD23 HOMOLOG B. [MASS=43171
3	**3**	Homo sapiens (Human) PNAS-125. [MASS=23755
3	**5**	Homo sapiens (Human) IGKV1-5 PROTEIN. [MASS=26234
3	**19**	Homo sapiens (Human) HEMOGLOBIN SUBUNIT GAMMA-1. [MASS=16009
3	**3**	Homo sapiens (Human) EXOSOME COMPLEX EXONUCLEASE RRP42. [MASS=31835
3	**3**	Homo sapiens (Human) ISOFORM 2 OF TRANSCRIPTION FACTOR BTF3. [MASS=17699
3	**4**	Homo sapiens (Human) HISTONE-BINDING PROTEIN RBBP4. [MASS=47525
3	**3**	Homo sapiens (Human) SERINE/THREONINE-PROTEIN KINASE MRCK BETA. [MASS=194315
3	**3**	Homo sapiens (Human) HYPOTHETICAL PROTEIN DKFZP686I0180 (FRAGMENT). [MASS=28810
3	**4**	Homo sapiens (Human) THYMOPOIETIN ISOFORM BETA. [MASS=50670
3	**3**	Homo sapiens (Human) DNA-DIRECTED RNA POLYMERASE II LARGEST SUBUNIT. [MASS=217206
3	**5**	Homo sapiens (Human) FACTOR VII ACTIVE SITE MUTANT IMMUNOCONJUGATE. [MASS=75553
3	**3**	Homo sapiens (Human) TUBULIN-SPECIFIC CHAPERONE A. [MASS=12724
3	**3**	Homo sapiens (Human) TRYPTOPHANYL-TRNA SYNTHETASE. [MASS=53165
3	**3**	Homo sapiens (Human) ISOFORM 1 OF SYMPLEKIN. [MASS=141148
3	**3**	Homo sapiens (Human) SERINE/THREONINE-PROTEIN PHOSPHATASE 4 CATALYTIC SUBUNIT. [MASS=35080
3	**3**	Homo sapiens (Human) ANTITHROMBIN III VARIANT. [MASS=52692
3	**7**	Homo sapiens (Human) UBIQUITIN-ACTIVATING ENZYME E1. [MASS=25052
3	**3**	Homo sapiens (Human) PREDICTED: SIMILAR TO CHLORIDE INTRACELLULAR CHANNEL PROTEIN 4. [MASS=17863
3	**3**	Homo sapiens (Human) ISOFORM 1 OF TRANSCRIPTION ELONGATION FACTOR SPT5. [MASS=121000
3	**4**	Homo sapiens (Human) EUKARYOTIC INITIATION FACTOR 5A ISOFORM I VARIANT A. [MASS=20170
3	**3**	Homo sapiens (Human) ISOFORM 3 OF DNA REPAIR PROTEIN RAD50. [MASS=138432
3	**3**	Homo sapiens (Human) COP9 SIGNALOSOME COMPLEX SUBUNIT 5. [MASS=37448

3	**3**	Homo sapiens (Human) HYPOTHETICAL PROTEIN DKFZP547J2313. [MASS=18829
3	**4**	Homo sapiens (Human) CORTICOSTEROID-BINDING GLOBULIN PRECURSOR. [MASS=45141
3	**4**	Homo sapiens (Human) PROFILIN 2 ISOFORM A. [MASS=15046
3	**4**	Homo sapiens (Human) ISOFORM GAMMA-1 OF SERINE/THREONINE-PROTEIN PHOSPHATASE PP1-GAMMA CATALYTIC SUBUNIT. [MASS=36984
3	**4**	Homo sapiens (Human) ISOFORM 1 OF UBIQUITIN-PROTEIN LIGASE BRE1B. [MASS=113678
3	**3**	Homo sapiens (Human) ISOFORM 1 OF RAS GTPASE-ACTIVATING PROTEIN 1. [MASS=116403
3	**5**	Homo sapiens (Human) ACTIN-RELATED PROTEIN 2/3 COMPLEX SUBUNIT 1A. [MASS=41569
3	**3**	Homo sapiens (Human) CADHERIN-5 PRECURSOR. [MASS=87516
3	**3**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S14. [MASS=16142
3	**3**	Homo sapiens (Human) LETHAL GIANT LARVAE HOMOLOG 1. [MASS=115388
3	**3**	Homo sapiens (Human) LEUCINE ZIPPER TRANSCRIPTION FACTOR-LIKE 1. [MASS=34592
3	**4**	Homo sapiens (Human) MEPRIN A SUBUNIT ALPHA PRECURSOR. [MASS=84368
3	**4**	Homo sapiens (Human) WD REPEAT PROTEIN 61. [MASS=33581
3	**3**	Homo sapiens (Human) TRIPARTITE MOTIF-CONTAINING PROTEIN 2. [MASS=81530
3	**4**	Homo sapiens (Human) ISOFORM 1 OF ATP-DEPENDENT RNA HELICASE DDX19B. [MASS=53927
3	**3**	Homo sapiens (Human) SORTING NEXIN 1 ISOFORM C. [MASS=53304
3	**3**	Homo sapiens (Human) HISTONE ACETYLTRANSFERASE TYPE B CATALYTIC SUBUNIT. [MASS=49513
3	**3**	Homo sapiens (Human) SWI/SNF-RELATED MATRIX-ASSOCIATED ACTIN-DEPENDENT REGULATOR OF CHROMATIN SUBFAMILY A MEMBER 5. [MASS=121905
3	**3**	Homo sapiens (Human) HEAT SHOCK 70 KDA PROTEIN 4L. [MASS=94486
3	**4**	Homo sapiens (Human) AFLATOXIN B1 ALDEHYDE REDUCTASE MEMBER 2. [MASS=39589
3	**4**	Homo sapiens (Human) D-DOPACHROME DECARBOXYLASE. [MASS=12581
3	**3**	Homo sapiens (Human) THIMET OLIGOPEPTIDASE. [MASS=78709
3	**3**	Homo sapiens (Human) 60S RIBOSOMAL PROTEIN L38. [MASS=8087
3	**3**	Homo sapiens (Human) ALDEHYDE DEHYDROGENASE 16 FAMILY, MEMBER A1. [MASS=85127
3	**3**	Homo sapiens (Human) CYTOCHROME B5 REDUCTASE ISOFORM 1. [MASS=34235
3	**3**	Homo sapiens (Human) NETRIN RECEPTOR DCC PRECURSOR. [MASS=158457
3	**4**	Homo sapiens (Human) ISOPENTENYL-DIPHOSPHATE DELTA ISOMERASE. [MASS=32485
3	**4**	Homo sapiens (Human) PHOSPHATIDYLINOSITOL TRANSFER PROTEIN, BETA. [MASS=31540
3	**3**	Homo sapiens (Human) HIGH MOBILITY GROUP PROTEIN B2. [MASS=23903

3	**5**	Homo sapiens (Human) TUMOR PROTEIN, TRANSLATIONALLY-CONTROLLED 1. [MASS=21526
3	**3**	Homo sapiens (Human) BLEOMYCIN HYDROLASE. [MASS=52562
3	**9**	Homo sapiens (Human) ALPHA-ENOLASE, LUNG SPECIFIC. [MASS=49477
3	**4**	Homo sapiens (Human) 60S RIBOSOMAL PROTEIN L12. [MASS=17819
3	**3**	Homo sapiens (Human) CELL DIVISION CYCLE 5-LIKE PROTEIN. [MASS=92251
3	**3**	Homo sapiens (Human) ISOFORM 2 OF UBIQUITIN CARBOXYL-TERMINAL HYDROLASE 47. [MASS=147180
3	**3**	Homo sapiens (Human) COMPLEMENT C5 PRECURSOR. [MASS=188331
3	**3**	Homo sapiens (Human) ISOFORM 1 OF CYTOPLASMIC LINKER PROTEIN 2. [MASS=115837
3	**3**	Homo sapiens (Human) THIOREDOXIN REDUCTASE 1, CYTOPLASMIC PRECURSOR. [MASS=54707
3	**4**	Homo sapiens (Human) HISTONE H1X. [MASS=22487
3	**3**	Homo sapiens (Human) ISOFORM GTBP-N OF DNA MISMATCH REPAIR PROTEIN MSH6. [MASS=152786
3	**3**	Homo sapiens (Human) BILIVERDIN REDUCTASE A PRECURSOR. [MASS=33428
3	**3**	Homo sapiens (Human) LAMINA-ASSOCIATED POLYPEPTIDE 2 ISOFORM ALPHA. [MASS=75361
3	**3**	Homo sapiens (Human) SYNAPTIC VESICLE MEMBRANE PROTEIN VAT-1 HOMOLOG. [MASS=41920
3	**3**	Homo sapiens (Human) 60S RIBOSOMAL PROTEIN L8. [MASS=27893
3	**3**	Homo sapiens (Human) PHYTANOYL-COA HYDROXYLASE INTERACTING PROTEIN-LIKE. [MASS=42486
3	**3**	Homo sapiens (Human) CONDENSIN COMPLEX SUBUNIT 2. [MASS=82535
3	**3**	Homo sapiens (Human) HIGH-MOBILITY GROUP BOX 1. [MASS=15185
3	**3**	Homo sapiens (Human) SELENIDE, WATER DIKINASE 1. [MASS=42911
3	**5**	Homo sapiens (Human) APOLIPOPROTEIN M. [MASS=21253
3	**3**	Homo sapiens (Human) HYPOTHETICAL PROTEIN DKFZP686M09245. [MASS=61598
3	**3**	Homo sapiens (Human) ISOFORM 1 OF EXOSOME COMPLEX EXONUCLEASE RRP44. [MASS=109003
3	**3**	Homo sapiens (Human) 60S RIBOSOMAL PROTEIN L10A. [MASS=24700
3	**3**	Homo sapiens (Human) ECHINODERM MICROTUBULE-ASSOCIATED PROTEIN-LIKE 4. [MASS=108903
3	**3**	Homo sapiens (Human) CALPAIN-1 CATALYTIC SUBUNIT. [MASS=81890
3	**4**	Homo sapiens (Human) 55 KDA PROTEIN. [MASS=55183
3	**3**	Homo sapiens (Human) ZYXIN. [MASS=67285
3	**5**	Homo sapiens (Human) DEVELOPMENTALLY-REGULATED GTP-BINDING PROTEIN 1. [MASS=40542
3	**3**	Homo sapiens (Human) TYROSYL-TRNA SYNTHETASE, CYTOPLASMIC. [MASS=59012
3	**3**	Homo sapiens (Human) PEROXISOMAL MULTIFUNCTIONAL ENZYME TYPE 2. [MASS=79555
3	**3**	Homo sapiens (Human) U4/U6.U5 TRI-SNRNP-ASSOCIATED PROTEIN 1. [MASS=90255
3	**3**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S21. [MASS=9111

3	**3**	Homo sapiens (Human) DNAJ HOMOLOG SUBFAMILY C MEMBER 7. [MASS=56441
3	**4**	Homo sapiens (Human) CALSYNTENIN 1 ISOFORM 2. [MASS=108643
3	**3**	Homo sapiens (Human) TWINFILIN ISOFORM 1. [MASS=43918
3	**3**	Homo sapiens (Human) CENTROSOMAL PROTEIN 170KDA ISOFORM ALPHA. [MASS=175436
3	**3**	Homo sapiens (Human) ISOFORM 1 OF 26S PROTEASE REGULATORY SUBUNIT 6B. [MASS=47366
3	**4**	Homo sapiens (Human) U1 SMALL NUCLEAR RIBONUCLEOPROTEIN A. [MASS=31148
3	**4**	Homo sapiens (Human) PEPTIDYL-PROLYL CIS-TRANS ISOMERASE A. [MASS=17881
3	**3**	Homo sapiens (Human) PEROXISOMAL MULTIFUNCTIONAL ENZYME TYPE 2. [MASS=79555
3	**3**	Homo sapiens (Human) RAS-RELATED PROTEIN RAB-5C. [MASS=23483
3	**3**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S8. [MASS=24074
3	**6**	Homo sapiens (Human) PERIPHERIN. [MASS=53878
3	**3**	Homo sapiens (Human) NUCLEOSIDE DIPHOSPHATE KINASE B. [MASS=17298
3	**5**	Homo sapiens (Human) SEC31L1 PROTEIN. [MASS=121651
3	**3**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S16. [MASS=16314
3	**3**	Homo sapiens (Human) UROPORPHYRINOGEN DECARBOXYLASE. [MASS=40787
3	**3**	Homo sapiens (Human) 114 KDA PROTEIN. [MASS=113977
3	**4**	Homo sapiens (Human) COLLAGEN ALPHA-1(V) CHAIN PRECURSOR. [MASS=183560
3	**3**	Homo sapiens (Human) CYTOPLASMIC DYNEIN 1 LIGHT INTERMEDIATE CHAIN 2. [MASS=54099
3	**3**	Homo sapiens (Human) CYTOSOLIC AMINOPEPTIDASE P. [MASS=74798
3	**3**	Homo sapiens (Human) ISOFORM 2 OF SPLICING FACTOR 1. [MASS=68502
3	**3**	Homo sapiens (Human) PREDICTED: SIMILAR TO BASIC LEUCINE ZIPPER AND W2 DOMAINS 1. [MASS=34090
3	**3**	Homo sapiens (Human) ISOFORM 1 OF URIDINE 5'-MONOPHOSPHATE SYNTHASE. [MASS=52222
3	**3**	Homo sapiens (Human) DEAD BOX POLYPEPTIDE 42 PROTEIN. [MASS=102975
3	**4**	Homo sapiens (Human) ISOFORM C OF NEURAL CELL ADHESION MOLECULE 1, 120 KDA ISOFORM PRECURSOR. [MASS=83985
3	**3**	Homo sapiens (Human) COLD-INDUCIBLE RNA-BINDING PROTEIN. [MASS=18648
3	**4**	Homo sapiens (Human) 60S RIBOSOMAL PROTEIN L18. [MASS=21503
3	**3**	Homo sapiens (Human) ISOFORM 1 OF JMJC DOMAIN-CONTAINING HISTONE DEMETHYLATION PROTEIN 2B. [MASS=191611
3	**3**	Homo sapiens (Human) RCC1 PROTEIN. [MASS=48146
3	**3**	Homo sapiens (Human) LEUCINE-RICH REPEAT-CONTAINING PROTEIN 47. [MASS=63473
3	**3**	Homo sapiens (Human) ISOFORM 1 OF RNA-BINDING PROTEIN NOVA-1. [MASS=52056
3	**6**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S10. [MASS=18898
3	**3**	Homo sapiens (Human) SPLICING FACTOR U2AF 65 KDA SUBUNIT. [MASS=53501

3	**3**	Homo sapiens (Human) ISOFORM SHORT OF PROTEASOME SUBUNIT ALPHA TYPE 1. [MASS=29556
3	**3**	Homo sapiens (Human) ALPHA-1-ACID GLYCOPROTEIN 2 PRECURSOR. [MASS=23603
3	**4**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S23. [MASS=15676
3	**3**	Homo sapiens (Human) DOLICHYL-DIPHOSPHOOLIGOSACCHARIDE--PROTEIN GLYCOSYLTRANSFERASE 67 KDA SUBUNIT PRECURSOR. [MASS=72778
3	**3**	Homo sapiens (Human) HYPOTHETICAL PROTEIN LOC387104. [MASS=103199
3	**3**	Homo sapiens (Human) PROTEIN TRANSPORT PROTEIN SEC24C. [MASS=118315
3	**4**	Homo sapiens (Human) THIOREDOXIN. [MASS=11606
3	**3**	Homo sapiens (Human) CYTOSOLIC PURINE 5'-NUCLEOTIDASE. [MASS=64970
3	**6**	Homo sapiens (Human) PREDICTED: SIMILAR TO RIBOSOMAL PROTEIN S3A ISOFORM 1. [MASS=24821
3	**4**	Homo sapiens (Human) ACIDIC LEUCINE-RICH NUCLEAR PHOSPHOPROTEIN 32 FAMILY MEMBER A. [MASS=28585
3	**3**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S25. [MASS=13742
3	**3**	Homo sapiens (Human) ADP-RIBOSYLATION FACTOR-LIKE PROTEIN 3. [MASS=20456
3	**4**	Homo sapiens (Human) CYSTATIN B. [MASS=11140
3	**3**	Homo sapiens (Human) PHOSPHOGLUCOMUTASE-2-LIKE 1. [MASS=70456
3	**3**	Homo sapiens (Human) 40S RIBOSOMAL PROTEIN S9. [MASS=22460
3	**3**	Homo sapiens (Human) ANKYRIN REPEAT AND FYVE DOMAIN CONTAINING 1 ISOFORM 1. [MASS=128486
3	**3**	Homo sapiens (Human) ISOFORM LONG OF COLD SHOCK DOMAIN-CONTAINING PROTEIN E1. [MASS=88885
3	**3**	Homo sapiens (Human) DEAD (ASP-GLU-ALA-ASP) BOX POLYPEPTIDE 39, ISOFORM 2. [MASS=35095
3	**3**	Homo sapiens (Human) 60S RIBOSOMAL PROTEIN L23A. [MASS=17695
3	**4**	Homo sapiens (Human) ALPHA-INTERNEXIN. [MASS=55391
3	**3**	Homo sapiens (Human) ISOFORM 3 OF ANAMORSIN. [MASS=32213
3	**3**	Homo sapiens (Human) SPLICING FACTOR, ARGININE/SERINE-RICH 4. [MASS=56678
3	**3**	Homo sapiens (Human) DEBRANCHING ENZYME HOMOLOG 1. [MASS=61555
3	**3**	Homo sapiens (Human) ISOFORM 2 OF PROTEASOME SUBUNIT ALPHA TYPE 3. [MASS=27516
3	**3**	Homo sapiens (Human) MICROSOMAL TRIGLYCERIDE TRANSFER PROTEIN LARGE SUBUNIT PRECURSOR. [MASS=99351
3	**4**	Homo sapiens (Human) ISOFORM B OF NEURONAL-SPECIFIC SEPTIN-3. [MASS=40100
3	**4**	Homo sapiens (Human) 60S RIBOSOMAL PROTEIN L28. [MASS=15616
3	**6**	Homo sapiens (Human) PREDICTED: SIMILAR TO HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN K ISOFORM A ISOFORM 2. [MASS=24258

Table 1.3. Common proteins from mass spectrometry analysis of embryonic rat CSF isolated from E12.5 LV, E14.5 LV and 4thV, and E17.5 LV. The number of peptides is listed from E14.5 4thV. A – represents number of unique peptides, B – represents number of total peptides.

A	B	Name of Protein	MW	Subcellular location	Function	Tissue specificity	Notes
120	617	AA1064 - apolipoprotein B	536024	Secreted	Lipid and fatty acid transport and metabolism	Plasma	Apo B-100 functions as a recognition signal for the cellular binding and internalization of LDL particles by the apoB/E receptor
66	382	Apolipoprotein B - fragment	165356	Secreted	Lipid and fatty acid transport and metabolism	Plasma	Fragment molecule
37	135	SPLICE ISOFORM 1 OF FIBRONECTIN PRECURSOR	272511	Secreted, extracellular space, extracellular matrix	Cell adhesion mediated signaling	Plasma fibronectin made by liver and cellular fibronectin made by fibroblasts, epithelial and other cell types is deposited in the extracellular matrix	Integrin signaling pathway
34	365	SPLICE ISOFORM 1 OF ALPHA-FETOPROTEIN PRECURSOR	68386	Secreted	Transport/Transfer-Carrier	Plasma	Binds copper, nickel, and fatty acids as well as, and bilirubin less well than, serum albumin.
31	120	APOLIPOPROTEIN A-IV PRECURSOR	44456	Secreted	Lipid and fatty acid transport and metabolism	Plasma	May have a role in chylomicrons and VLDL secretion and catabolism. Apoa-IV is a major component of HDL and chylomicrons.
28	53	ALPHA-2-MACROGLOBULIN PRECURSOR	163701	Secreted	Serine Protease Inhibitor	Plasma	Plays role in acute phase response

21	26	GPI-ANCHORED CERULOPLASMIN	123749	Cell Membrane	Transport, Transfer/Carrier, Oxidoreductase	Brain	Metal ion binding oxidoreductase activity ion transport
21	35	ALPHA-1-INHIBITOR 3 PRECURSOR	163773	Secreted	Serine Protease Inhibitor	Plasma	Belongs to the alpha-2-macroglobulin family involved in inflammtory response
20	96	BA1-667 - Transferrin	107448	Secreted	Transport, Transfer/Carrier	Plasma	Iron ion homeostasis, iron ion transport
19	30	CONTACTIN -2 PRECURSOR	113043	Cell Membrane	Cell Adhesion - Neurogenesis	In neural tissues in embryos, and in adult brain, spinal cord and cerebellum.	May play a role in the initial growth and guidance of axons. Belongs to the immunoglobulin superfamily.
18	79	APOLIPOPROTEIN A-I PRECURSOR	30088	Secreted	Lipid and fatty acid transport and metabolism	Major protein of plasma HDL, also found in chylomicrons.	Participates in the reverse transport of cholesterol from tissues to the liver for excretion by promoting cholesterol efflux from tissues and by acting as a cofactor for the lecithin cholesterol acyltransferase (LCAT).
18	97	SERUM ALBUMIN PRECURSOR	68719	Secreted	Transport, Transfer/Carrier	Plasma.	The main protein of plasma, has a good binding capacity for water, Ca(2+), Na(+), K(+), fatty acids, hormones, bilirubin and drugs. Its main function is the regulation of the colloidal osmotic pressure of blood.
18	33	PREDICTED: NIDOGEN	138365	Secreted, extracellular space, extracellular matrix	Cell - extracellular matrix adhesion	Wide distribution	Found in basement membranes often associated with laminin.

15	34	ALPHA-1-ANTIPROTEINASE PRECURSOR	46136	Secreted	Serine Protease Inhibitor	Plasma	Blood coagulation. The primary target is elastase, but also has a moderate affinity for plasmin and thrombin.
15	17	DA1-24 - Complement Factor B	124379	Secreted	Serine Protease - Complement Mediated Immunity	Plasma	Hydrolase, Peptidase
14	23	PREDICTED: SIMILAR TO CADHERIN-5	135230	Cell junction, cell membrane	Cell Adhesion	Endothelial tissues and brain	Cell - Cell interactions and juntions
13	20	ALPHA-2 ANTIPLASMIN	46465	Secreted	Serine Protease Inhibitor	Plasma	Blood coagulation
13	18	SPLICE ISOFORM 1 OF AGRIN PRECURSOR	208646	Secreted, extracellular space, extracellular matrix	Cell adhesion mediated signaling	Embryonic nervous system and muscle	Component of the basal lamina that binds to laminin.
13	25	PREDICTED: SIMILAR TO HEPARAN SULFATE PROTEOGLYCAN 2 (Perlecan)	377284	Secreted, extracellular space, extracellular matrix	Cell adhesion mediated signaling	Widely distrubuted	Integral component of basement membranes
13	19	INTER-ALPHA-INHIBITOR H4 HEAVY CHAIN	103755	Secreted	Serine Protease Inhibitor	Plasma	Involved in acute phase response
12	14	GELSOLIN	86286	Secreted and Cytoplasm	Cell structure	Ubiquitous	Actin binding protein, may be involved in myelination
12	15	SERINE/CYSTEINE PROTEINASE INHIBITOR, CLADE C, MEMBER 1	52234	Secreted	Protease inhibitor with a wide spectrum of protein targets	Plasma	Belongs to the serpin family
12	22	COMPLEMENT C3 PRECURSOR	186460	Secreted	Complement mediated immunity	Plasma	Plays a central role in the activation of the complement system.
12	24	APOLIPOPROTEIN E PRECURSOR	35753	Secreted	Lipid and fatty acid transport and metabolism	Plasma	Mediates the binding, internalization, and catabolism of lipoprotein particles

11	14	LAR RECEPTOR-LINKED TYROSINE PHOSPHATASE	181130	Cell Membrane	Cell adhesion mediated signaling, cell structure and motility	Widely distrubuted	May play a role in neurite outgrowth.
11	12	DELETED IN COLORECTAL CANCER	158142	Membrane - Intracellular	Ligand mediated signaling, cell adhesion	During development expressed highly in brain and neural tube	Netrin receptor activity, transcription coactivator activity, axon guidance, and apoptosis
11	12	SERINE PEPTIDASE INHIBITOR, CLADE G, MEMBER 1	55611	Secreted	Protease inhibitor	Plasma	Involved in the regulation of classical component pathway
11	17	CORTICOSTEROID-BINDING GLOBULIN PRECURSOR	44672	Secreted	Transpost and Serine Protease Inhibitor	Expressed by the liver; secreted in plasma.	Major transport protein for glucocorticoids and progestins in the blood
11	12	PREDICTED: SIMILAR TO LAMININ B1	228429	Secreted, extracellular space, extracellular matrix	Extracellular matrix linker protein-mediated signaling	Widely distributed in basement membranes	Is thought to mediate the attachment, migration and organization of cells into tissues during embryonic development by interacting with other extracellular matrix components.
11	11	ELONGATION FACTOR 2	95153	Cytoplasm - Intracellular	Protein biosynthesis - Translational elongation factor	Ubiquitous	Promotes translocation of protein chain from A site to P site on ribosome
11	14	SPLICE ISOFORM 1 OF FIBRINOGEN ALPHA CHAIN PRECURSOR	86686	Secreted	Blood clotting	Plasma	Monomers polymerize into fibrin and acts as a cofactor in platelet aggregation
10	21	NEURAL-CADHERIN PRECURSOR	99686	Cell Membrane	Cell adhesion	Testis and neurons	May be involved in neuronal tissue recognition

10	22	PREDICTED: SIMILAR TO FIBULIN-1 PRECURSOR	78072	Secreted, extracellular space, extracellular matrix	Cell adhesion mediated signaling	Detected in most organs (brain, heart, lung, spleen, liver and kidney). Neurons are the predominant source of production in the brain. Not expressed significantly by astrocytes or microglia.	Incorporated into fibronectin-containing matrix fibers. May play a role in cell adhesion and migration along protein fibers within the extracellular matrix (ECM). Could be important for certain developmental processes and contribute to the supramolecular organization of ECM architecture, in particular to those of basement membranes.
10	11	ECTONUCLEOTIDE PYROPHOSPHATASE/PHOSPHODIESTERASE 2	101310	Membrane	Hydrolase	Abundantly expressed in cerebrum and cerebellum. Localized in secretory epithelial cells in the brain and the eye including choroid plexus epithelial cells, ciliary epithelial cells, iris pigment epithelial cells, and retinal pigment cells.	Hydrolytically removes 5'-nucleotides successively from the 3'-hydroxy termini of 3'-hydroxy-terminated oligonucleotides

10	21	COLLAGEN ALPHA-1(I) CHAIN PRECURSOR	137886	Secreted, extracellular space, extracellular matrix	Cell adhesion - Cell structure	Forms the fibrils of tendon, ligaments and bones	Component of connective tissue
10	21	LUMICAN PRECURSOR	38279	Secreted, extracellular space, extracellular matrix	Cell adhesion mediated signaling	Widely distributed	Binds to laminin
9	51	TRANSTHYRETIN PRECURSOR	15720	Secreted	Hormone transport	Most abundant in the choroid plexus. Also present in the liver	Thyroid hormone-binding protein. Probably transports thyroxine from the bloodstream to the brain
9	13	CATHEPSIN B PRECURSOR	37470	Lysosome	Cysteine protease	Widely distributed	Participates in intracellular degradation and turnover of proteins. Has been implicated in tumor invasion and metastasis
9	13	ALPHA(1)-INHIBITOR 3, VARIANT I PRECURSOR	165326	Secreted	Serine Protease Inhibitor	Serum	Invovled in acute phase inflammatory response
9	11	PREDICTED: VON WILLEBRAND FACTOR	308474	Secreted, extracellular space, extracellular matrix	Cell adhesion - Blood clotting	Plasma	Major coagulation factor
9	18	LOC367586 PROTEIN - Immunoglobulin Gamma heavy Chain	50949	Cell Membrane	B-cell and antibody-mediated immunity	Plasma	Associates non-covalently with beta-2-microglobulin, antigen binding
8	10	HEAT SHOCK PROTEIN 86	84815	Cytoplasm	Molecular chaperone, protein folding, stress response	Ubiquitous	
8	8	HEPHAESTIN PRECURSOR	129593	Membrane	Oxidase	Expressed highly in intestine, lung and brain	May function as a ferroxidase for ferrous (II) to ferric ion (III) conversion and in copper transport and homeostasis

8	13	COLLAGEN ALPHA-1(III) CHAIN PRECURSOR	138936	Secreted, extracellular space, extracellular matrix	Cell adhesion - Cell structure	Widely distributed, highly expressed in colon and blood vessels	Component of connective tissue
8	9	SPLICE ISOFORM 1 OF REELIN PRECURSOR	387531	Secreted, extracellular space, extracellular matrix	Serine protease	Brain	Plays a role in layering of neurons in the cerebral cortex and cerebellum. Regulates microtubule function in neurons and neuronal migration. Affects migration of sympathetic preganglionic neurons in the spinal cord, where it seems to act as a barrier to neuronal migration
8	20	PLASMINOGEN PRECURSOR	90536	Secreted	Protease	Plasma	Plasmin dissolves the fibrin of blood clots and acts as a proteolytic factor in a variety of other processes including embryonic development, tissue remodeling, tumor invasion, and inflammation
8	12	EPSILON 1 GLOBIN	16105	Secreted	Oxygen Transport, Transfer - Carrier Protein	Blood	Involved in oxygen transport from the lung to the various peripheral tissues
8	13	SPLICE ISOFORM HMW OF KININOGEN -1 PRECURSOR	70933	Secreted	Cysteine protease inhibitor	Plasma	Bradykinin is released from kininogen by plasma kallikrein
8	19	SPLICE ISOFORM GAMMA-B OF FIBRINOGEN GAMMA CHAIN PRECURSOR	50633	Secreted	Blood clotting	Plasma	Monomers polymerize into fibrin and also acts as a cofactor in platelet aggregation

8	9	CADHERIN-6 PRECURSOR	88341	Cell Membrane	Cell adhesion	Highly expressed in kidney and brain	Also known as Kidney cadherin
7	9	TUBULIN BETA-5 CHAIN	49671	Intracellular	Cell structure, cell mobility, intracellular protein traffic	Ubiquitously expressed with highest levels in spleen, thymus and immature brain	Tubulin is the major constituent of microtubules
7	8	ANGIOTENSINOGEN PRECURSOR	51982	Secreted	Serine Protease Inhibitor	Expressed by the liver and secreted in plasma	Helps regulate volume and mineral balance of body fluids
7	8	SPARC-LIKE PROTEIN 1 PRECURSOR	70634	Secreted, extracellular space, extracellular matrix	Matrix glycoprotein Sc1	Expressed in many types of neurons in the brain	Function unknown, believed to bind calcium and play a role in brain development
7	7	156 KDA PROTEIN - Neogenin precursor	156144	Membrane	Cell adhesion	Widely expressed	May be involved as a regulatory protein in the transition of undifferentiated proliferating cells to their differentiated state. Belongs to the immunoglobulin superfamily.
7	9	ACTIN, ALPHA SKELETAL MUSCLE	42051	Cytoplasm	Cell structure, cell motility	Muscle	Actins are highly conserved proteins that are involved in various types of cell motility and are ubiquitously expressed in all eukaryotic cells.
7	9	ELONGATION FACTOR 1-ALPHA 1	50114	Cytoplasm	Protein biosynthesis, translation regulation	Ubiquitous	Links tRNA to ribosome during protein synthesis
7	7	TRANSITIONAL ENDOPLASMIC RETICULUM ATPASE	89534	Intracellular	Protein targeting and localization, intracellular protein traffic	Ubiquitous	Necessary for the fragmentation of Golgi stacks during mitosis and for their reassembly after mitosis. Involved in the formation of the transitional endoplasmic reticulum (tER).

7	11	COLLAGEN ALPHA-2(I) CHAIN PRECURSOR	129564	Secreted, extracellular space, extracellular matrix	Cell adhesion - Cell structure	Forms the fibrils of tendon, ligaments and bones	Involved in skeletal development
7	7	ALPHA-MANNOSIDASE 2	131242	Golgi apparatus - Intracellular	Glycosidase	All tissues, mostly in adrenal and thymus	Involved in N-glycosylation
7	9	SPLICE ISOFORM 1 OF ATTRACTIN PRECURSOR	163296	Cell membrane	Cell adhesion - Immune defense	Widely distributed, highly expressed in colon and brain	Involved in the initial immune cell clustering during inflammatory response and may regulate chemotactic activity of chemokines. Has a critical role in normal myelination in the central nervous system, and enhancing cell survival against oxidative stress.
6	9	TUBULIN ALPHA-1 CHAIN	50136	Intracellular	Cell structure, cell mobility, chromosome segregation, intracellular protein traffic	Widely distributed	Tubulin is the major constituent of microtubules.
6	8	SPLICE ISOFORM 1 OF NEURONAL CELL ADHESION MOLECULE PRECURSOR	133912	Cell membrane	Cell adhesion	Widely distributed, highly expressed in brain	Ankyrin-binding protein involved in neuron-neuron adhesion. May play a role in the molecular assembly of the nodes of Ranvier
6	8	ALPHA-2-GLOBIN CHAIN	15285	Secreted	Oxygen Transport, Transfer - Carrier Protein	Blood	Involved in oxygen transport from the lung to the various peripheral tissues
6	6	ARCADLIN	103800	Cell Membrane	Cell adhesion	Brain	Neural activity-regulated cadherin may be involved in long term potentiation

6	9	TENASCIN (FRAGMENT)	62473	Secreted, extracellular space, extracellular matrix	Cell adhesion	Widely distrubuted	Negative regulation of cell adhesion
6	12	PREDICTED: RETINOL BINDING PROTEIN 4, PLASMA	23220	Secreted	Vitamin/Co-factor transport - retinol binding, transporter activity	Plasma	Delivers retinol from the liver stores to the peripheral tissues. In plasma, the RBP-retinol complex interacts with transthyretin, this prevents its loss by filtration through the kidney glomeruli.
6	10	PREDICTED: CALSYNTENIN 1	109351	Cell Membrane	Cell adhesion	Widely distributed	May modulate calcium-mediated postsynaptic signals
6	8	PREDICTED: NIDOGEN 2	173960	Secreted, extracellular space, extracellular matrix, basement membrane	Cell adhesion, Cell - extracellular matrix interaction	Widely distributed in basement membranes	Sulfated glycoprotein widely distributed in basement membranes and tightly associated with laminin. Also binds to collagen IV and perlecan. It probably has a role in cell-extracellular matrix interactions
6	7	PREDICTED: SIMILAR TO PYRUVATE KINASE (EC 2.7.1.40) ISOZYME M2 - RAT	57731	Intracellular	Carbohydrate degradation, glycolysis	Widely distributed	ATP + pyruvate = ADP + phosphoenolpyruvate
6	7	T-KININOGEN	47618	Secreted	Cysteine protease inhibitor	Plasma	Plays a role in blood clotting and regulation of vasoconstriction and dilation
6	10	PREDICTED: CADHERIN 11	88036	Cell Membrane	Cell adhesion	Widely distributed	Involved in mesenchymal tissue formation
6	6	PREDICTED: TUMOR REJECTION ANTIGEN GP96	74208	Cytoplasm	Molecular chaperone, protein folding, stress response	Widely distributed	Highly homologous to endoplasmin precursor

6	8	PREDICTED: SIMILAR TO STABILIN-1	288663	Membrane	Extracellular matrix structural protein, extracellular matrix protein-mediated signaling	High levels found in human spleen, lymph node, liver and placenta	Acts as a scavenger receptor for acetylated low density lipoprotein. Binds to both Gram-positive and Gram-negative bacteria and may play a role in defense against bacterial infection. When inhibited in endothelial tube formation assays, there is a marked decrease in cell-cell interactions, suggesting a role in angiogenesis
6	7	COMPLEMENT COMPONENT 2	83699	Secreted	Serine protease, complement-mediated immunity	Plasma	Belongs to the peptidase S1 family
6	9	FETUB PROTEIN	43169	Secreted	Cysteine protease inhibitor	Liver	Inhibits insulin receptor tyrosine kinase activity,
5	6	PROFILIN-1	14826	Intracellular	Cell structure	Ubiquitous	At high concentrations, profilin prevents the polymerization of actin, whereas it enhances it at low concentrations
5	5	HYPOTHETICAL PROTEIN LOC314432, Similar to ubiquitin-protein ligase (EC 6.3.2.19) E1	117788	Intracellular	Proteolysis	Ubiquitous	Ubiquitin activating enzyme activity
5	12	SERINE PEPTIDASE INHIBITOR, CLADE F, MEMBER 2	54893	Secreted	Serine Protease Inhibitor	Plasma	Belongs to the serpin family
5	8	COLLAGEN ALPHA-1(V) CHAIN PRECURSOR	184610	Secreted, extracellular space, extracellular matrix	Extracellular matrix, Structural protein	Ubiquitous	Component of connective tissue
5	5	COMPLEMENT C4 PRECURSOR	192163	Secreted	Complement-mediated immunity	Plasma	Inflammatory response

5	7	HYPOTHETICAL PROTEIN RGD1305887 - TUBULIN BETA CHAIN	50059	Intracellular	Cell structure, cell mobility, chromosome segregation, intracellular protein traffic	Ubiquitous	Tubulin is the major constituent of microtubules
5	6	QUIESCIN Q6	82412	Isoform 1: Membrane; Isoform 2: Secreted protein	Oxidase	Widely distributed, expressed in heart, placenta, lung, liver, skeletal muscle, pancreas and very weakly in brain and kidney	May contribute to disulfide bond formation in a variety of secreted proteins
5	6	PREDICTED: SIMILAR TO PHOSPHOLIPID TRANSFER PROTEIN	65430	Secreted	Lipid and fatty acid transport	Plasma	Involved in phospholipid transfer in the serum.
5	5	ALPHA-1-MACROGLOBULIN	167125	Secreted	Serine protease inhibitor	Plasma	Also known as PREGNANCY ZONE PROTEIN
5	5	PREDICTED: TYROSINE KINASE RECEPTOR 1	125210	Cell Membrane	Receptor protein-tyrosine kinase	Unknown	Unknown
5	26	EXTRACELLULAR SUPEROXIDE DISMUTASE [CU-ZN] PRECURSOR	26620	Secreted, extracellular space, extracellular matrix	Oxidoreductase - Immunity and Defense	Widely distributed	Destroys radicals which are normally produced within the cells and which are toxic to biological systems.
5	11	PEPTIDYLPROLYL ISOMERASE C	23009	Cytoplasm	Isomerase, Protein folding, Nuclear transport	Widely distributed, highly expressed in eye, vascular tissue, kidney and brain	Involved in immunity and defense

5	6	PROTEIN KINASE C-BINDING PROTEIN NELL2	91334	Secreted	Cell communication, Cell adhesion, Cell structure	Widely distributed	Regulation of growth and neurogenesis
4	7	PREDICTED: DYSTROGLYCAN 1	96706	Membrane	Extracellular matrix protein-mediated signaling	Ubiquitous	Basement membrane
4	4	PREDICTED: SIMILAR TO HEPATIC MULTIPLE INOSITOL POLYPHOSPHATE PHOSPHATASE	54619	Endoplasmic reticulum	Nucleotide phosphatase	Widely expressed with highest levels in kidney and liver	Calcium mediated signaling involved in cell proliferation and differentiation
4	4	PROMININ-1S1 SPLICE VARIANT	96632	Cell Membrane	Cellular component, integral to membrane	Hematopoeitc stem cells, retina, placenta, lung brain	May be involved in membrane traffic. Has been localized to extracellular membrane bound particles in the CSF.
4	5	EPSILON 3 GLOBIN	16540	Secreted	Oxygen Transport, Transfer - Carrier Protein	Blood	Involved in oxygen transport from the lung to the various peripheral tissues
4	9	CYSTATIN C PRECURSOR	15437	Secreted, extracellular space, extracellular matrix	Cysteine protease inhibitor	Widely distributed with high expression in brain and muscle	Regulation of programmed cell death
4	4	PREDICTED: SIMILAR TO PROTOCADHERIN 18 PRECURSOR	123552	Cell Membrane	Cell adhesion	Expressed in brain	May be involved in the establishment and maintenance of specific neuronal connections in the brain
4	7	SPLICE ISOFORM V0 OF VERSICAN CORE PROTEIN PRECURSOR (FRAGMENT)	300008	Secreted, extracellular space, extracellular matrix	Extracellular matrix protein-mediated signaling, cell adhesion, cell motility	Widely distributed	May be involved in axon regeneration and physiological response to wounding

4	5	PROTOCADHERIN GAMMA SUBFAMILY C, 3	101038	Cell Membrane	Cell adhesion	Widely distributed, highly expressed in pineal gland	May play a role during spermatogenesis
4	4	SORTILIN PRECURSOR	91169	Membranes; localized endosomes, golgi, lysosomes and nucleus	Functions as a sorting receptor, endocytosis, general intracellular vesicle transport	Highly expressed in fat, brain, and lung	Also known as Neurotensin receptor 3
4	4	ISCHEMIA RESPONSIVE 94 KDA PROTEIN	94057	Intracellular, Cytoplasm	Heat shock, protein folding, stress response	Widely distributed	Heat shock 70 kDa protein 4
4	4	MANNOSE 6-PHOSPHATE /INSULIN-LIKE GROWTH FACTOR II RECEPTOR	273608	Cell Membrane	Insulin/IGF signaling pathway	Widely distributed	Soluble receptor found in serum, amniotic fluid and urine.
4	5	COMPLEMENT INHIBITORY FACTOR H	140344	Secreted	Complement-mediated immunity	Plasma	Regulation of complement activation
4	6	TENASCIN (FRAGMENT)	67815	Secreted, extracellular space, extracellular matrix	Cell adhesion, extracellular matrix glycoprotein-mediated signaling	Widely distrubuted	Negative regulation of cell adhesion. Ligand for integrin receptors.
4	4	PREDICTED: SIMILAR TO VINCULIN	116615	Intracellular	Cell adhesion, cell structure	Unknown	Non-motor actin binding protein
3	3	14-3-3 PROTEIN ZETA/DELTA	27771	Cytoplasm	Chaperone, signal transduction	Highly expressed in brain	Adapter protein implicated in the regulation of a large spectrum of both general and specialized signaling pathway
3	4	CREATINE KINASE B-TYPE	42712	Cytoplasm	Kinase, energy modulation	Brain specific isoform	Phosphocreatine metabolism that may be necessary for brain development

3	3	PEROXIREDOXIN-2	21652	Cytoplasm	Oxidoreductase, Peroxidase	Widely distributed, highly expressed in bone marrow, heart, brain, kidney and muscle	Antioxidation and free radical removal
3	3	PREDICTED: SIMILAR TO CRB2 PROTEIN	138781	Membrane	Membrane-bound signaling molecule?	Unknown	Immunity and defense, mRNA transcription regulation
3	4	ACTIN, CYTOPLASMIC 1	41737	Cytoplasm	Cell structure, cell mobility, intracellular protein traffic	Ubiquitous	Actins are highly conserved proteins that are involved in various types of cell motility and are ubiquitously expressed in all eukaryotic cells.
3	4	LOW-DENSITY LIPOPROTEIN RECEPTOR PRECURSOR	96622	Cell Membrane	Lipid and fatty acid transport and metabolism	Plasma	Binds LDL, the major cholesterol-carrying lipoprotein of plasma, and transports it into cells by endocytosis
3	3	FATTY ACID SYNTHASE	272650	Intracellular-cytoplasm	Lipid and fatty acid biosynthesis	Ubiquitously expressed	Invovled in catalyzing the formation of long chain fatty acids.
3	4	PEPTIDYL-PROLYL CIS-TRANS ISOMERASE A	17743	Cytoplasm	Isomerase, Protein folding, Nuclear transport	Widely distributed, highly expressed in nerve ganglia	PPIases accelerate the folding of proteins
3	4	BETA-2-MICROGLOBULIN PRECURSOR	13720	Cell Membrane	Immune response, Major histocompatibility complex antigen	Expressed on nucleated cells	Beta-chain of major histocompatibility complex class I molecules
3	6	FOLLISTATIN-RELATED PROTEIN 1 PRECURSOR	34622	Secreted	Select regulatory molecule - Homeostatis	Widely distributed, highly expressed in vascular tissue and nerve ganglia	Modulates action of some growth factors on cell proliferation and differentiation

3	3	SERINE (OR CYSTEINE) PROTEINASE INHIBITOR, CLADE A (ALPHA-1 ANTIPROTEINASE, ANTITRYPSIN), MEMBER 6	44671	Secreted	Serine Protease Inhibitor	Plasma	Belongs to the serpin family
3	6	SP120 - Heterogeneous nuclear ribonucleoprotein U	87748	Intracellular	Transporter activity - RNA binding	Widely distributed	Nuclear scaffold protein
3	6	RIBOSOMAL PROTEIN S27A	17951	Intracellular	Protein biosynthesis	Ubiquitous	Ribosomal structural protein
3	4	SPLICE ISOFORM 2 OF RECEPTOR-TYPE TYROSINE-PROTEIN PHOSPHATASE ZETA PRECURSOR	164596	Cell Membrane	Cell surface receptor mediated signal transduction	CNS	May be involved in the regulation of specific developmental processes in the CNS.
3	3	VIMENTIN	53602	Intracellular	Cell structure	Widely distributed, highly expressed in nerve ganglia	Found in various non-epithelial cells, especially mesenchymal cells
3	3	CULLIN-ASSOCIATED NEDD8-DISSOCIATED PROTEIN 1	136362	Nucleus	Transcriptional Enhancer	Detected in heart, brain, spleen, liver, skeletal muscle, kidney and testis	Also negative regulator of ubiquitin ligase complex

3	3	LEUKEMIA INHIBITORY FACTOR RECEPTOR PRECURSOR	122394	Isoform 1: Cell membrane; Isoform 2: Secreted	Cytokine receptor - Signal transducing molecule	Secreted form found in plasma. Membrane form highly expressed in placenta, liver, kidney, heart, lung and brain.	The soluble form inhibits the biological activity of LIF by blocking its binding to receptors on target cells
3	3	CLATHRIN HEAVY CHAIN	191599	Intracellular - vesicle coat	Ligand-mediated signaling, Receptor mediated endocytosis	Ubiquitously expressed	Involved in the formation of clathrin coated vesicles during vesicle endocytosis
2	3	IG KAPPA CHAIN C REGION, B ALLELE	11601	Secreted	Immunoglobulin; B-cell and antibody-mediated immunity	Lymphoreticular tissue	Immunoglobulin family
2	2	EUKARYOTIC TRANSLATION INITIATION FACTOR 4A2	46489	Intracellular	Protein biosynthesis, Translation Initiation factor	Ubiquitous	Required for mRNA binding to ribosome
2	3	VITAMIN D-BINDING PROTEIN PRECURSOR	53544	Secreted	Transport	Found in plasma, ascitic fluid, cerebrospinal fluid, and urine and on the surface of many cell types.	Binds and carries vitamin D and also prevents actin polymerization

2	3	PREDICTED: SIMILAR TO ALPHA ENOLASE	46489	Cytoplasm. Cell membrane	Glycolysis and plasminogen activation	Expressed in embryo and in most adult tissues, striated muscle, neurons	Multifunctional enzyme that plays a part in various processes such as growth control, hypoxia tolerance and allergic responses. May also function in the fibrinolytic system due to its ability to serve as a receptor and activator of plasminogen on the cell surface of several cell types
2	3	EPITHELIAL-CADHERIN PRECURSOR	98715	Cell Membrane, Cell junction	Cell adhesion	Widely distributed, highly expressed in the colon	May play a role in axonal growth and synapse formation
2	2	PREDICTED: similar to T-complex protein 1 subunit theta	59745	Cytoplasm	Chaperone	Widely distributed, highly expressed in brain	Belongs to the TCP-1 chaperonin family
2	2	NUCLEAR AUTOANTIGENIC SPERM PROTEIN	84200	Intracellular	Transport	Widely expressed	Required for DNA replication, normal cell cycle progression and cell proliferation
2	2	PREDICTED: SIMILAR TO PROGRAMMED CELL DEATH 6 INTERACTING PROTEIN	75806	Cytoplasm	Transmembrane receptor regulatory/adaptor protein	Expressed in astrocytes and glioma cells	DNA damage response, signal transduction resulting in induction of apoptosis
2	2	HEAT SHOCK PROTEIN HSP 90-BETA	83185	Cytoplasm	Chaperone, protein folding, stress response	Ubiquitous	Belongs to the heat shock protein 90 family
2	6	DERMCIDIN	11284	Secreted	Neuronal survival, phosphatase activity	Brain, skin	A maternal blood-borne factor promotes survival of the developing thalamus
2	8	AMBP PROTEIN PRECURSOR	38851	Secreted	Serine protease inhibitor	Plasma, urine, and cerebrospinal fluid	It appears not only as a free monomer but also in complexes with IgA and albumin

2	2	PREDICTED: AMINOPEPTIDASE PUROMYCIN SENSITIVE	103344	Cytoplasm	Metalloprotease - Aminopeptidase activity	Widely distributed, highly detected in hippocampus	Also known as METALLOPROTEASE MP100
2	2	PREDICTED: SIMILAR TO FILAMIN A	290169	Intracellular	Cell structure, Cell motility	Ubiquitous	Non-motor actin binding protein
2	2	MYOSIN-10	228965	Intracellular	Cell structure, cell motility	Brain	Actin binding motor protein
2	4	HISTONE H1.2	21856	Nucleus	Chromatin packaging and remodeling	Ubiquitous	Necessary for condensation of nuclear DNA
2	2	GTP-BINDING NUCLEAR PROTEIN RAN, TESTIS-SPECIFIC ISOFORM	24451	Nucleus	Nucleocytoplasmic transport	Testis	Required for the import of protein into the nucleus and also for RNA export.
2	2	14-3-3 PROTEIN EPSILON	29174	Cytoplasm	Chaperone, signal transduction	Present at high levels in the pineal gland early in development	Adapter protein implicated in the regulation of a large spectrum of both general and specialized signaling pathway

Table 1.4. Protein matches E12.5

Unique peptides	Total peptides	Protein matches E12.5
121	**587**	Rattus norvegicus (Rat) AA1064-apolipoprotein B. [MASS=536024
64	**367**	Rattus norvegicus (Rat) Apolipoprotein B - fragment. [MASS=165356
34	**96**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF FIBRONECTIN PRECURSOR. [MASS=272511
29	**104**	Rattus norvegicus (Rat) APOLIPOPROTEIN A-IV PRECURSOR. [MASS=44456
28	**32**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO FILAMIN A. [MASS=290169
27	**227**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF ALPHA-FETOPROTEIN PRECURSOR. [MASS=68386
26	**62**	Rattus norvegicus (Rat) ALPHA-1-INHIBITOR 3 PRECURSOR. [MASS=163773
26	**32**	Rattus norvegicus (Rat) FATTY ACID SYNTHASE. [MASS=272650
22	**33**	Rattus norvegicus (Rat) GPI-ANCHORED CERULOPLASMIN. [MASS=123749
20	**123**	Rattus norvegicus (Rat) SERUM ALBUMIN PRECURSOR. [MASS=68719
19	**20**	Rattus norvegicus (Rat) MYOSIN-10. [MASS=228965
18	**38**	Rattus norvegicus (Rat) HEAT SHOCK PROTEIN 86. [MASS=84815
18	**27**	Rattus norvegicus (Rat) ELONGATION FACTOR 2. [MASS=95153
18	**43**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PYRUVATE KINASE (EC 2.7.1.40) ISOZYME M2 - RAT. [MASS=57731
17	**32**	Rattus norvegicus (Rat) ALPHA-1-ANTIPROTEINASE PRECURSOR. [MASS=46136
17	**25**	Rattus norvegicus (Rat) COMPLEMENT C3 PRECURSOR. [MASS=186460
17	**63**	Rattus norvegicus (Rat) BA1-667 - Transferrin. [MASS=107448
16	**56**	Rattus norvegicus (Rat) APOLIPOPROTEIN A-I PRECURSOR. [MASS=30088
16	**28**	Rattus norvegicus (Rat) ALPHA-2-MACROGLOBULIN PRECURSOR. [MASS=163701
16	**17**	Rattus norvegicus (Rat) CLATHRIN HEAVY CHAIN. [MASS=191599
14	**14**	Rattus norvegicus (Rat) DYNEIN HEAVY CHAIN, CYTOSOLIC. [MASS=532252
13	**23**	Rattus norvegicus (Rat) RAT ALPHA(1)-INHIBITOR 3, VARIANT I PRECURSOR. [MASS=165326
13	**16**	Rattus norvegicus (Rat) PREDICTED: NIDOGEN. [MASS=138365
13	**13**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CAD PROTEIN. [MASS=250725
13	**15**	Rattus norvegicus (Rat) VIMENTIN. [MASS=53602
13	**14**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO GCN1 GENERAL CONTROL OF AMINO-ACID SYNTHESIS 1- LIKE 1. [MASS=302942
12	**12**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN LOC314432-Similar to ubiquitin-protein ligase (EC 6.3.2.19) E1. [MASS=117788
12	**17**	Rattus norvegicus (Rat) ATP-CITRATE SYNTHASE. [MASS=120781
12	**15**	Rattus norvegicus (Rat) TRANSITIONAL ENDOPLASMIC RETICULUM ATPASE. [MASS=89534
11	**14**	Rattus norvegicus (Rat) ALPHA-2 ANTIPLASMIN. [MASS=46465
11	**12**	Rattus norvegicus (Rat) IMPORTIN BETA-1 SUBUNIT. [MASS=97184
11	**14**	Rattus norvegicus (Rat) CULLIN-ASSOCIATED NEDD8-DISSOCIATED PROTEIN 1. [MASS=136362
11	**40**	Rattus norvegicus (Rat) TUBULIN ALPHA-1 CHAIN. [MASS=50136

11	**18**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO FIBULIN-1 PRECURSOR. [MASS=78072
11	**18**	Rattus norvegicus (Rat) APOLIPOPROTEIN E PRECURSOR. [MASS=35753
11	**11**	Rattus norvegicus (Rat) Glutamyl-prolyl-tRNA synthetase. [MASS=170088
11	**11**	Rattus norvegicus (Rat) MYOSIN-9. [MASS=226207
11	**15**	Rattus norvegicus (Rat) INTER-ALPHA-INHIBITOR H4 HEAVY CHAIN. [MASS=103755
10	**12**	Rattus norvegicus (Rat) GELSOLIN. [MASS=86286
10	**10**	Rattus norvegicus (Rat) NUCLEAR AUTOANTIGENIC SPERM PROTEIN. [MASS=84200
10	**16**	Rattus norvegicus (Rat) SP120-Heterogeneous nuclear ribonucleoprotein U. [MASS=87748
10	**11**	Rattus norvegicus (Rat) CONTACTIN-2 PRECURSOR. [MASS=113043
9	**10**	Rattus norvegicus (Rat) PHOSPHOGLYCERATE KINASE 1. [MASS=44423
9	**10**	Rattus norvegicus (Rat) HEAT SHOCK COGNATE 71 KDA PROTEIN. [MASS=70871
9	**22**	Rattus norvegicus (Rat) TUBULIN BETA-5 CHAIN. [MASS=49671
9	**12**	Rattus norvegicus (Rat) CONTRAPSIN-LIKE PROTEASE INHIBITOR 6 PRECURSOR. [MASS=46652
9	**19**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN RGD1305887-TUBULIN BETA CHAIN. [MASS=50059
9	**11**	Rattus norvegicus (Rat) PROMININ-1S1 SPLICE VARIANT. [MASS=96632
9	**9**	Rattus norvegicus (Rat) IKAP. [MASS=149171
9	**10**	Rattus norvegicus (Rat) PREDICTED: NEURAL PRECURSOR CELL EXPRESSED, DEVELOPMENTALLY DOWN- REGULATED GENE 4A. [MASS=112368
9	**18**	Rattus norvegicus (Rat) ACTIN, ALPHA SKELETAL MUSCLE. [MASS=42051
9	**27**	Rattus norvegicus (Rat) ELONGATION FACTOR 1-ALPHA 1. [MASS=50114
9	**12**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEPARAN SULFATE PROTEOGLYCAN 2. [MASS=377284
9	**9**	Rattus norvegicus (Rat) SPLICE ISOFORM LONG OF HYALURONAN AND PROTEOGLYCAN LINK PROTEIN 1 PRECURSOR. [MASS=40262
8	**32**	Rattus norvegicus (Rat) TRANSTHYRETIN PRECURSOR. [MASS=15720
8	**8**	Rattus norvegicus (Rat) ISCHEMIA RESPONSIVE 94 KDA PROTEIN. [MASS=94057
8	**12**	Rattus norvegicus (Rat) NEURAL-CADHERIN PRECURSOR. [MASS=99686
8	**15**	Rattus norvegicus (Rat) CONTRAPSIN-LIKE PROTEASE INHIBITOR 3 PRECURSOR. [MASS=46277
8	**10**	Rattus norvegicus (Rat) LUMICAN PRECURSOR. [MASS=38279
8	**8**	Rattus norvegicus (Rat) PREDICTED: MINI CHROMOSOME MAINTENANCE DEFICIENT 6. [MASS=92815
8	**11**	Rattus norvegicus (Rat) SERINE PEPTIDASE INHIBITOR, CLADE G, MEMBER 1. [MASS=55611
8	**10**	Rattus norvegicus (Rat) PREDICTED: LAMININ, GAMMA 1. [MASS=177387
8	**8**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RNA HELICASE A. [MASS=150362
8	**11**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CADHERIN-5. [MASS=135230
8	**12**	Rattus norvegicus (Rat) EPSILON 1 GLOBIN. [MASS=16105
8	**8**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO METHIONINE-TRNA SYNTHETASE. [MASS=101582
8	**8**	Rattus norvegicus (Rat) EXPORTIN-1. [MASS=123335

8	**12**	Rattus norvegicus (Rat) LOC367586 PROTEIN-Immunoglobulin Gamma heavy Chain. [MASS=50949
8	**8**	Rattus norvegicus (Rat) PREDICTED: AMINOPEPTIDASE PUROMYCIN SENSITIVE. [MASS=103344
8	**9**	Rattus norvegicus (Rat) PREDICTED: similar to T-complex protein 1 subunit theta. [MASS=59745
8	**8**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO FILAMIN B. [MASS=291469
8	**8**	Rattus norvegicus (Rat) STAPHYLOCOCCAL NUCLEASE DOMAIN-CONTAINING PROTEIN 1. [MASS=101952
8	**9**	Rattus norvegicus (Rat) SPLICE ISOFORM V0 OF VERSICAN CORE PROTEIN PRECURSOR (FRAGMENT). [MASS=300008
8	**14**	Rattus norvegicus (Rat) FETUB PROTEIN. [MASS=43169
8	**8**	Rattus norvegicus (Rat) DA1-24-Complement Factor B. [MASS=124379
7	**9**	Rattus norvegicus (Rat) RAT T-KININOGEN. [MASS=47618
7	**9**	Rattus norvegicus (Rat) SERINE/CYSTEINE PROTEINASE INHIBITOR, CLADE C, MEMBER 1. [MASS=52234
7	**8**	Rattus norvegicus (Rat) CLIP-ASSOCIATING PROTEIN 2. [MASS=140638
7	**9**	Rattus norvegicus (Rat) RIBONUCLEOTIDE REDUCTASE M1. [MASS=90293
7	**7**	Rattus norvegicus (Rat) ECTONUCLEOTIDE PYROPHOSPHATASE/PHOSPHODIESTERASE 2. [MASS=101310
7	**8**	Rattus norvegicus (Rat) HEPHAESTIN PRECURSOR. [MASS=129593
7	**7**	Rattus norvegicus (Rat) NONO/P54NRB HOMOLOG. [MASS=75487
7	**14**	Rattus norvegicus (Rat) PREDICTED: MICROTUBULE-ASSOCIATED PROTEIN 1B. [MASS=269643
7	**7**	Rattus norvegicus (Rat) PREDICTED NUCLEOLIN-RELATED PROTEIN NRP. [MASS=57036
7	**8**	Rattus norvegicus (Rat) NESTIN. [MASS=208797
7	**7**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF AGRIN PRECURSOR. [MASS=208646
7	**8**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF CULLIN-ASSOCIATED NEDD8-DISSOCIATED PROTEIN 2. [MASS=139673
6	**10**	Rattus norvegicus (Rat) CREATINE KINASE B-TYPE. [MASS=42712
6	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SPLICING FACTOR 3B, SUBUNIT 3, 130KDA. [MASS=174174
6	**8**	Rattus norvegicus (Rat) GLUCOSE PHOSPHATE ISOMERASE. [MASS=62827
6	**11**	Rattus norvegicus (Rat) CONTRAPSIN-LIKE PROTEASE INHIBITOR 1 PRECURSOR. [MASS=46562
6	**9**	Rattus norvegicus (Rat) PLASMINOGEN PRECURSOR. [MASS=90536
6	**7**	Rattus norvegicus (Rat) Inter-alpha trypsin inhibitor, heavy chain 3. [MASS=98968
6	**7**	Rattus norvegicus (Rat) LEUCYL-TRNA SYNTHETASE. [MASS=134279
6	**7**	Rattus norvegicus (Rat) ALPHA-2-GLOBIN CHAIN. [MASS=15285
6	**6**	Rattus norvegicus (Rat) CC2-27. [MASS=120523
6	**6**	Rattus norvegicus (Rat) PREDICTED: TUMOR REJECTION ANTIGEN GP96. [MASS=92771
6	**11**	Rattus norvegicus (Rat) PREDICTED: RETINOL BINDING PROTEIN 4, PLASMA. [MASS=50139
6	**7**	Rattus norvegicus (Rat) PREDICTED: TRIPARTITE MOTIF PROTEIN 28. [MASS=108785
6	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CELLULAR APOPTOSIS SUSCEPTIBILITY PROTEIN. [MASS=110214

6	**9**	Rattus norvegicus (Rat) COLLAGEN ALPHA-1(I) CHAIN PRECURSOR. [MASS=137886
6	**7**	Rattus norvegicus (Rat) ANGIOTENSINOGEN PRECURSOR. [MASS=51982
6	**12**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF ALPHA-1B-GLYCOPROTEIN PRECURSOR. [MASS=56479
6	**6**	Rattus norvegicus (Rat) VALYL-TRNA SYNTHETASE. [MASS=141275
6	**7**	Rattus norvegicus (Rat) CHAPERONIN CONTAINING TCP1, SUBUNIT 2. [MASS=57458
6	**6**	Rattus norvegicus (Rat) CHAPERONIN CONTAINING TCP1, SUBUNIT 5. [MASS=59537
6	**9**	Rattus norvegicus (Rat) CORTICOSTEROID-BINDING GLOBULIN PRECURSOR. [MASS=44672
6	**8**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L18. [MASS=21527
6	**6**	Rattus norvegicus (Rat) Neogenin precursor. [MASS=156144
6	**7**	Rattus norvegicus (Rat) TRIPEPTIDYL-PEPTIDASE 2. [MASS=138162
6	**7**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO LAMININ B1. [MASS=228429
6	**8**	Rattus norvegicus (Rat) MANNOSE 6-PHOSPHATE/INSULIN-LIKE GROWTH FACTOR II RECEPTOR. [MASS=273608
6	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SMC2 PROTEIN. [MASS=134280
6	**6**	Rattus norvegicus (Rat) 14-3-3 PROTEIN EPSILON. [MASS=29174
6	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO COATOMER PROTEIN COMPLEX SUBUNIT ALPHA. [MASS=138360
6	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CHROMATIN-SPECIFIC TRANSCRIPTION ELONGATION FACTOR, 140 KDA SUBUNIT. [MASS=130435
6	**6**	Rattus norvegicus (Rat) PREDICTED: KINESIN FAMILY MEMBER 4. [MASS=139682
5	**8**	Rattus norvegicus (Rat) ACTIN, CYTOPLASMIC 1. [MASS=41737
5	**5**	Rattus norvegicus (Rat) PREDICTED similar to C-1-TETRAHYDROFOLATE SYNTHASE, CYTOPLASMIC. [MASS=100351
5	**8**	Rattus norvegicus (Rat) CATHEPSIN B PRECURSOR. [MASS=37470
5	**6**	Rattus norvegicus (Rat) PROTEASOME (PROSOME, MACROPAIN) 26S SUBUNIT, NON-ATPASE, 2. [MASS=100188
5	**7**	Rattus norvegicus (Rat) PREDICTED: CADHERIN 11. [MASS=88036
5	**6**	Rattus norvegicus (Rat) RAB GDP DISSOCIATION INHIBITOR BETA. [MASS=50685
5	**5**	Rattus norvegicus (Rat) PREDICTED similar to Nuclear autoantigenic sperm protein. [MASS=45764
5	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIKEN CDNA B430218L07 GENE. [MASS=143906
5	**5**	Rattus norvegicus (Rat) LAR RECEPTOR-LINKED TYROSINE PHOSPHATASE. [MASS=181130
5	**7**	Rattus norvegicus (Rat) SPLICE ISOFORM GAMMA-B OF FIBRINOGEN GAMMA CHAIN PRECURSOR. [MASS=50633
5	**5**	Rattus norvegicus (Rat) ADENOSYLHOMOCYSTEINASE. [MASS=47407
5	**5**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF PROTEIN SET. [MASS=33406
5	**5**	Rattus norvegicus (Rat) IRON-RESPONSIVE ELEMENT-BINDING PROTEIN 1. [MASS=98128
5	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO EUKARYOTIC TRANSLATION INITIATION FACTOR 3, SUBUNIT 10 THETA, 150/170KDA. [MASS=192616

5	**9**	Rattus norvegicus (Rat) SERINE PEPTIDASE INHIBITOR, CLADE F, MEMBER 2. [MASS=54893
5	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SEROTRANSFERRIN PRECURSOR. [MASS=76607
5	**7**	Rattus norvegicus (Rat) COLLAGEN ALPHA-1(III) CHAIN PRECURSOR. [MASS=138936
5	**8**	Rattus norvegicus (Rat) TENASCIN (FRAGMENT). [MASS=62473
5	**7**	Rattus norvegicus (Rat) NUCLEOSOME ASSEMBLY PROTEIN 1-LIKE 1. [MASS=45373
5	**5**	Rattus norvegicus (Rat) PREDICTED: VON WILLEBRAND FACTOR. [MASS=308474
5	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEPATIC MULTIPLE INOSITOL POLYPHOSPHATE PHOSPHATASE. [MASS=54619
5	**6**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN SA. [MASS=32693
5	**5**	Rattus norvegicus (Rat) TRIOSEPHOSPHATE ISOMERASE. [MASS=26790
5	**6**	Rattus norvegicus (Rat) HEMOPEXIN PRECURSOR. [MASS=51291
5	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CCTETA, ETA SUBUNIT OF THE CHAPERONIN CONTAINING TCP-1. [MASS=75684
5	**7**	Rattus norvegicus (Rat) PROFILIN-1. [MASS=14826
5	**6**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF NEURONAL CELL ADHESION MOLECULE PRECURSOR. [MASS=133912
5	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO FRAS1 RELATED EXTRACELLULAR MATRIX PROTEIN 2. [MASS=378709
5	**8**	Rattus norvegicus (Rat) T-COMPLEX PROTEIN 1 SUBUNIT DELTA. [MASS=57968
5	**6**	Rattus norvegicus (Rat) SPLICE ISOFORM HMW OF KININOGEN-1 PRECURSOR. [MASS=70933
5	**8**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIBOSOMAL PROTEIN L6. [MASS=32944
5	**6**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L4. [MASS=47126
4	**4**	Rattus norvegicus (Rat) IG KAPPA CHAIN C REGION, B ALLELE. [MASS=11601
4	**4**	Rattus norvegicus (Rat) EUKARYOTIC TRANSLATION INITIATION FACTOR 4A2. [MASS=46489
4	**7**	Rattus norvegicus (Rat) HNRPK PROTEIN. [MASS=51028
4	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RAN BINDING PROTEIN 5. [MASS=133476
4	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RAN BINDING PROTEIN 5. [MASS=99947
4	**5**	Rattus norvegicus (Rat) RATSG1. [MASS=49199
4	**9**	Rattus norvegicus (Rat) HEAT SHOCK PROTEIN HSP 90-BETA. [MASS=83185
4	**6**	Rattus norvegicus (Rat) PEPTIDYL-PROLYL CIS-TRANS ISOMERASE A. [MASS=17743
4	**6**	Rattus norvegicus (Rat) PEROXIREDOXIN-2. [MASS=21652
4	**7**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN D0. [MASS=38192
4	**4**	Rattus norvegicus (Rat) PREDICTED: similar to Heterogeneous nuclear ribonucleoproteins A2/B1. [MASS=32468
4	**4**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S3A. [MASS=29814
4	**4**	Rattus norvegicus (Rat) TXNRD1 PROTEIN. [MASS=63002

4	**5**	Rattus norvegicus (Rat) EUKARYOTIC TRANSLATION INITIATION FACTOR 4A, ISOFORM 1. [MASS=46154
4	**4**	Rattus norvegicus (Rat) 14-3-3 PROTEIN THETA. [MASS=27778
4	**4**	Rattus norvegicus (Rat) ALPHA ISOFORM OF REGULATORY SUBUNIT A, PROTEIN PHOSPHATASE 2. [MASS=65323
4	**4**	Rattus norvegicus (Rat) PROTEIN KINASE C-BINDING PROTEIN NELL2. [MASS=91334
4	**4**	Rattus norvegicus (Rat) STRUCTURAL MAINTENANCE OF CHROMOSOME 3. [MASS=138448
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO IMPORTIN 7. [MASS=119704
4	**4**	Rattus norvegicus (Rat) CADHERIN-6 PRECURSOR. [MASS=88341
4	**7**	Rattus norvegicus (Rat) VITAMIN D-BINDING PROTEIN PRECURSOR. [MASS=53544
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALANYL-TRNA SYNTHETASE. [MASS=106811
4	**4**	Rattus norvegicus (Rat) PREDICTED: TRANSFORMING GROWTH FACTOR, BETA INDUCED, 68 KDA. [MASS=74369
4	**4**	Rattus norvegicus (Rat) PREDICTED: similar to phosphoribosylformylglycinamidine synthase. [MASS=146178
4	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CRB2 PROTEIN. [MASS=138781
4	**4**	Rattus norvegicus (Rat) AFAMIN PRECURSOR. [MASS=69335
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RANBP21. [MASS=136714
4	**6**	Rattus norvegicus (Rat) BETA-2-MICROGLOBULIN PRECURSOR. [MASS=13720
4	**6**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L13. [MASS=24178
4	**6**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S6. [MASS=28681
4	**5**	Rattus norvegicus (Rat) 14-3-3 PROTEIN GAMMA. [MASS=28171
4	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PROGRAMMED CELL DEATH 6 INTERACTING PROTEIN. [MASS=75806
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PUTATIVE PRE-MRNA SPLICING FACTOR RNA HELICASE. [MASS=90977
4	**15**	Rattus norvegicus (Rat) EXTRACELLULAR SUPEROXIDE DISMUTASE [CU-ZN] PRECURSOR. [MASS=26620
4	**4**	Rattus norvegicus (Rat) SMC4L1 PROTEIN. [MASS=146806
4	**4**	Rattus norvegicus (Rat) SPLICEOSOME RNA HELICASE BAT1. [MASS=49035
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 40S RIBOSOMAL PROTEIN S9. [MASS=22648
4	**4**	Rattus norvegicus (Rat) 60S ACIDIC RIBOSOMAL PROTEIN P0. [MASS=34215
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO P30 DBC PROTEIN. [MASS=114440
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ISOLEUCINE-TRNA SYNTHETASE. [MASS=144169
4	**5**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S10. [MASS=18916
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO VINCULIN. [MASS=116615
4	**4**	Rattus norvegicus (Rat) PREDICTED: CALSYNTENIN 1. [MASS=109351
4	**4**	Rattus norvegicus (Rat) FAR UPSTREAM ELEMENT-BINDING PROTEIN 2. [MASS=74226

4	**5**	Rattus norvegicus (Rat) L-LACTATE DEHYDROGENASE A CHAIN. [MASS=36451
4	**4**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF ACETYL-COA CARBOXYLASE 1. [MASS=265421
4	**4**	Rattus norvegicus (Rat) MICROTUBULE-ASSOCIATED PROTEIN 4. [MASS=110301
4	**4**	Rattus norvegicus (Rat) COLD SHOCK DOMAIN-CONTAINING PROTEIN E1. [MASS=88895
4	**4**	Rattus norvegicus (Rat) 26S PROTEASOME NON-ATPASE REGULATORY SUBUNIT 1. [MASS=105748
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RAS GTPASE-ACTIVATING-LIKE PROTEIN IQGAP1. [MASS=196522
4	**5**	Rattus norvegicus (Rat) GTP-BINDING NUCLEAR PROTEIN RAN, TESTIS-SPECIFIC ISOFORM. [MASS=24451
3	**3**	Rattus norvegicus (Rat) 14-3-3 PROTEIN ZETA/DELTA. [MASS=27771
3	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALPHA ENOLASE. [MASS=46489
3	**5**	Rattus norvegicus (Rat) GLUTATHIONE PEROXIDASE 3 PRECURSOR. [MASS=25393
3	**6**	Rattus norvegicus (Rat) PREDICTED: DYSTROGLYCAN 1. [MASS=96706
3	**3**	Rattus norvegicus (Rat) COFILIN-1. [MASS=24588
3	**3**	Rattus norvegicus (Rat) HEAT-SHOCK PROTEIN 105 KDA. [MASS=96419
3	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALPHA NAC/1.9.2. PROTEIN. [MASS=23384
3	**7**	Rattus norvegicus (Rat) TUMOR NECROSIS FACTOR TYPE 1 RECEPTOR ASSOCIATED PROTEIN. [MASS=80461
3	**4**	Rattus norvegicus (Rat) FRUCTOSE-BISPHOSPHATE ALDOLASE A. [MASS=39221
3	**3**	Rattus norvegicus (Rat) PREDICTED: BRAIN GLYCOGEN PHOSPHORYLASE. [MASS=96738
3	**7**	Rattus norvegicus (Rat) CYSTATIN C PRECURSOR. [MASS=15437
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PTK7 PROTEIN TYROSINE KINASE 7. [MASS=139818
3	**10**	Rattus norvegicus (Rat) RIBOSOMAL PROTEIN S27A. [MASS=17951
3	**3**	Rattus norvegicus (Rat) COMPLEMENT C4 PRECURSOR. [MASS=192163
3	**3**	Rattus norvegicus (Rat) POLY [ADP-RIBOSE] POLYMERASE 1. [MASS=112529
3	**4**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S4, X ISOFORM. [MASS=29467
3	**4**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S8. [MASS=24074
3	**3**	Rattus norvegicus (Rat) EPSILON 3 GLOBIN. [MASS=16540
3	**3**	Rattus norvegicus (Rat) PREDICTED: PHOSPHORIBOSYLGLYCINAMIDE FORMYLTRANSFERASE. [MASS=107580
3	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEAT SHOCK PROTEIN HSP 90-BETA. [MASS=80701
3	**3**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF ATTRACTIN PRECURSOR. [MASS=163296
3	**3**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S3. [MASS=26674
3	**7**	Rattus norvegicus (Rat) PREDICTED similar to HEAT SHOCK PROTEIN 86. [MASS=56953
3	**3**	Rattus norvegicus (Rat) GAMMA-GLUTAMYL HYDROLASE PRECURSOR. [MASS=35830
3	**3**	Rattus norvegicus (Rat) QUIESCIN Q6. [MASS=82412

3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO DNA REPLICATION LICENSING FACTOR MCM3. [MASS=83429
3	**3**	Rattus norvegicus (Rat) DELETED IN COLORECTAL CANCER. [MASS=158142
3	**3**	Rattus norvegicus (Rat) ALPHA-ACTININ-1. [MASS=102960
3	**3**	Rattus norvegicus (Rat) COATOMER SUBUNIT BETA'. [MASS=102420
3	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO P59 IMMUNOPHILIN. [MASS=80396
3	**3**	Rattus norvegicus (Rat) FIBRINOGEN BETA CHAIN PRECURSOR. [MASS=54303
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 40S RIBOSOMAL PROTEIN S3. [MASS=26630
3	**3**	Rattus norvegicus (Rat) ALPHA-1-ACID GLYCOPROTEIN PRECURSOR. [MASS=23575
3	**3**	Rattus norvegicus (Rat) ALPHA-1-MACROGLOBULIN. [MASS=167125
3	**3**	Rattus norvegicus (Rat) LIVER CARBOXYLESTERASE 1 PRECURSOR. [MASS=60175
3	**3**	Rattus norvegicus (Rat) SIMILAR TO RIKEN CDNA 2810409H07. [MASS=44535
3	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PHOSPHOLIPID TRANSFER PROTEIN. [MASS=65430
3	**3**	Rattus norvegicus (Rat) 26S PROTEASE REGULATORY SUBUNIT 8. [MASS=45626
3	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEAT SHOCK PROTEIN HSP 90-BETA. [MASS=54660
3	**3**	Rattus norvegicus (Rat) SUPEROXIDE DISMUTASE. [MASS=15780
3	**3**	Rattus norvegicus (Rat) PREDICTED: HYPOTHETICAL PROTEIN XP_579585. [MASS=275729
3	**3**	Rattus norvegicus (Rat) LOW-DENSITY LIPOPROTEIN RECEPTOR PRECURSOR. [MASS=96622
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PROTOCADHERIN 18 PRECURSOR. [MASS=123552
3	**3**	Rattus norvegicus (Rat) SPLICE ISOFORM B OF AP-1 COMPLEX SUBUNIT BETA-1. [MASS=103873
3	**3**	Rattus norvegicus (Rat) COLLAGEN ALPHA-2(I) CHAIN PRECURSOR. [MASS=129564
3	**3**	Rattus norvegicus (Rat) SHEN-DAN. [MASS=131080
3	**3**	Rattus norvegicus (Rat) SPARC-LIKE PROTEIN 1 PRECURSOR. [MASS=70634
3	**3**	Rattus norvegicus (Rat) NUCLEOSIDE DIPHOSPHATE KINASE B. [MASS=17283
3	**3**	Rattus norvegicus (Rat) D-3-PHOSPHOGLYCERATE DEHYDROGENASE. [MASS=56362
3	**3**	Rattus norvegicus (Rat) PROTEIN DISULFIDE-ISOMERASE A3 PRECURSOR. [MASS=57079
3	**3**	Rattus norvegicus (Rat) LARGE PROLINE-RICH PROTEIN BAT3. [MASS=114647
3	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO IMPORTIN 9. [MASS=131739
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 25 KDA FK506-BINDING PROTEIN. [MASS=25179
3	**3**	Rattus norvegicus (Rat) DNA POLYMERASE DELTA CATALYTIC SUBUNIT. [MASS=123601
3	**3**	Rattus norvegicus (Rat) CHAPERONIN SUBUNIT 6A. [MASS=58017

3	**3**	Rattus norvegicus (Rat) SPLICE ISOFORM 2 OF INTERLEUKIN ENHANCER-BINDING FACTOR 3. [MASS=97680
3	**3**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF REELIN PRECURSOR. [MASS=387531
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO DNA REPLICATION LICENSING FACTOR MCM2. [MASS=102272
3	**3**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S18. [MASS=17719
3	**4**	Rattus norvegicus (Rat) HISTIDINE-RICH GLYCOPROTEIN. [MASS=57581
3	**4**	Rattus norvegicus (Rat) HISTONE H1.2. [MASS=21856
3	**3**	Rattus norvegicus (Rat) DYNACTIN-1. [MASS=141930
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO REGULATOR OF NONSENSE TRANSCRIPTS 1. [MASS=88226
3	**3**	Rattus norvegicus (Rat) VIGILIN. [MASS=141584
3	**4**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L3. [MASS=46005
3	**3**	Rattus norvegicus (Rat) ALPHA-MANNOSIDASE 2. [MASS=131242
3	**3**	Rattus norvegicus (Rat) PROTOCADHERIN. [MASS=505997
3	**3**	Rattus norvegicus (Rat) PROLIFERATION-ASSOCIATED 2G4, 38KDA. [MASS=43657
3	**5**	Rattus norvegicus (Rat) STATHMIN. [MASS=17157
3	**3**	Rattus norvegicus (Rat) PREDICTED: similar to 60S ribosomal protein L38. [MASS=8215
3	**3**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S7. [MASS=22127
3	**3**	Rattus norvegicus (Rat) COLLAGEN ALPHA-1(V) CHAIN PRECURSOR. [MASS=184610
3	**3**	Rattus norvegicus (Rat) HAUSP. [MASS=128431
3	**3**	Rattus norvegicus (Rat) PROTOCADHERIN GAMMA SUBFAMILY C, 3. [MASS=101038
3	**5**	Rattus norvegicus (Rat) NUCLEOLIN. [MASS=77276
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO UBIQUITIN SPECIFIC PROTEASE 9, X-LINKED. [MASS=290681
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ENHANCER-TRAP-LOCUS-1. [MASS=159154
3	**6**	Rattus norvegicus (Rat) PHOSPHOGLYCERATE MUTASE 2. [MASS=28624
3	**5**	Rattus norvegicus (Rat) DAMAGE-SPECIFIC DNA BINDING PROTEIN 1. [MASS=127059
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SIDEKICK 2. [MASS=466498
3	**3**	Rattus norvegicus (Rat) PEPTIDYLPROLYL ISOMERASE C. [MASS=23009
3	**3**	Rattus norvegicus (Rat) TENASCIN (FRAGMENT). [MASS=67815
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIBOSOMAL PROTEIN L28. [MASS=16313
2	**2**	Rattus norvegicus (Rat) ALPHA-ENOLASE. [MASS=46997
2	**2**	Rattus norvegicus (Rat) PREDICTED similar to T-KININOGEN 2 PRECURSOR (Fragment). [MASS=72419
2	**3**	Rattus norvegicus (Rat) HYRAC. [MASS=31353
2	**2**	Rattus norvegicus (Rat) HEAT SHOCK-RELATED 70 KDA PROTEIN 2. [MASS=69528
2	**3**	Rattus norvegicus (Rat) PROLIFERATING CELL NUCLEAR ANTIGEN. [MASS=28749
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALPHA ENOLASE. [MASS=27286

2	3	Rattus norvegicus (Rat) HYDROXYMETHYLGLUTARYL-COA SYNTHASE, CYTOPLASMIC. [MASS=57434
2	3	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEAT SHOCK 70KDA PROTEIN 4 LIKE. [MASS=136266
2	2	Rattus norvegicus (Rat) RUVB-LIKE 2. [MASS=51147
2	3	Rattus norvegicus (Rat) SPLICE ISOFORM 2 OF PLASMINOGEN ACTIVATOR INHIBITOR 1 RNA-BINDING PROTEIN. [MASS=42984
2	2	Rattus norvegicus (Rat) RUVB-LIKE 1. [MASS=50214
2	2	Rattus norvegicus (Rat) GLUTATHIONE S-TRANSFERASE P. [MASS=23308
2	2	Rattus norvegicus (Rat) MANNOSIDASE, ALPHA, CLASS 1A, MEMBER 1. [MASS=73125
2	2	Rattus norvegicus (Rat) RHO GDP DISSOCIATION INHIBITOR (GDI) ALPHA. [MASS=23407
2	2	Rattus norvegicus (Rat) SPLICE ISOFORM PYBP1 OF POLYPYRIMIDINE TRACT-BINDING PROTEIN 1. [MASS=56937
2	3	Rattus norvegicus (Rat) PREDICTED-HEAT SHOCK PROTEIN HSP 90-BETA (Frgament). [MASS=50669
2	2	Rattus norvegicus (Rat) METALLOPROTEINASE INHIBITOR 1 PRECURSOR. [MASS=23794
2	2	Rattus norvegicus (Rat) PREDICTED: NIDOGEN 2. [MASS=173960
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ENO1 PROTEIN. [MASS=47532
2	2	Rattus norvegicus (Rat) SORTILIN PRECURSOR. [MASS=91169
2	3	Rattus norvegicus (Rat) 60S ACIDIC RIBOSOMAL PROTEIN P2. [MASS=11692
2	3	Rattus norvegicus (Rat) FOLLISTATIN-RELATED PROTEIN 1 PRECURSOR. [MASS=34622
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PSMC6 PROTEIN. [MASS=45797
2	2	Rattus norvegicus (Rat) SYNTENIN-1. [MASS=32423
2	2	Rattus norvegicus (Rat) INOSINE MONOPHOSPHATE DEHYDROGENASE 2. [MASS=55799
2	2	Rattus norvegicus (Rat) PREDICTED: ATPASE, H+ TRANSPORTING, LYSOSOMAL ACCESSORY PROTEIN 2. [MASS=66094
2	2	Rattus norvegicus (Rat) DNA PRIMASE LARGE SUBUNIT. [MASS=58603
2	2	Rattus norvegicus (Rat) EUKARYOTIC TRANSLATION INITIATION FACTOR 3 SUBUNIT 9. [MASS=107985
2	2	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF SEX HORMONE-BINDING GLOBULIN PRECURSOR. [MASS=44533
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO COLLAGEN ALPHA1 TYPE VI-PRECURSOR. [MASS=130760
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 26S PROTEASOME NON-ATPASE REGULATORY SUBUNIT 11. [MASS=54019
2	2	Rattus norvegicus (Rat) PREDICTED-HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN A1. [MASS=33656
2	2	Rattus norvegicus (Rat) GUANINE NUCLEOTIDE-BINDING PROTEIN BETA SUBUNIT 2-LIKE 1. [MASS=35419
2	3	Rattus norvegicus (Rat) PREDICTED: EUKARYOTIC TRANSLATION ELONGATION FACTOR 1 GAMMA. [MASS=72445
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO DEAD/H BOX POLYPEPTIDE 36 PROTEIN. [MASS=113843
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PYRUVATE KINASE 3. [MASS=84928
2	3	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HSPC263. [MASS=37041

2	2	Rattus norvegicus (Rat) FIBRILLIN-2. [MASS=313374
2	2	Rattus norvegicus (Rat) 15 KDA PROTEIN. [MASS=14671
2	2	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF FIBRINOGEN ALPHA CHAIN PRECURSOR. [MASS=86686
2	2	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S13. [MASS=17091
2	3	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF DNA-BINDING PROTEIN A. [MASS=38852
2	2	Rattus norvegicus (Rat) RETINOL-BINDING PROTEIN I, CELLULAR. [MASS=15703
2	2	Rattus norvegicus (Rat) TPA: proteasome subunit beta type 6-like. [MASS=25304
2	2	Rattus norvegicus (Rat) PROTEIN ARGININE N-METHYLTRANSFERASE 1. [MASS=42436
2	2	Rattus norvegicus (Rat) TRANSLATIONALLY-CONTROLLED TUMOR PROTEIN. [MASS=19462
2	3	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO STABILIN-1. [MASS=288663
2	2	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L7. [MASS=30329
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SERINE PROTEASE INHIBITOR 2.4. [MASS=46841
2	2	Rattus norvegicus (Rat) NUCLEOSIDE DIPHOSPHATE KINASE A. [MASS=17193
2	2	Rattus norvegicus (Rat) EUKARYOTIC TRANSLATION INITIATION FACTOR 5A-1. [MASS=16701
2	2	Rattus norvegicus (Rat) PREDICTED-40S ribosomal protein S17. [MASS=16340
2	3	Rattus norvegicus (Rat) SPLICE ISOFORM 2 OF RECEPTOR-TYPE TYROSINE-PROTEIN PHOSPHATASE ZETA PRECURSOR. [MASS=164596
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CCR4-NOT TRANSCRIPTION COMPLEX, SUBUNIT 1 ISOFORM A. [MASS=93683
2	2	Rattus norvegicus (Rat) HEAT SHOCK 70 KDA PROTEIN 1A/1B. [MASS=70185
2	3	Rattus norvegicus (Rat) RECEPTOR-LIKE PROTEIN TYROSINE PHOSPHATASE KAPPA EXTRACELLULAR REGION. [MASS=56159
2	3	Rattus norvegicus (Rat) NUCLEIC ACID BINDING FACTOR PRM10. [MASS=33815
2	2	Rattus norvegicus (Rat) SPLICE ISOFORM APP770 OF AMYLOID BETA A4 PROTEIN PRECURSOR (FRAGMENT). [MASS=86704
2	5	Rattus norvegicus (Rat) PREDICTED: similar to Fibulin-1 precursor. [MASS=75381
2	2	Rattus norvegicus (Rat) CADHERIN EGF LAG SEVEN-PASS G-TYPE RECEPTOR 2. [MASS=317122
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ARX. [MASS=121446
2	4	Rattus norvegicus (Rat) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN C. [MASS=34385
2	2	Rattus norvegicus (Rat) PREDICTED: PROTEASOME (PROSOME, MACROPAIN) SUBUNIT, BETA TYPE 5. [MASS=37128
2	2	Rattus norvegicus (Rat) 109 KDA PROTEIN. [MASS=108509
2	2	Rattus norvegicus (Rat) AMBP PROTEIN PRECURSOR. [MASS=38851
2	2	Rattus norvegicus (Rat) PROTEASOME. [MASS=60688
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIBOSOMAL PROTEIN L14. [MASS=18408
2	2	Rattus norvegicus (Rat) LOW-DENSITY LIPOPROTEIN RECEPTOR-RELATED PROTEIN 2 PRECURSOR. [MASS=519276
2	2	Rattus norvegicus (Rat) GRP78 BINDING PROTEIN. [MASS=110574

2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO COLLAGEN ALPHA 2(IV) CHAIN PRECURSOR - MOUSE. [MASS=192535
2	**2**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L7A. [MASS=29864
2	**3**	Rattus norvegicus (Rat) PREDICTED-Proteasome 26S subunit, ATPase 3. [MASS=50509
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO N-TERMINAL ACEYLTRANSFERASE 1. [MASS=100994
2	**2**	Rattus norvegicus (Rat) O-GLCNACASE. [MASS=102918
2	**2**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S21. [MASS=9127
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CYFIP1 PROTEIN. [MASS=144933
2	**4**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF 40S RIBOSOMAL PROTEIN S24. [MASS=15423
2	**7**	Rattus norvegicus (Rat) DERMCIDIN. [MASS=11284
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 60S RIBOSOMAL PROTEIN L26. [MASS=24366
2	**2**	Rattus norvegicus (Rat) PREDICTED: SPLICING FACTOR 3B, SUBUNIT 1. [MASS=152445
2	**2**	Rattus norvegicus (Rat) HAPTOGLOBIN PRECURSOR. [MASS=38549
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO EXPRESSED SEQUENCE AI314180. [MASS=203921
2	**2**	Rattus norvegicus (Rat) ARCADLIN. [MASS=103800
2	**2**	Rattus norvegicus (Rat) EPITHELIAL-CADHERIN PRECURSOR. [MASS=98715
2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 60S RIBOSOMAL PROTEIN L7A. [MASS=13842
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO NISCHARIN. [MASS=148481
2	**2**	Rattus norvegicus (Rat) SPARC PRECURSOR. [MASS=34384
2	**2**	Rattus norvegicus (Rat) SERINE (OR CYSTEINE) PROTEINASE INHIBITOR, CLADE A (ALPHA-1 ANTIPROTEINASE, ANTITRYPSIN), MEMBER 6. [MASS=44671
2	**2**	Rattus norvegicus (Rat) VESICLE ASSOCIATED PROTEIN. [MASS=135350
2	**3**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN ALDOAL1. [MASS=39492
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO EUKARYOTIC TRANSLATION INITIATION FACTOR 4, GAMMA 1 ISOFORM A. [MASS=93472
2	**2**	Rattus norvegicus (Rat) SPLICE ISOFORM CDK2-ALPHA OF CELL DIVISION PROTEIN KINASE 2. [MASS=33887
2	**2**	Rattus norvegicus (Rat) COMPLEMENT COMPONENT 2. [MASS=83699
2	**2**	Rattus norvegicus (Rat) ZINC PHOSPHODIESTERASE ELAC PROTEIN 2. [MASS=92340
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 116 KDA U5 SMALL NUCLEAR RIBONUCLEOPROTEIN COMPONENT. [MASS=109478
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 40S RIBOSOMAL PROTEIN S16. [MASS=20192
2	**2**	Rattus norvegicus (Rat) SERINE/THREONINE-PROTEIN PHOSPHATASE 2A CATALYTIC SUBUNIT BETA ISOFORM. [MASS=35575
2	**2**	Rattus norvegicus (Rat) MATRIN-3. [MASS=94447
2	**2**	Rattus norvegicus (Rat) LEUKEMIA INHIBITORY FACTOR RECEPTOR PRECURSOR. [MASS=122394
2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO POLY(RC)-BINDING PROTEIN 1. [MASS=37498

2	2	Rattus norvegicus (Rat) LRRGT00164. [MASS=111258
2	2	Rattus norvegicus (Rat) DNA LIGASE 1. [MASS=102482
2	2	Rattus norvegicus (Rat) HEMOGLOBIN ALPHA-1/2 SUBUNIT. [MASS=15197
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIBOSOMAL PROTEIN L34. [MASS=13582
2	2	Rattus norvegicus (Rat) TRANSKETOLASE. [MASS=71159
2	2	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN M. [MASS=74350
2	3	Rattus norvegicus (Rat) HISTONE H2A. [MASS=14189
2	2	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S25. [MASS=13742
2	2	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN RGD1305890. [MASS=31776
2	2	Rattus norvegicus (Rat) SSB PROTEIN. [MASS=43926
2	2	Rattus norvegicus (Rat) C-REACTIVE PROTEIN PRECURSOR. [MASS=25468
2	2	Rattus norvegicus (Rat) GLUCOSAMINE. [MASS=60914
2	2	Rattus norvegicus (Rat) TUBULIN BETA CHAIN. [MASS=49963
2	2	Rattus norvegicus (Rat) LEUKOCYTE COMMON ANTIGEN-RELATED PHOSPHATASE PRECURSOR. [MASS=212954
2	2	Rattus norvegicus (Rat) PREDICTED similar to POSTSYNAPTIC DENSITY PROTEIN. [MASS=186848
2	2	Rattus norvegicus (Rat) COMPLEMENT INHIBITORY FACTOR H. [MASS=140344
2	2	Rattus norvegicus (Rat) PROTEASOME SUBUNIT BETA TYPE 2. [MASS=22912
2	2	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S11. [MASS=18431
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO EIF4G1 PROTEIN. [MASS=175705
2	2	Rattus norvegicus (Rat) 92 KDA PROTEIN. [MASS=91785
2	3	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RANBP4. [MASS=118926
2	7	Rattus norvegicus (Rat) BETA-ENOLASE. [MASS=46830
2	2	Rattus norvegicus (Rat) PEROXIREDOXIN-1. [MASS=22109
2	3	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO APOLIPOPROTEIN C2. [MASS=10695
2	2	Rattus norvegicus (Rat) UDP-N-ACETYLGLUCOSAMINE--PEPTIDE N-ACETYLGLUCOSAMINYLTRANSFERASE 110 KDA SUBUNIT. [MASS=116954
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO NUCLEAR PORE COMPLEX-ASSOCIATED INTRANUCLEAR COILED-COIL PROTEIN TPR. [MASS=279947
2	2	Rattus norvegicus (Rat) PROTEASOME SUBUNIT ALPHA TYPE 6. [MASS=27399
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HCF. [MASS=215082
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SHPRH PROTEIN. [MASS=192457
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 60S RIBOSOMAL PROTEIN L12. [MASS=17847
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO TRANSLIN-ASSOCIATED FACTOR X (TSNAX) INTERACTING PROTEIN 1. [MASS=85228
2	2	Rattus norvegicus (Rat) JUNCTION PLAKOGLOBIN. [MASS=81801
2	5	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO GLYCERALDEHYDE-3-PHOSPHATE DEHYDROGENASE. [MASS=35856
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO DESMOPLAKIN ISOFORM II. [MASS=264186

2	**2**	Rattus norvegicus (Rat) GM2 GANGLIOSIDE ACTIVATOR PROTEIN. [MASS=21493
2	**2**	Rattus norvegicus (Rat) KINESIN-LIKE PROTEIN KIF15. [MASS=159554
2	**2**	Rattus norvegicus (Rat) 29 KDA PROTEIN. [MASS=29242
2	**2**	Rattus norvegicus (Rat) RIBOSOMAL PROTEIN L13A. [MASS=23446
2	**2**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L8. [MASS=27893
2	**2**	Rattus norvegicus (Rat) PREDICTED: TYROSINE KINASE RECEPTOR 1. [MASS=125210

Table 1.5. Protein matches E14.5 LV

Unique peptides	Total peptides	Protein matches E14.5 LV
107	**437**	Rattus norvegicus (Rat) AA1064-apolipoprotein B. [MASS=536024
62	**293**	Rattus norvegicus (Rat) Apolipoprotein B - fragment. [MASS=165356
34	**73**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF FIBRONECTIN PRECURSOR. [MASS=272511
32	**90**	Rattus norvegicus (Rat) APOLIPOPROTEIN A-IV PRECURSOR. [MASS=44456
29	**290**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF ALPHA-FETOPROTEIN PRECURSOR. [MASS=68386
24	**54**	Rattus norvegicus (Rat) ALPHA-2-MACROGLOBULIN PRECURSOR. [MASS=163701
24	**30**	Rattus norvegicus (Rat) GPI-ANCHORED CERULOPLASMIN. [MASS=123749
22	**38**	Rattus norvegicus (Rat) ALPHA-1-INHIBITOR 3 PRECURSOR. [MASS=163773
21	**22**	Rattus norvegicus (Rat) FATTY ACID SYNTHASE. [MASS=272650
21	**96**	Rattus norvegicus (Rat) BA1-667 - Transferrin. [MASS=107448
19	**60**	Rattus norvegicus (Rat) APOLIPOPROTEIN A-I PRECURSOR. [MASS=30088
19	**112**	Rattus norvegicus (Rat) SERUM ALBUMIN PRECURSOR. [MASS=68719
17	**19**	Rattus norvegicus (Rat) PREDICTED: NIDOGEN. [MASS=138365
15	**38**	Rattus norvegicus (Rat) ALPHA-1-ANTIPROTEINASE PRECURSOR. [MASS=46136
15	**20**	Rattus norvegicus (Rat) CONTACTIN-2 PRECURSOR. [MASS=113043
14	**18**	Rattus norvegicus (Rat) HEAT SHOCK PROTEIN 86. [MASS=84815
14	**29**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PYRUVATE KINASE (EC 2.7.1.40) ISOZYME M2 - RAT. [MASS=57731
12	**17**	Rattus norvegicus (Rat) ALPHA-2 ANTIPLASMIN. [MASS=46465
12	**24**	Rattus norvegicus (Rat) NEURAL-CADHERIN PRECURSOR. [MASS=99686
12	**22**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CADHERIN-5. [MASS=135230
12	**14**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO LAMININ B1. [MASS=228429
11	**12**	Rattus norvegicus (Rat) GELSOLIN. [MASS=86286
11	**13**	Rattus norvegicus (Rat) ELONGATION FACTOR 2. [MASS=95153
11	**18**	Rattus norvegicus (Rat) COMPLEMENT C3 PRECURSOR. [MASS=186460
11	**13**	Rattus norvegicus (Rat) TRANSITIONAL ENDOPLASMIC RETICULUM ATPASE. [MASS=89534
11	**11**	Rattus norvegicus (Rat) NUCLEAR AUTOANTIGENIC SPERM PROTEIN. [MASS=84200
11	**18**	Rattus norvegicus (Rat) CORTICOSTEROID-BINDING GLOBULIN PRECURSOR. [MASS=44672
11	**22**	Rattus norvegicus (Rat) APOLIPOPROTEIN E PRECURSOR. [MASS=35753
10	**47**	Rattus norvegicus (Rat) TRANSTHYRETIN PRECURSOR. [MASS=15720
10	**17**	Rattus norvegicus (Rat) RAT ALPHA(1)-INHIBITOR 3, VARIANT I PRECURSOR. [MASS=165326
10	**13**	Rattus norvegicus (Rat) CONTRAPSIN-LIKE PROTEASE INHIBITOR 6 PRECURSOR. [MASS=46652
10	**12**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO KINESIN FAMILY MEMBER 23. [MASS=108791
10	**16**	Rattus norvegicus (Rat) COLLAGEN ALPHA-1(I) CHAIN PRECURSOR. [MASS=137886

10	**10**	Rattus norvegicus (Rat) CLATHRIN HEAVY CHAIN. [MASS=191599
9	**20**	Rattus norvegicus (Rat) TUBULIN ALPHA-1 CHAIN. [MASS=50136
9	**9**	Rattus norvegicus (Rat) LAR RECEPTOR-LINKED TYROSINE PHOSPHATASE. [MASS=181130
9	**11**	Rattus norvegicus (Rat) IMPORTIN BETA-1 SUBUNIT. [MASS=97184
9	**9**	Rattus norvegicus (Rat) PREDICTED: VON WILLEBRAND FACTOR. [MASS=308474
9	**15**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEPARAN SULFATE PROTEOGLYCAN 2. [MASS=377284
9	**9**	Rattus norvegicus (Rat) PREDICTED: LAMININ, GAMMA 1. [MASS=177387
9	**20**	Rattus norvegicus (Rat) LUMICAN PRECURSOR. [MASS=38279
9	**9**	Rattus norvegicus (Rat) Neogenin precursor. [MASS=156144
9	**16**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO FIBULIN-1 PRECURSOR. [MASS=78072
9	**10**	Rattus norvegicus (Rat) DA1-24-Complement Factor B. [MASS=124379
9	**12**	Rattus norvegicus (Rat) ACTIN, ALPHA SKELETAL MUSCLE. [MASS=42051
9	**13**	Rattus norvegicus (Rat) INTER-ALPHA-INHIBITOR H4 HEAVY CHAIN. [MASS=103755
8	**16**	Rattus norvegicus (Rat) TUBULIN BETA-5 CHAIN. [MASS=49671
8	**14**	Rattus norvegicus (Rat) CONTRAPSIN-LIKE PROTEASE INHIBITOR 1 PRECURSOR. [MASS=46562
8	**14**	Rattus norvegicus (Rat) SERINE PEPTIDASE INHIBITOR, CLADE G, MEMBER 1. [MASS=55611
8	**9**	Rattus norvegicus (Rat) ISCHEMIA RESPONSIVE 94 KDA PROTEIN. [MASS=94057
8	**8**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN LOC314432-Similar to ubiquitin-protein ligase (EC 6.3.2.19) E1. [MASS=117788
8	**10**	Rattus norvegicus (Rat) HEPHAESTIN PRECURSOR. [MASS=129593
8	**15**	Rattus norvegicus (Rat) PLASMINOGEN PRECURSOR. [MASS=90536
8	**8**	Rattus norvegicus (Rat) CADHERIN-6 PRECURSOR. [MASS=88341
8	**10**	Rattus norvegicus (Rat) ECTONUCLEOTIDE PYROPHOSPHATASE/PHOSPHODIESTERASE 2. [MASS=101310
8	**10**	Rattus norvegicus (Rat) PROMININ-1S1 SPLICE VARIANT. [MASS=96632
8	**9**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF AGRIN PRECURSOR. [MASS=208646
8	**20**	Rattus norvegicus (Rat) LOC367586 PROTEIN-Immunoglobulin Gamma heavy Chain. [MASS=50949
8	**10**	Rattus norvegicus (Rat) VIMENTIN. [MASS=53602
7	**12**	Rattus norvegicus (Rat) CONTRAPSIN-LIKE PROTEASE INHIBITOR 3 PRECURSOR. [MASS=46277
7	**9**	Rattus norvegicus (Rat) PREDICTED: NIDOGEN 2. [MASS=173960
7	**8**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF REELIN PRECURSOR. [MASS=387531
7	**7**	Rattus norvegicus (Rat) PREDICTED: TRANSFORMING GROWTH FACTOR, BETA INDUCED, 68 KDA. [MASS=74369
7	**10**	Rattus norvegicus (Rat) SERINE/CYSTEINE PROTEINASE INHIBITOR, CLADE C, MEMBER 1. [MASS=52234
7	**7**	Rattus norvegicus (Rat) IKAP. [MASS=149171
7	**8**	Rattus norvegicus (Rat) DELETED IN COLORECTAL CANCER. [MASS=158142
7	**7**	Rattus norvegicus (Rat) COMPLEMENT C4 PRECURSOR. [MASS=192163

7	**13**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN RGD1305887-TUBULIN BETA CHAIN. [MASS=50059
7	**12**	Rattus norvegicus (Rat) SP120-Heterogeneous nuclear ribonucleoprotein U. [MASS=87748
7	**7**	Rattus norvegicus (Rat) COLLAGEN ALPHA-2(I) CHAIN PRECURSOR. [MASS=129564
7	**7**	Rattus norvegicus (Rat) PREDICTED: similar to T-complex protein 1 subunit theta. [MASS=59745
6	**8**	Rattus norvegicus (Rat) CATHEPSIN B PRECURSOR. [MASS=37470
6	**8**	Rattus norvegicus (Rat) ANGIOTENSINOGEN PRECURSOR. [MASS=51982
6	**7**	Rattus norvegicus (Rat) RAT T-KININOGEN. [MASS=47618
6	**6**	Rattus norvegicus (Rat) TENASCIN (FRAGMENT). [MASS=62473
6	**8**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF ATTRACTIN PRECURSOR. [MASS=163296
6	**7**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIKEN CDNA B430218L07 GENE. [MASS=143906
6	**7**	Rattus norvegicus (Rat) PROFILIN-1. [MASS=14826
6	**9**	Rattus norvegicus (Rat) PREDICTED: CADHERIN 11. [MASS=88036
6	**10**	Rattus norvegicus (Rat) SPLICE ISOFORM GAMMA-B OF FIBRINOGEN GAMMA CHAIN PRECURSOR. [MASS=50633
6	**12**	Rattus norvegicus (Rat) ELONGATION FACTOR 1-ALPHA 1. [MASS=50114
6	**8**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CRB2 PROTEIN. [MASS=138781
6	**6**	Rattus norvegicus (Rat) TRIPEPTIDYL-PEPTIDASE 2. [MASS=138162
6	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CAD PROTEIN. [MASS=250725
6	**7**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RNA HELICASE A. [MASS=150362
5	**8**	Rattus norvegicus (Rat) CREATINE KINASE B-TYPE. [MASS=42712
5	**5**	Rattus norvegicus (Rat) PHOSPHOGLYCERATE KINASE 1. [MASS=44423
5	**5**	Rattus norvegicus (Rat) HEAT SHOCK COGNATE 71 KDA PROTEIN. [MASS=70871
5	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PROGRAMMED CELL DEATH 6 INTERACTING PROTEIN. [MASS=75806
5	**5**	Rattus norvegicus (Rat) FIBRINOGEN BETA CHAIN PRECURSOR. [MASS=54303
5	**5**	Rattus norvegicus (Rat) ATP-CITRATE SYNTHASE. [MASS=120781
5	**5**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF NEURONAL CELL ADHESION MOLECULE PRECURSOR. [MASS=133912
5	**11**	Rattus norvegicus (Rat) CYSTATIN C PRECURSOR. [MASS=15437
5	**7**	Rattus norvegicus (Rat) PEROXIREDOXIN-2. [MASS=21652
5	**10**	Rattus norvegicus (Rat) ACTIN, CYTOPLASMIC 1. [MASS=41737
5	**5**	Rattus norvegicus (Rat) TRIOSEPHOSPHATE ISOMERASE. [MASS=26790
5	**5**	Rattus norvegicus (Rat) LEUCYL-TRNA SYNTHETASE. [MASS=134279
5	**8**	Rattus norvegicus (Rat) SPLICE ISOFORM V0 OF VERSICAN CORE PROTEIN PRECURSOR (FRAGMENT). [MASS=300008
5	**5**	Rattus norvegicus (Rat) GAMMA-GLUTAMYL HYDROLASE PRECURSOR. [MASS=35830
5	**13**	Rattus norvegicus (Rat) PREDICTED: RETINOL BINDING PROTEIN 4, PLASMA. [MASS=50139
5	**5**	Rattus norvegicus (Rat) PROTEIN KINASE C-BINDING PROTEIN NELL2. [MASS=91334

5	**5**	Rattus norvegicus (Rat) PREDICTED: TYROSINE KINASE RECEPTOR 1. [MASS=125210
5	**5**	Rattus norvegicus (Rat) CHAPERONIN CONTAINING TCP1, SUBUNIT 2. [MASS=57458
5	**5**	Rattus norvegicus (Rat) ALPHA-1-MACROGLOBULIN. [MASS=167125
5	**5**	Rattus norvegicus (Rat) Inter-alpha trypsin inhibitor, heavy chain 3. [MASS=98968
5	**6**	Rattus norvegicus (Rat) SPLICE ISOFORM LONG OF HYALURONAN AND PROTEOGLYCAN LINK PROTEIN 1 PRECURSOR. [MASS=40262
5	**5**	Rattus norvegicus (Rat) PREDICTED: TRIPARTITE MOTIF PROTEIN 28. [MASS=108785
5	**5**	Rattus norvegicus (Rat) STAPHYLOCOCCAL NUCLEASE DOMAIN-CONTAINING PROTEIN 1. [MASS=101952
5	**5**	Rattus norvegicus (Rat) PREDICTED: MINI CHROMOSOME MAINTENANCE DEFICIENT 6. [MASS=92815
5	**5**	Rattus norvegicus (Rat) 170 KDA PROTEIN-Glutamyl-prolyl-tRNA synthetase. [MASS=170088
5	**5**	Rattus norvegicus (Rat) MYOSIN-10. [MASS=228965
5	**5**	Rattus norvegicus (Rat) ALPHA-MANNOSIDASE 2. [MASS=131242
5	**5**	Rattus norvegicus (Rat) PREDICTED: NEURAL PRECURSOR CELL EXPRESSED, DEVELOPMENTALLY DOWN- REGULATED GENE 4A. [MASS=112368
5	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO GCN1 GENERAL CONTROL OF AMINO-ACID SYNTHESIS 1- LIKE 1. [MASS=302942
4	**7**	Rattus norvegicus (Rat) PREDICTED: DYSTROGLYCAN 1. [MASS=96706
4	**5**	Rattus norvegicus (Rat) 14-3-3 PROTEIN ZETA/DELTA. [MASS=27771
4	**4**	Rattus norvegicus (Rat) GLUCOSE PHOSPHATE ISOMERASE. [MASS=62827
4	**5**	Rattus norvegicus (Rat) EPSILON 1 GLOBIN. [MASS=16105
4	**4**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF FIBRINOGEN ALPHA CHAIN PRECURSOR. [MASS=86686
4	**4**	Rattus norvegicus (Rat) PREDICTED: similar to Heterogeneous nuclear ribonucleoproteins A2/B1. [MASS=32468
4	**6**	Rattus norvegicus (Rat) ALPHA-2-GLOBIN CHAIN. [MASS=15285
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RAN BINDING PROTEIN 5. [MASS=99947
4	**4**	Rattus norvegicus (Rat) PEPTIDYL-PROLYL CIS-TRANS ISOMERASE A. [MASS=17743
4	**4**	Rattus norvegicus (Rat) L-LACTATE DEHYDROGENASE A CHAIN. [MASS=36451
4	**8**	Rattus norvegicus (Rat) PREDICTED: similar to Fibulin-1 precursor. [MASS=75381
4	**4**	Rattus norvegicus (Rat) PROTEASOME (PROSOME, MACROPAIN) 26S SUBUNIT, NON-ATPASE, 2. [MASS=100188
4	**4**	Rattus norvegicus (Rat) AFAMIN PRECURSOR. [MASS=69335
4	**5**	Rattus norvegicus (Rat) SPARC-LIKE PROTEIN 1 PRECURSOR. [MASS=70634
4	**10**	Rattus norvegicus (Rat) SERINE PEPTIDASE INHIBITOR, CLADE F, MEMBER 2. [MASS=54893
4	**5**	Rattus norvegicus (Rat) SORTILIN PRECURSOR. [MASS=91169
4	**4**	Rattus norvegicus (Rat) PREDICTED: AMINOPEPTIDASE PUROMYCIN SENSITIVE. [MASS=103344

4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PROTOCADHERIN 1 ISOFORM 2 PRECURSOR. [MASS=138914
4	**4**	Rattus norvegicus (Rat) EXPORTIN-1. [MASS=123335
4	**6**	Rattus norvegicus (Rat) SPLICE ISOFORM HMW OF KININOGEN-1 PRECURSOR. [MASS=70933
4	**7**	Rattus norvegicus (Rat) GLUTATHIONE PEROXIDASE 3 PRECURSOR. [MASS=25393
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PTK7 PROTEIN TYROSINE KINASE 7. [MASS=139818
4	**4**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF SEX HORMONE-BINDING GLOBULIN PRECURSOR. [MASS=44533
4	**6**	Rattus norvegicus (Rat) PEPTIDYLPROLYL ISOMERASE C. [MASS=23009
4	**5**	Rattus norvegicus (Rat) QUIESCIN Q6. [MASS=82412
4	**6**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN D0. [MASS=38192
4	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PHOSPHOLIPID TRANSFER PROTEIN. [MASS=65430
4	**4**	Rattus norvegicus (Rat) HEAT SHOCK PROTEIN HSP 90-BETA. [MASS=83185
4	**6**	Rattus norvegicus (Rat) LOW-DENSITY LIPOPROTEIN RECEPTOR PRECURSOR. [MASS=96622
4	**5**	Rattus norvegicus (Rat) BETA-2-MICROGLOBULIN PRECURSOR. [MASS=13720
4	**5**	Rattus norvegicus (Rat) FETUB PROTEIN. [MASS=43169
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PROTOCADHERIN 18 PRECURSOR. [MASS=123552
4	**5**	Rattus norvegicus (Rat) COMPLEMENT COMPONENT 2. [MASS=83699
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEPATIC MULTIPLE INOSITOL POLYPHOSPHATE PHOSPHATASE. [MASS=54619
4	**4**	Rattus norvegicus (Rat) NESTIN. [MASS=208797
4	**4**	Rattus norvegicus (Rat) SPLICE ISOFORM 2 OF RECEPTOR-TYPE TYROSINE-PROTEIN PHOSPHATASE ZETA PRECURSOR. [MASS=164596
4	**4**	Rattus norvegicus (Rat) CULLIN-ASSOCIATED NEDD8-DISSOCIATED PROTEIN 1. [MASS=136362
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PROTOCADHERIN 19 PRECURSOR. [MASS=125989
4	**9**	Rattus norvegicus (Rat) COLLAGEN ALPHA-1(III) CHAIN PRECURSOR. [MASS=138936
4	**5**	Rattus norvegicus (Rat) EPSILON 3 GLOBIN. [MASS=16540
4	**5**	Rattus norvegicus (Rat) MANNOSE 6-PHOSPHATE/INSULIN-LIKE GROWTH FACTOR II RECEPTOR. [MASS=273608
4	**4**	Rattus norvegicus (Rat) PREDICTED NUCLEOLIN-RELATED PROTEIN NRP. [MASS=57036
4	**4**	Rattus norvegicus (Rat) DYNEIN HEAVY CHAIN, CYTOSOLIC. [MASS=532252
4	**4**	Rattus norvegicus (Rat) PEROXIREDOXIN-1. [MASS=22109
4	**22**	Rattus norvegicus (Rat) EXTRACELLULAR SUPEROXIDE DISMUTASE [CU-ZN] PRECURSOR. [MASS=26620
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO FILAMIN A. [MASS=290169
4	**5**	Rattus norvegicus (Rat) COMPLEMENT INHIBITORY FACTOR H. [MASS=140344
4	**4**	Rattus norvegicus (Rat) PREDICTED: KINESIN FAMILY MEMBER 4. [MASS=139682

4	**4**	Rattus norvegicus (Rat) CELL GROWTH REGULATOR WITH EF HAND DOMAIN 1. [MASS=30835
4	**4**	Rattus norvegicus (Rat) LEUKEMIA INHIBITORY FACTOR RECEPTOR PRECURSOR. [MASS=122394
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PLEXIN-B2 PRECURSOR. [MASS=216119
4	**5**	Rattus norvegicus (Rat) LOW-DENSITY LIPOPROTEIN RECEPTOR-RELATED PROTEIN 2 PRECURSOR. [MASS=519276
4	**4**	Rattus norvegicus (Rat) LEUKOCYTE COMMON ANTIGEN-RELATED PHOSPHATASE PRECURSOR. [MASS=212954
4	**7**	Rattus norvegicus (Rat) PROTOCADHERIN GAMMA SUBFAMILY C, 3. [MASS=101038
4	**4**	Rattus norvegicus (Rat) MYOSIN-9. [MASS=226207
4	**4**	Rattus norvegicus (Rat) 14-3-3 PROTEIN EPSILON. [MASS=29174
4	**4**	Rattus norvegicus (Rat) THROMBOSPONDIN 1. [MASS=129671
4	**7**	Rattus norvegicus (Rat) HISTONE H1.2. [MASS=21856
3	**3**	Rattus norvegicus (Rat) RATSG1. [MASS=49199
3	**3**	Rattus norvegicus (Rat) CC2-27. [MASS=120523
3	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALPHA ENOLASE. [MASS=46489
3	**4**	Rattus norvegicus (Rat) HYRAC. [MASS=31353
3	**5**	Rattus norvegicus (Rat) VITAMIN D-BINDING PROTEIN PRECURSOR. [MASS=53544
3	**5**	Rattus norvegicus (Rat) EUKARYOTIC TRANSLATION INITIATION FACTOR 4A2. [MASS=46489
3	**3**	Rattus norvegicus (Rat) PREDICTED: similar to phosphoribosylformylglycinamidine synthase. [MASS=146178
3	**4**	Rattus norvegicus (Rat) FOLLISTATIN-RELATED PROTEIN 1 PRECURSOR. [MASS=34622
3	**3**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN SA. [MASS=32693
3	**3**	Rattus norvegicus (Rat) 14-3-3 PROTEIN THETA. [MASS=27778
3	**3**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L18. [MASS=21527
3	**4**	Rattus norvegicus (Rat) ADENOSYLHOMOCYSTEINASE. [MASS=47407
3	**3**	Rattus norvegicus (Rat) SPARC PRECURSOR. [MASS=34384
3	**3**	Rattus norvegicus (Rat) PROCOLLAGEN-LYSINE,2-OXOGLUTARATE 5-DIOXYGENASE 3 PRECURSOR. [MASS=85060
3	**3**	Rattus norvegicus (Rat) PREDICTED similar to C-1-TETRAHYDROFOLATE SYNTHASE, CYTOPLASMIC. [MASS=100351
3	**3**	Rattus norvegicus (Rat) M-CADHERIN. [MASS=85753
3	**11**	Rattus norvegicus (Rat) RIBOSOMAL PROTEIN S27A. [MASS=17951
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALPHA NAC/1.9.2. PROTEIN. [MASS=23384
3	**5**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF ALPHA-1B-GLYCOPROTEIN PRECURSOR. [MASS=56479
3	**3**	Rattus norvegicus (Rat) SUPEROXIDE DISMUTASE. [MASS=15780
3	**4**	Rattus norvegicus (Rat) EUKARYOTIC TRANSLATION INITIATION FACTOR 4A, ISOFORM 1. [MASS=46154
3	**5**	Rattus norvegicus (Rat) COLLAGEN ALPHA-1(V) CHAIN PRECURSOR. [MASS=184610
3	**3**	Rattus norvegicus (Rat) NONO/P54NRB HOMOLOG. [MASS=75487
3	**3**	Rattus norvegicus (Rat) PREDICTED: CALSYNTENIN 1. [MASS=109351
3	**3**	Rattus norvegicus (Rat) RUVB-LIKE 1. [MASS=50214

3	**4**	Rattus norvegicus (Rat) PREDICTED similar to POSTSYNAPTIC DENSITY PROTEIN. [MASS=186848
3	**3**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L4. [MASS=47126
3	**3**	Rattus norvegicus (Rat) PROTEIN DISULFIDE-ISOMERASE PRECURSOR. [MASS=56951
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO LAMININ-2 ALPHA2 CHAIN PRECURSOR. [MASS=359007
3	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO INTER-ALPHA-INHIBITOR H2 CHAIN. [MASS=105715
3	**3**	Rattus norvegicus (Rat) SHEN-DAN. [MASS=131080
3	**3**	Rattus norvegicus (Rat) FAR UPSTREAM ELEMENT-BINDING PROTEIN 2. [MASS=74226
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO IMPORTIN 9. [MASS=131739
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO VINCULIN. [MASS=116615
3	**4**	Rattus norvegicus (Rat) PREDICTED similar to Nuclear autoantigenic sperm protein. [MASS=45764
3	**3**	Rattus norvegicus (Rat) FAM3C-LIKE PROTEIN. [MASS=24714
3	**3**	Rattus norvegicus (Rat) D-3-PHOSPHOGLYCERATE DEHYDROGENASE. [MASS=56362
3	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO COLLAGEN ALPHA 2(IV) CHAIN PRECURSOR - MOUSE. [MASS=192535
3	**4**	Rattus norvegicus (Rat) PROLIFERATION-ASSOCIATED 2G4, 38KDA. [MASS=43657
3	**6**	Rattus norvegicus (Rat) 14-3-3 PROTEIN GAMMA. [MASS=28171
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RAS GTPASE-ACTIVATING-LIKE PROTEIN IQGAP1. [MASS=196522
3	**3**	Rattus norvegicus (Rat) PROTOCADHERIN. [MASS=505997
3	**3**	Rattus norvegicus (Rat) CHAPERONIN SUBUNIT 6A. [MASS=58017
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO EUKARYOTIC TRANSLATION INITIATION FACTOR 3, SUBUNIT 10 THETA, 150/170KDA. [MASS=192616
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO VERY LARGE G PROTEIN-COUPLED RECEPTOR 1. [MASS=413840
3	**3**	Rattus norvegicus (Rat) CADHERIN EGF LAG SEVEN-PASS G-TYPE RECEPTOR 2. [MASS=317122
3	**4**	Rattus norvegicus (Rat) STATHMIN. [MASS=17157
3	**3**	Rattus norvegicus (Rat) GTP-BINDING NUCLEAR PROTEIN RAN, TESTIS-SPECIFIC ISOFORM. [MASS=24451
3	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ISOLEUCINE-TRNA SYNTHETASE. [MASS=144169
3	**3**	Rattus norvegicus (Rat) HISTONE H1.0. [MASS=20754
2	**2**	Rattus norvegicus (Rat) COFILIN-1. [MASS=24588
2	**4**	Rattus norvegicus (Rat) ALPHA-2-HS-GLYCOPROTEIN PRECURSOR. [MASS=37982
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO LERK-5. [MASS=37282
2	**3**	Rattus norvegicus (Rat) L-LACTATE DEHYDROGENASE B CHAIN. [MASS=36481
2	**2**	Rattus norvegicus (Rat) PREDICTED: PROTOCADHERIN 12. [MASS=127964
2	**2**	Rattus norvegicus (Rat) PREDICTED: ATPASE, H+ TRANSPORTING, LYSOSOMAL ACCESSORY PROTEIN 2. [MASS=66094

2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEAT SHOCK PROTEIN HSP 90-BETA. [MASS=80701
2	2	Rattus norvegicus (Rat) IGH-1A PROTEIN. [MASS=51403
2	2	Rattus norvegicus (Rat) FIBRILLIN-2. [MASS=313374
2	2	Rattus norvegicus (Rat) NUCLEOSOME ASSEMBLY PROTEIN 1-LIKE 1. [MASS=45373
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO UBIQUITIN-CONJUGATING ENZYME E2 L3. [MASS=17862
2	2	Rattus norvegicus (Rat) FRUCTOSE-BISPHOSPHATE ALDOLASE A. [MASS=39221
2	2	Rattus norvegicus (Rat) APOLIPOPROTEIN M PRECURSOR. [MASS=21513
2	2	Rattus norvegicus (Rat) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN C. [MASS=34385
2	2	Rattus norvegicus (Rat) IG KAPPA CHAIN C REGION, B ALLELE. [MASS=11601
2	4	Rattus norvegicus (Rat) PYRUVATE KINASE, MUSCLE. [MASS=57976
2	2	Rattus norvegicus (Rat) NUCLEOSIDE DIPHOSPHATE KINASE A. [MASS=17193
2	2	Rattus norvegicus (Rat) TUBULIN, BETA, 2. [MASS=49801
2	2	Rattus norvegicus (Rat) PREDICTED: GLYCOPROTEIN-4-BETA-GALACTOSYLTRANSFERASE 2. [MASS=44484
2	2	Rattus norvegicus (Rat) ALPHA-1-ACID GLYCOPROTEIN PRECURSOR. [MASS=23575
2	2	Rattus norvegicus (Rat) BETA-1,3-N-ACETYLGLUCOSAMINYLTRANSFERASE LUNATIC FRINGE. [MASS=41958
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ELASTIN MICROFIBRIL INTERFACER 1. [MASS=107560
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN A2/B1. [MASS=38284
2	2	Rattus norvegicus (Rat) TPA: proteasome subunit beta type 6-like. [MASS=25304
2	2	Rattus norvegicus (Rat) BETA-2-GLYCOPROTEIN 1 PRECURSOR. [MASS=33197
2	2	Rattus norvegicus (Rat) GRP78 BINDING PROTEIN. [MASS=110574
2	2	Rattus norvegicus (Rat) HAPTOGLOBIN PRECURSOR. [MASS=38549
2	3	Rattus norvegicus (Rat) PREDICTED: similar to alpha 1 type II collagen. [MASS=138706
2	2	Rattus norvegicus (Rat) COLLAGEN TYPE A1(XI)7-8. [MASS=45691
2	2	Rattus norvegicus (Rat) PROPROTEIN CONVERTASE SUBTILISIN/KEXIN TYPE 9 PRECURSOR. [MASS=74709
2	2	Rattus norvegicus (Rat) NUCLEIC ACID BINDING FACTOR PRM10. [MASS=33815
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALPHA 3 TYPE VI COLLAGEN ISOFORM 1 PRECURSOR. [MASS=369017
2	2	Rattus norvegicus (Rat) MANNOSIDASE 2, ALPHA B1. [MASS=114327
2	3	Rattus norvegicus (Rat) METALLOPROTEINASE INHIBITOR 1 PRECURSOR. [MASS=23794
2	2	Rattus norvegicus (Rat) CHAPERONIN CONTAINING TCP1, SUBUNIT 5. [MASS=59537
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO VESICULAR INTEGRAL-MEMBRANE PROTEIN VIP36 PRECURSOR. [MASS=40393
2	2	Rattus norvegicus (Rat) IRON-RESPONSIVE ELEMENT-BINDING PROTEIN 1. [MASS=98128

2	2	Rattus norvegicus (Rat) RIBONUCLEOTIDE REDUCTASE M1. [MASS=90293
2	2	Rattus norvegicus (Rat) 60S ACIDIC RIBOSOMAL PROTEIN P0. [MASS=34215
2	4	Rattus norvegicus (Rat) AMBP PROTEIN PRECURSOR. [MASS=38851
2	2	Rattus norvegicus (Rat) SYNTENIN-1. [MASS=32423
2	3	Rattus norvegicus (Rat) RECEPTOR-LIKE PROTEIN TYROSINE PHOSPHATASE KAPPA EXTRACELLULAR REGION. [MASS=56159
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEMICENTIN 1. [MASS=639647
2	3	Rattus norvegicus (Rat) EPITHELIAL-CADHERIN PRECURSOR. [MASS=98715
2	2	Rattus norvegicus (Rat) VASCULAR CELL ADHESION PROTEIN 1 PRECURSOR. [MASS=81246
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CG1841-PA, ISOFORM A. [MASS=52522
2	2	Rattus norvegicus (Rat) CLUSTERIN PRECURSOR. [MASS=51375
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 40S RIBOSOMAL PROTEIN S3. [MASS=26630
2	2	Rattus norvegicus (Rat) PREDICTED similar to HEAT SHOCK PROTEIN HSP 90-BETA. [MASS=50669
2	2	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L13. [MASS=24178
2	2	Rattus norvegicus (Rat) ARCADLIN. [MASS=103800
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CELLULAR APOPTOSIS SUSCEPTIBILITY PROTEIN. [MASS=110214
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SEMAPHORIN 6D-4. [MASS=159473
2	2	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L3. [MASS=46005
2	2	Rattus norvegicus (Rat) TENASCIN (FRAGMENT). [MASS=67815
2	2	Rattus norvegicus (Rat) HEAT SHOCK 70 KDA PROTEIN 1A/1B. [MASS=70185
2	2	Rattus norvegicus (Rat) PREDICTED: similar to Slit-like 2. [MASS=72321
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO POLY(RC)-BINDING PROTEIN 1. [MASS=37498
2	2	Rattus norvegicus (Rat) C-REACTIVE PROTEIN PRECURSOR. [MASS=25468
2	3	Rattus norvegicus (Rat) PREDICTED similar to FIBRINOGEN, GAMMA POLYPEPTIDE. [MASS=49121
2	2	Rattus norvegicus (Rat) NEUROSERPIN PRECURSOR. [MASS=46278
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PUTATIVE PRE-MRNA SPLICING FACTOR RNA HELICASE. [MASS=90977
2	3	Rattus norvegicus (Rat) SERINE (OR CYSTEINE) PROTEINASE INHIBITOR, CLADE A (ALPHA-1 ANTIPROTEINASE, ANTITRYPSIN), MEMBER 6. [MASS=44671
2	3	Rattus norvegicus (Rat) HEMOPEXIN PRECURSOR. [MASS=51291
2	2	Rattus norvegicus (Rat) PREDICTED: BRAIN GLYCOGEN PHOSPHORYLASE. [MASS=96738
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 40S RIBOSOMAL PROTEIN S9. [MASS=22648
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 60S RIBOSOMAL PROTEIN L12. [MASS=17847
2	2	Rattus norvegicus (Rat) SEZ6B. [MASS=105607
2	2	Rattus norvegicus (Rat) SEMA4B PROTEIN (FRAGMENT). [MASS=79477
2	2	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF NEUROFASCIN PRECURSOR. [MASS=138004

2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO COLLAGEN ALPHA1 TYPE VI-PRECURSOR. [MASS=130760
2	**2**	Rattus norvegicus (Rat) 60S ACIDIC RIBOSOMAL PROTEIN P2. [MASS=11692
2	**5**	Rattus norvegicus (Rat) DERMCIDIN. [MASS=11284
2	**2**	Rattus norvegicus (Rat) EPSILON 2 GLOBIN. [MASS=16388
2	**2**	Rattus norvegicus (Rat) TUBULIN BETA CHAIN. [MASS=49963
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SERINE PROTEASE INHIBITOR 2.4. [MASS=46841
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO COATOMER PROTEIN COMPLEX SUBUNIT ALPHA. [MASS=138360
2	**2**	Rattus norvegicus (Rat) PREDICTED: similar to Periostin precursor (PN) (Osteoblast-specific factor 2) (OSF-2). [MASS=90252
2	**2**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF MYOSIN-11 (FRAGMENT). [MASS=152492
2	**2**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S10. [MASS=18916
2	**3**	Rattus norvegicus (Rat) HISTIDINE-RICH GLYCOPROTEIN. [MASS=57581
2	**3**	Rattus norvegicus (Rat) RAB GDP DISSOCIATION INHIBITOR BETA. [MASS=50685
2	**2**	Rattus norvegicus (Rat) LIVER CARBOXYLESTERASE 1 PRECURSOR. [MASS=60175
2	**2**	Rattus norvegicus (Rat) PREDICTED: TUMOR REJECTION ANTIGEN GP96. [MASS=92771
2	**2**	Rattus norvegicus (Rat) LOC362795 PROTEIN. [MASS=52392
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO UBIQUITIN CARBOXYL-TERMINAL HYDROLASE 5. [MASS=95779
2	**2**	Rattus norvegicus (Rat) INOSINE MONOPHOSPHATE DEHYDROGENASE 2. [MASS=55799
2	**2**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN RGD1305890. [MASS=31776
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO BETA-GALACTOSIDASE PRECURSOR. [MASS=73228
2	**2**	Rattus norvegicus (Rat) MICROFIBRILLAR-ASSOCIATED PROTEIN 4. [MASS=29050
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO LAMININ ALPHA-1 CHAIN PRECURSOR - MOUSE. [MASS=338692
2	**2**	Rattus norvegicus (Rat) SPLICEOSOME RNA HELICASE BAT1. [MASS=49035
2	**2**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L24. [MASS=17779
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO STABILIN-1. [MASS=288663
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 26S PROTEASOME NON-ATPASE REGULATORY SUBUNIT 11. [MASS=54019
2	**2**	Rattus norvegicus (Rat) PREDICTED: similar to 60S ribosomal protein L29. [MASS=16961

Table 1.6. Protein matches E14.5 4thV

Unique peptides	Total peptides	Protein matches E14.5 4thV
120	**617**	Rattus norvegicus (Rat) AA1064-apolipoprotein B. [MASS=536024
66	**382**	Rattus norvegicus (Rat) Apolipoprotein B - fragment. [MASS=165356
37	**135**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF FIBRONECTIN PRECURSOR. [MASS=272511
34	**365**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF ALPHA-FETOPROTEIN PRECURSOR. [MASS=68386
31	**120**	Rattus norvegicus (Rat) APOLIPOPROTEIN A-IV PRECURSOR. [MASS=44456
28	**53**	Rattus norvegicus (Rat) ALPHA-2-MACROGLOBULIN PRECURSOR. [MASS=163701
21	**26**	Rattus norvegicus (Rat) GPI-ANCHORED CERULOPLASMIN. [MASS=123749
21	**35**	Rattus norvegicus (Rat) ALPHA-1-INHIBITOR 3 PRECURSOR. [MASS=163773
20	**96**	Rattus norvegicus (Rat) BA1-667 - Transferrin. [MASS=107448
19	**30**	Rattus norvegicus (Rat) CONTACTIN-2 PRECURSOR. [MASS=113043
18	**79**	Rattus norvegicus (Rat) APOLIPOPROTEIN A-I PRECURSOR. [MASS=30088
18	**97**	Rattus norvegicus (Rat) SERUM ALBUMIN PRECURSOR. [MASS=68719
18	**33**	Rattus norvegicus (Rat) PREDICTED: NIDOGEN. [MASS=138365
15	**34**	Rattus norvegicus (Rat) ALPHA-1-ANTIPROTEINASE PRECURSOR. [MASS=46136
15	**17**	Rattus norvegicus (Rat) DA1-24-Complement Factor B. [MASS=124379
14	**23**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CADHERIN-5. [MASS=135230
13	**20**	Rattus norvegicus (Rat) ALPHA-2 ANTIPLASMIN. [MASS=46465
13	**18**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF AGRIN PRECURSOR. [MASS=208646
13	**25**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEPARAN SULFATE PROTEOGLYCAN 2. [MASS=377284
13	**19**	Rattus norvegicus (Rat) INTER-ALPHA-INHIBITOR H4 HEAVY CHAIN. [MASS=103755
12	**14**	Rattus norvegicus (Rat) GELSOLIN. [MASS=86286
12	**15**	Rattus norvegicus (Rat) SERINE/CYSTEINE PROTEINASE INHIBITOR, CLADE C, MEMBER 1. [MASS=52234
12	**22**	Rattus norvegicus (Rat) COMPLEMENT C3 PRECURSOR. [MASS=186460
12	**24**	Rattus norvegicus (Rat) APOLIPOPROTEIN E PRECURSOR. [MASS=35753
11	**14**	Rattus norvegicus (Rat) LAR RECEPTOR-LINKED TYROSINE PHOSPHATASE. [MASS=181130
11	**12**	Rattus norvegicus (Rat) DELETED IN COLORECTAL CANCER. [MASS=158142
11	**12**	Rattus norvegicus (Rat) SERINE PEPTIDASE INHIBITOR, CLADE G, MEMBER 1. [MASS=55611
11	**17**	Rattus norvegicus (Rat) CORTICOSTEROID-BINDING GLOBULIN PRECURSOR. [MASS=44672
11	**12**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO LAMININ B1. [MASS=228429
11	**11**	Rattus norvegicus (Rat) ELONGATION FACTOR 2. [MASS=95153

11	**14**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF FIBRINOGEN ALPHA CHAIN PRECURSOR. [MASS=86686
11	**16**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALPHA 3 TYPE VI COLLAGEN ISOFORM 1 PRECURSOR. [MASS=369017
10	**21**	Rattus norvegicus (Rat) NEURAL-CADHERIN PRECURSOR. [MASS=99686
10	**14**	Rattus norvegicus (Rat) PREDICTED: LAMININ, GAMMA 1. [MASS=177387
10	**22**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO FIBULIN-1 PRECURSOR. [MASS=78072
10	**11**	Rattus norvegicus (Rat) ECTONUCLEOTIDE PYROPHOSPHATASE/PHOSPHODIESTERASE 2. [MASS=101310
10	**21**	Rattus norvegicus (Rat) COLLAGEN ALPHA-1(I) CHAIN PRECURSOR. [MASS=137886
10	**21**	Rattus norvegicus (Rat) LUMICAN PRECURSOR. [MASS=38279
9	**51**	Rattus norvegicus (Rat) TRANSTHYRETIN PRECURSOR. [MASS=15720
9	**13**	Rattus norvegicus (Rat) CATHEPSIN B PRECURSOR. [MASS=37470
9	**10**	Rattus norvegicus (Rat) FIBRINOGEN BETA CHAIN PRECURSOR. [MASS=54303
9	**13**	Rattus norvegicus (Rat) RAT ALPHA(1)-INHIBITOR 3, VARIANT I PRECURSOR. [MASS=165326
9	**11**	Rattus norvegicus (Rat) PREDICTED: VON WILLEBRAND FACTOR. [MASS=308474
9	**18**	Rattus norvegicus (Rat) LOC367586 PROTEIN-Immunoglobulin Gamma heavy Chain. [MASS=50949
9	**11**	Rattus norvegicus (Rat) SPLICE ISOFORM LONG OF HYALURONAN AND PROTEOGLYCAN LINK PROTEIN 1 PRECURSOR. [MASS=40262
8	**10**	Rattus norvegicus (Rat) HEAT SHOCK PROTEIN 86. [MASS=84815
8	**8**	Rattus norvegicus (Rat) HEPHAESTIN PRECURSOR. [MASS=129593
8	**13**	Rattus norvegicus (Rat) COLLAGEN ALPHA-1(III) CHAIN PRECURSOR. [MASS=138936
8	**9**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF REELIN PRECURSOR. [MASS=387531
8	**20**	Rattus norvegicus (Rat) PLASMINOGEN PRECURSOR. [MASS=90536
8	**12**	Rattus norvegicus (Rat) EPSILON 1 GLOBIN. [MASS=16105
8	**13**	Rattus norvegicus (Rat) SPLICE ISOFORM HMW OF KININOGEN-1 PRECURSOR. [MASS=70933
8	**19**	Rattus norvegicus (Rat) SPLICE ISOFORM GAMMA-B OF FIBRINOGEN GAMMA CHAIN PRECURSOR. [MASS=50633
8	**9**	Rattus norvegicus (Rat) CADHERIN-6 PRECURSOR. [MASS=88341
7	**9**	Rattus norvegicus (Rat) TUBULIN BETA-5 CHAIN. [MASS=49671
7	**8**	Rattus norvegicus (Rat) ANGIOTENSINOGEN PRECURSOR. [MASS=51982
7	**8**	Rattus norvegicus (Rat) SPARC-LIKE PROTEIN 1 PRECURSOR. [MASS=70634
7	**7**	Rattus norvegicus (Rat) Neogenin precursor. [MASS=156144
7	**16**	Rattus norvegicus (Rat) CONTRAPSIN-LIKE PROTEASE INHIBITOR 3 PRECURSOR. [MASS=46277
7	**9**	Rattus norvegicus (Rat) ACTIN, ALPHA SKELETAL MUSCLE. [MASS=42051
7	**9**	Rattus norvegicus (Rat) ELONGATION FACTOR 1-ALPHA 1. [MASS=50114
7	**7**	Rattus norvegicus (Rat) TRANSITIONAL ENDOPLASMIC RETICULUM ATPASE. [MASS=89534
7	**11**	Rattus norvegicus (Rat) COLLAGEN ALPHA-2(I) CHAIN PRECURSOR. [MASS=129564
7	**7**	Rattus norvegicus (Rat) ALPHA-MANNOSIDASE 2. [MASS=131242

7	**9**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF ATTRACTIN PRECURSOR. [MASS=163296
6	**9**	Rattus norvegicus (Rat) TUBULIN ALPHA-1 CHAIN. [MASS=50136
6	**6**	Rattus norvegicus (Rat) CONTRAPSIN-LIKE PROTEASE INHIBITOR 6 PRECURSOR. [MASS=46652
6	**8**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF NEURONAL CELL ADHESION MOLECULE PRECURSOR. [MASS=133912
6	**7**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIKEN CDNA B430218L07 GENE. [MASS=143906
6	**6**	Rattus norvegicus (Rat) PREDICTED: TRANSFORMING GROWTH FACTOR, BETA INDUCED, 68 KDA. [MASS=74369
6	**8**	Rattus norvegicus (Rat) ALPHA-2-GLOBIN CHAIN. [MASS=15285
6	**6**	Rattus norvegicus (Rat) ARCADLIN. [MASS=103800
6	**9**	Rattus norvegicus (Rat) TENASCIN (FRAGMENT). [MASS=62473
6	**12**	Rattus norvegicus (Rat) PREDICTED: RETINOL BINDING PROTEIN 4, PLASMA. [MASS=50139
6	**10**	Rattus norvegicus (Rat) PREDICTED: CALSYNTENIN 1. [MASS=109351
6	**7**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF ALPHA-1B-GLYCOPROTEIN PRECURSOR. [MASS=56479
6	**8**	Rattus norvegicus (Rat) PREDICTED: NIDOGEN 2. [MASS=173960
6	**7**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PYRUVATE KINASE (EC 2.7.1.40) ISOZYME M2 - RAT. [MASS=57731
6	**7**	Rattus norvegicus (Rat) RAT T-KININOGEN. [MASS=47618
6	**10**	Rattus norvegicus (Rat) PREDICTED: CADHERIN 11. [MASS=88036
6	**6**	Rattus norvegicus (Rat) PREDICTED: TUMOR REJECTION ANTIGEN GP96. [MASS=92771
6	**8**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO STABILIN-1. [MASS=288663
6	**7**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEMICENTIN 1. [MASS=639647
6	**7**	Rattus norvegicus (Rat) COMPLEMENT COMPONENT 2. [MASS=83699
6	**9**	Rattus norvegicus (Rat) FETUB PROTEIN. [MASS=43169
5	**6**	Rattus norvegicus (Rat) PROFILIN-1. [MASS=14826
5	**9**	Rattus norvegicus (Rat) CONTRAPSIN-LIKE PROTEASE INHIBITOR 1 PRECURSOR. [MASS=46562
5	**5**	Rattus norvegicus (Rat) PROPROTEIN CONVERTASE SUBTILISIN/KEXIN TYPE 9 PRECURSOR. [MASS=74709
5	**5**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN LOC314432-Similar to ubiquitin-protein ligase (EC 6.3.2.19) E1. [MASS=117788
5	**12**	Rattus norvegicus (Rat) SERINE PEPTIDASE INHIBITOR, CLADE F, MEMBER 2. [MASS=54893
5	**8**	Rattus norvegicus (Rat) COLLAGEN ALPHA-1(V) CHAIN PRECURSOR. [MASS=184610
5	**5**	Rattus norvegicus (Rat) COMPLEMENT C4 PRECURSOR. [MASS=192163
5	**7**	Rattus norvegicus (Rat) GLUTATHIONE PEROXIDASE 3 PRECURSOR. [MASS=25393
5	**8**	Rattus norvegicus (Rat) FIBRILLIN-2. [MASS=313374
5	**6**	Rattus norvegicus (Rat) SPLICE ISOFORM APP770 OF AMYLOID BETA A4 PROTEIN PRECURSOR (FRAGMENT). [MASS=86704
5	**7**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN RGD1305887-TUBULIN BETA CHAIN. [MASS=50059
5	**6**	Rattus norvegicus (Rat) QUIESCIN Q6. [MASS=82412

5	**5**	Rattus norvegicus (Rat) Inter-alpha trypsin inhibitor, heavy chain 3. [MASS=98968
5	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PHOSPHOLIPID TRANSFER PROTEIN. [MASS=65430
5	**7**	Rattus norvegicus (Rat) PREDICTED: HYPOTHETICAL PROTEIN XP_344107. [MASS=189275
5	**5**	Rattus norvegicus (Rat) ALPHA-1-MACROGLOBULIN. [MASS=167125
5	**5**	Rattus norvegicus (Rat) PREDICTED: TYROSINE KINASE RECEPTOR 1. [MASS=125210
5	**26**	Rattus norvegicus (Rat) EXTRACELLULAR SUPEROXIDE DISMUTASE [CU-ZN] PRECURSOR. [MASS=26620
5	**11**	Rattus norvegicus (Rat) PEPTIDYLPROLYL ISOMERASE C. [MASS=23009
5	**6**	Rattus norvegicus (Rat) PROTEIN KINASE C-BINDING PROTEIN NELL2. [MASS=91334
4	**7**	Rattus norvegicus (Rat) PREDICTED: DYSTROGLYCAN 1. [MASS=96706
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEPATIC MULTIPLE INOSITOL POLYPHOSPHATE PHOSPHATASE. [MASS=54619
4	**4**	Rattus norvegicus (Rat) PROMININ-1S1 SPLICE VARIANT. [MASS=96632
4	**5**	Rattus norvegicus (Rat) EPSILON 3 GLOBIN. [MASS=16540
4	**9**	Rattus norvegicus (Rat) CYSTATIN C PRECURSOR. [MASS=15437
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PTK7 PROTEIN TYROSINE KINASE 7. [MASS=139818
4	**5**	Rattus norvegicus (Rat) GRP78 BINDING PROTEIN. [MASS=110574
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PROTOCADHERIN 18 PRECURSOR. [MASS=123552
4	**4**	Rattus norvegicus (Rat) M-CADHERIN. [MASS=85753
4	**16**	Rattus norvegicus (Rat) PREDICTED: similar to Fibulin-1 precursor. [MASS=75381
4	**4**	Rattus norvegicus (Rat) AFAMIN PRECURSOR. [MASS=69335
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SEMA6A PROTEIN. [MASS=114583
4	**7**	Rattus norvegicus (Rat) SPLICE ISOFORM V0 OF VERSICAN CORE PROTEIN PRECURSOR (FRAGMENT). [MASS=300008
4	**5**	Rattus norvegicus (Rat) PROTOCADHERIN GAMMA SUBFAMILY C, 3. [MASS=101038
4	**4**	Rattus norvegicus (Rat) SORTILIN PRECURSOR. [MASS=91169
4	**4**	Rattus norvegicus (Rat) ISCHEMIA RESPONSIVE 94 KDA PROTEIN. [MASS=94057
4	**4**	Rattus norvegicus (Rat) MANNOSE 6-PHOSPHATE/INSULIN-LIKE GROWTH FACTOR II RECEPTOR. [MASS=273608
4	**4**	Rattus norvegicus (Rat) PROCOLLAGEN-LYSINE,2-OXOGLUTARATE 5-DIOXYGENASE 3 PRECURSOR. [MASS=85060
4	**5**	Rattus norvegicus (Rat) COMPLEMENT INHIBITORY FACTOR H. [MASS=140344
4	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO LAMININ-2 ALPHA2 CHAIN PRECURSOR. [MASS=359007
4	**6**	Rattus norvegicus (Rat) TENASCIN (FRAGMENT). [MASS=67815
4	**6**	Rattus norvegicus (Rat) FIBULIN-2 ISOFORM A. [MASS=126193
4	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO COLLAGEN ALPHA1 TYPE VI-PRECURSOR. [MASS=130760
4	**5**	Rattus norvegicus (Rat) PROTHROMBIN PRECURSOR (FRAGMENT). [MASS=70412
4	**5**	Rattus norvegicus (Rat) TRANSCOBALAMIN-2 PRECURSOR. [MASS=47420

4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO VINCULIN. [MASS=116615
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PLEXIN-B2 PRECURSOR. [MASS=216119
3	**3**	Rattus norvegicus (Rat) 14-3-3 PROTEIN ZETA/DELTA. [MASS=27771
3	**3**	Rattus norvegicus (Rat) COLLAGEN TYPE A1(XI)7-8. [MASS=45691
3	**3**	Rattus norvegicus (Rat) PROTECTIVE PROTEIN FOR BETA-GALACTOSIDASE. [MASS=51216
3	**4**	Rattus norvegicus (Rat) CREATINE KINASE B-TYPE. [MASS=42712
3	**3**	Rattus norvegicus (Rat) PEROXIREDOXIN-2. [MASS=21652
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PROTOCADHERIN 1 ISOFORM 2 PRECURSOR. [MASS=138914
3	**3**	Rattus norvegicus (Rat) GAMMA-GLUTAMYL HYDROLASE PRECURSOR. [MASS=35830
3	**3**	Rattus norvegicus (Rat) PREDICTED: similar to Slit-like 2. [MASS=72321
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CRB2 PROTEIN. [MASS=138781
3	**4**	Rattus norvegicus (Rat) ACTIN, CYTOPLASMIC 1. [MASS=41737
3	**4**	Rattus norvegicus (Rat) LOW-DENSITY LIPOPROTEIN RECEPTOR PRECURSOR. [MASS=96622
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO LERK-5. [MASS=37282
3	**4**	Rattus norvegicus (Rat) HEPATOCYTE GROWTH FACTOR ACTIVATOR. [MASS=70737
3	**3**	Rattus norvegicus (Rat) MANNOSIDASE 2, ALPHA B1. [MASS=114327
3	**3**	Rattus norvegicus (Rat) NEUROPILIN-2 PRECURSOR. [MASS=104473
3	**3**	Rattus norvegicus (Rat) PROCOLLAGEN C-ENDOPEPTIDASE ENHANCER 1 PRECURSOR. [MASS=50185
3	**3**	Rattus norvegicus (Rat) FATTY ACID SYNTHASE. [MASS=272650
3	**4**	Rattus norvegicus (Rat) PEPTIDYL-PROLYL CIS-TRANS ISOMERASE A. [MASS=17743
3	**3**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF SEX HORMONE-BINDING GLOBULIN PRECURSOR. [MASS=44533
3	**4**	Rattus norvegicus (Rat) CELL GROWTH REGULATOR WITH EF HAND DOMAIN 1. [MASS=30835
3	**3**	Rattus norvegicus (Rat) ROUNDABOUT HOMOLOG 1 PRECURSOR. [MASS=180748
3	**4**	Rattus norvegicus (Rat) BETA-2-MICROGLOBULIN PRECURSOR. [MASS=13720
3	**6**	Rattus norvegicus (Rat) FOLLISTATIN-RELATED PROTEIN 1 PRECURSOR. [MASS=34622
3	**3**	Rattus norvegicus (Rat) CLUSTERIN PRECURSOR. [MASS=51375
3	**3**	Rattus norvegicus (Rat) PROTEIN DISULFIDE-ISOMERASE PRECURSOR. [MASS=56951
3	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO INTER-ALPHA-INHIBITOR H2 CHAIN. [MASS=105715
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ELASTIN MICROFIBRIL INTERFACER 1. [MASS=107560
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALPHA 2 TYPE VI COLLAGEN ISOFORM 2C2A PRECURSOR. [MASS=98272
3	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO COLLAGEN ALPHA 2(IV) CHAIN PRECURSOR - MOUSE. [MASS=192535
3	**3**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF NEUROFASCIN PRECURSOR. [MASS=138004

3	**3**	Rattus norvegicus (Rat) SERINE (OR CYSTEINE) PROTEINASE INHIBITOR, CLADE A (ALPHA-1 ANTIPROTEINASE, ANTITRYPSIN), MEMBER 6. [MASS=44671
3	**6**	Rattus norvegicus (Rat) SP120-Heterogeneous nuclear ribonucleoprotein U. [MASS=87748
3	**6**	Rattus norvegicus (Rat) RIBOSOMAL PROTEIN S27A. [MASS=17951
3	**4**	Rattus norvegicus (Rat) SPLICE ISOFORM 2 OF RECEPTOR-TYPE TYROSINE-PROTEIN PHOSPHATASE ZETA PRECURSOR. [MASS=164596
3	**3**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L13. [MASS=24178
3	**3**	Rattus norvegicus (Rat) PREDICTED: COMPLEMENT COMPONENT 7. [MASS=90661
3	**3**	Rattus norvegicus (Rat) VIMENTIN. [MASS=53602
3	**3**	Rattus norvegicus (Rat) LEUKOCYTE COMMON ANTIGEN-RELATED PHOSPHATASE PRECURSOR. [MASS=207012
3	**3**	Rattus norvegicus (Rat) NEUROSERPIN PRECURSOR. [MASS=46278
3	**4**	Rattus norvegicus (Rat) NEUROCAN CORE PROTEIN PRECURSOR. [MASS=135545
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO AMYLOID BETA (A4) PRECURSOR-LIKE PROTEIN 1. [MASS=68777
3	**3**	Rattus norvegicus (Rat) HEPARIN COFACTOR 2 PRECURSOR. [MASS=54552
3	**3**	Rattus norvegicus (Rat) NETRIN RECEPTOR UNC5C PRECURSOR. [MASS=103135
3	**3**	Rattus norvegicus (Rat) CULLIN-ASSOCIATED NEDD8-DISSOCIATED PROTEIN 1. [MASS=136362
3	**3**	Rattus norvegicus (Rat) LEUKEMIA INHIBITORY FACTOR RECEPTOR PRECURSOR. [MASS=122394
3	**3**	Rattus norvegicus (Rat) CLATHRIN HEAVY CHAIN. [MASS=191599
3	**3**	Rattus norvegicus (Rat) FAM3C-LIKE PROTEIN. [MASS=24714
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO LAMININ ALPHA-1 CHAIN PRECURSOR - MOUSE. [MASS=338692
3	**3**	Rattus norvegicus (Rat) THROMBOSPONDIN 1. [MASS=129671
2	**2**	Rattus norvegicus (Rat) MANNOSIDASE, ALPHA, CLASS 1A, MEMBER 1. [MASS=73125
2	**3**	Rattus norvegicus (Rat) HYRAC. [MASS=31353
2	**2**	Rattus norvegicus (Rat) SEZ6B. [MASS=105607
2	**3**	Rattus norvegicus (Rat) IG KAPPA CHAIN C REGION, B ALLELE. [MASS=11601
2	**2**	Rattus norvegicus (Rat) EUKARYOTIC TRANSLATION INITIATION FACTOR 4A2. [MASS=46489
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CG1841-PA, ISOFORM A. [MASS=52522
2	**2**	Rattus norvegicus (Rat) ALPHA-2-HS-GLYCOPROTEIN PRECURSOR. [MASS=37982
2	**3**	Rattus norvegicus (Rat) VITAMIN D-BINDING PROTEIN PRECURSOR. [MASS=53544
2	**2**	Rattus norvegicus (Rat) VACUOLAR ATP SYNTHASE SUBUNIT S1 PRECURSOR. [MASS=51123
2	**2**	Rattus norvegicus (Rat) PREDICTED: ATPASE, H+ TRANSPORTING, LYSOSOMAL ACCESSORY PROTEIN 2. [MASS=66094
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PROCOLLAGEN, TYPE IX, ALPHA 2. [MASS=71422
2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALPHA ENOLASE. [MASS=46489

2	**3**	Rattus norvegicus (Rat) SOLUBLE CALCIUM-ACTIVATED NUCLEOTIDASE 1. [MASS=45659
2	**2**	Rattus norvegicus (Rat) VASCULAR CELL ADHESION PROTEIN 1 PRECURSOR. [MASS=81246
2	**2**	Rattus norvegicus (Rat) PREDICTED: similar to alpha 1 type II collagen. [MASS=138706
2	**2**	Rattus norvegicus (Rat) C-REACTIVE PROTEIN PRECURSOR. [MASS=25468
2	**3**	Rattus norvegicus (Rat) EPITHELIAL-CADHERIN PRECURSOR. [MASS=98715
2	**2**	Rattus norvegicus (Rat) BIFUNCTIONAL HEPARAN SULFATE N-DEACETYLASE/N-SULFOTRANSFERASE 1 (EC 2.8.2.8) (GLUCOSAMINYL N-DEACETYLASE/N-SULFOTRANSFERASE 1) (NDST-1) (. [MASS=101202
2	**2**	Rattus norvegicus (Rat) SPARC PRECURSOR. [MASS=34384
2	**2**	Rattus norvegicus (Rat) PREDICTED: GLYCOPROTEIN-4-BETA-GALACTOSYLTRANSFERASE 2. [MASS=44484
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PAPPALYSIN-2 PRECURSOR. [MASS=204770
2	**2**	Rattus norvegicus (Rat) MASP-3 PROTEIN. [MASS=82497
2	**2**	Rattus norvegicus (Rat) PREDICTED: similar to T-complex protein 1 subunit theta. [MASS=59745
2	**2**	Rattus norvegicus (Rat) NUCLEAR AUTOANTIGENIC SPERM PROTEIN. [MASS=84200
2	**2**	Rattus norvegicus (Rat) SUPEROXIDE DISMUTASE. [MASS=15780
2	**3**	Rattus norvegicus (Rat) APOLIPOPROTEIN D PRECURSOR. [MASS=21635
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PROGRAMMED CELL DEATH 6 INTERACTING PROTEIN. [MASS=75806
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SEMAPHORIN 6D-4. [MASS=159473
2	**4**	Rattus norvegicus (Rat) IGH-1A PROTEIN. [MASS=51403
2	**2**	Rattus norvegicus (Rat) L-LACTATE DEHYDROGENASE A CHAIN. [MASS=36451
2	**3**	Rattus norvegicus (Rat) RECEPTOR-LIKE PROTEIN TYROSINE PHOSPHATASE KAPPA EXTRACELLULAR REGION. [MASS=56159
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SEROTRANSFERRIN PRECURSOR. [MASS=76607
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RAN BINDING PROTEIN 5. [MASS=133476
2	**3**	Rattus norvegicus (Rat) APOLIPOPROTEIN M PRECURSOR. [MASS=21513
2	**2**	Rattus norvegicus (Rat) HEAT SHOCK PROTEIN HSP 90-BETA. [MASS=83185
2	**2**	Rattus norvegicus (Rat) CATHEPSIN D PRECURSOR. [MASS=44681
2	**3**	Rattus norvegicus (Rat) MICROFIBRILLAR-ASSOCIATED PROTEIN 4. [MASS=29050
2	**2**	Rattus norvegicus (Rat) FRUCTOSE-BISPHOSPHATE ALDOLASE A. [MASS=39221
2	**3**	Rattus norvegicus (Rat) ADAMTS-1 PRECURSOR. [MASS=105719
2	**2**	Rattus norvegicus (Rat) BETA-2-GLYCOPROTEIN 1 PRECURSOR. [MASS=33197
2	**2**	Rattus norvegicus (Rat) BONE MORPHOGENETIC PROTEIN 1. [MASS=111332
2	**2**	Rattus norvegicus (Rat) RECEPTOR-LIKE PROTEIN TYROSINE PHOSPHATASE GAMMA B-TYPE ISOFORM. [MASS=156024

2	**6**	Rattus norvegicus (Rat) DERMCIDIN. [MASS=11284
2	**2**	Rattus norvegicus (Rat) CALUMENIN PRECURSOR. [MASS=36997
2	**2**	Rattus norvegicus (Rat) PREDICTED: similar to Periostin precursor (PN) (Osteoblast-specific factor 2) (OSF-2). [MASS=90252
2	**8**	Rattus norvegicus (Rat) AMBP PROTEIN PRECURSOR. [MASS=38851
2	**2**	Rattus norvegicus (Rat) PROBABLE G-PROTEIN COUPLED RECEPTOR 116 PRECURSOR. [MASS=149446
2	**2**	Rattus norvegicus (Rat) PLATELET ENDOTHELIAL CELL ADHESION MOLECULE PRECURSOR. [MASS=76189
2	**3**	Rattus norvegicus (Rat) PREDICTED similar to FIBRINOGEN, GAMMA POLYPEPTIDE. [MASS=49121
2	**2**	Rattus norvegicus (Rat) PREDICTED: AMINOPEPTIDASE PUROMYCIN SENSITIVE. [MASS=103344
2	**2**	Rattus norvegicus (Rat) SPLICE ISOFORM PAM-1 OF PEPTIDYL-GLYCINE ALPHA-AMIDATING MONOOXYGENASE PRECURSOR. [MASS=108819
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO FILAMIN A. [MASS=290169
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PROTOCADHERIN 19 PRECURSOR. [MASS=125989
2	**2**	Rattus norvegicus (Rat) VITAMIN K-DEPENDENT PROTEIN S PRECURSOR. [MASS=74627
2	**2**	Rattus norvegicus (Rat) SEMA4B PROTEIN (FRAGMENT). [MASS=79477
2	**2**	Rattus norvegicus (Rat) RHO GDP DISSOCIATION INHIBITOR (GDI) ALPHA. [MASS=23407
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO EXPRESSED SEQUENCE C79407. [MASS=113188
2	**2**	Rattus norvegicus (Rat) MYOSIN-10. [MASS=228965
2	**2**	Rattus norvegicus (Rat) GM2 GANGLIOSIDE ACTIVATOR PROTEIN. [MASS=21493
2	**2**	Rattus norvegicus (Rat) PREDICTED: PROCOLLAGEN, TYPE XII, ALPHA 1. [MASS=367709
2	**2**	Rattus norvegicus (Rat) EPSILON 2 GLOBIN. [MASS=16388
2	**4**	Rattus norvegicus (Rat) HISTONE H1.2. [MASS=21856
2	**2**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L8. [MASS=27893
2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO LIPOPROTEIN RECEPTOR-RELATED PROTEIN. [MASS=504889
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SUSHI, VON WILLEBRAND FACTOR TYPE A, EGF AND PENTRAXIN DOMAIN CONTAINING 1. [MASS=383558
2	**2**	Rattus norvegicus (Rat) GTP-BINDING NUCLEAR PROTEIN RAN, TESTIS-SPECIFIC ISOFORM. [MASS=24451
2	**2**	Rattus norvegicus (Rat) 14-3-3 PROTEIN EPSILON. [MASS=29174
2	**2**	Rattus norvegicus (Rat) INSULIN-LIKE GROWTH FACTOR-BINDING PROTEIN COMPLEX ACID LABILE CHAIN PRECURSOR. [MASS=66812

Table 1.7. Protein matches E17.5 LV

Unique peptides	Total peptides	Protein matches E17.5 LV
111	**414**	Rattus norvegicus (Rat) AA1064-apolipoprotein B. [MASS=536024
58	**226**	Rattus norvegicus (Rat) Apolipoprotein B - fragment. [MASS=165356
45	**61**	Rattus norvegicus (Rat) DYNEIN HEAVY CHAIN, CYTOSOLIC. [MASS=532252
40	**55**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO FILAMIN A. [MASS=290169
39	**44**	Rattus norvegicus (Rat) FATTY ACID SYNTHASE. [MASS=272650
39	**79**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF FIBRONECTIN PRECURSOR. [MASS=272511
37	**99**	Rattus norvegicus (Rat) ALPHA-2-MACROGLOBULIN PRECURSOR. [MASS=163701
33	**418**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF ALPHA-FETOPROTEIN PRECURSOR. [MASS=68386
28	**30**	Rattus norvegicus (Rat) MYOSIN-10. [MASS=228965
26	**78**	Rattus norvegicus (Rat) APOLIPOPROTEIN A-IV PRECURSOR. [MASS=44456
25	**33**	Rattus norvegicus (Rat) CONTACTIN-1 PRECURSOR. [MASS=113495
23	**160**	Rattus norvegicus (Rat) SERUM ALBUMIN PRECURSOR. [MASS=68719
23	**29**	Rattus norvegicus (Rat) ALPHA-1-MACROGLOBULIN. [MASS=167125
20	**21**	Rattus norvegicus (Rat) MYOSIN-9. [MASS=226207
20	**49**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO INTER-ALPHA-INHIBITOR H2 CHAIN. [MASS=105715
19	**47**	Rattus norvegicus (Rat) ALPHA-1-ANTIPROTEINASE PRECURSOR. [MASS=46136
19	**24**	Rattus norvegicus (Rat) ELONGATION FACTOR 2. [MASS=95153
19	**19**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CAD PROTEIN. [MASS=250725
18	**24**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN LOC314432-Similar to ubiquitin-protein ligase (EC 6.3.2.19) E1. [MASS=117788
18	**102**	Rattus norvegicus (Rat) BA1-667 - Transferrin. [MASS=107448
17	**20**	Rattus norvegicus (Rat) DA1-24-Complement Factor B. [MASS=124379
17	**34**	Rattus norvegicus (Rat) PREDICTED: MICROTUBULE-ASSOCIATED PROTEIN 1B. [MASS=269643
16	**17**	Rattus norvegicus (Rat) CONTACTIN-2 PRECURSOR. [MASS=113043
16	**23**	Rattus norvegicus (Rat) HEAT SHOCK PROTEIN 86. [MASS=84815
16	**17**	Rattus norvegicus (Rat) CLATHRIN HEAVY CHAIN. [MASS=191599
15	**25**	Rattus norvegicus (Rat) COMPLEMENT C3 PRECURSOR. [MASS=186460
15	**15**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO GCN1 GENERAL CONTROL OF AMINO-ACID SYNTHESIS 1- LIKE 1. [MASS=302942
14	**32**	Rattus norvegicus (Rat) APOLIPOPROTEIN A-I PRECURSOR. [MASS=30088
14	**46**	Rattus norvegicus (Rat) CORTICOSTEROID-BINDING GLOBULIN PRECURSOR. [MASS=44672
14	**15**	Rattus norvegicus (Rat) CULLIN-ASSOCIATED NEDD8-DISSOCIATED PROTEIN 1. [MASS=136362
14	**42**	Rattus norvegicus (Rat) TUBULIN ALPHA-1 CHAIN. [MASS=50136
14	**14**	Rattus norvegicus (Rat) GPI-ANCHORED CERULOPLASMIN. [MASS=123749

14	**28**	Rattus norvegicus (Rat) ECTONUCLEOTIDE PYROPHOSPHATASE/PHOSPHODIESTERASE 2. [MASS=101310
13	**18**	Rattus norvegicus (Rat) GELSOLIN. [MASS=86286
13	**15**	Rattus norvegicus (Rat) VIMENTIN. [MASS=53602
12	**21**	Rattus norvegicus (Rat) TRANSITIONAL ENDOPLASMIC RETICULUM ATPASE. [MASS=89534
12	**12**	Rattus norvegicus (Rat) COMPLEMENT COMPONENT 2. [MASS=83699
12	**15**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO DESMOPLAKIN ISOFORM II. [MASS=264186
12	**15**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALPHA 3 TYPE VI COLLAGEN ISOFORM 1 PRECURSOR. [MASS=369017
11	**11**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO COATOMER PROTEIN COMPLEX SUBUNIT ALPHA. [MASS=138360
11	**19**	Rattus norvegicus (Rat) CLUSTERIN PRECURSOR. [MASS=51375
11	**16**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PYRUVATE KINASE (EC 2.7.1.40) ISOZYME M2 - RAT. [MASS=57731
11	**15**	Rattus norvegicus (Rat) ALPHA-1-INHIBITOR 3 PRECURSOR. [MASS=163773
11	**11**	Rattus norvegicus (Rat) HEPHAESTIN PRECURSOR. [MASS=129593
11	**36**	Rattus norvegicus (Rat) LOC367586 PROTEIN-Immunoglobulin Gamma heavy Chain. [MASS=50949
11	**19**	Rattus norvegicus (Rat) ACTIN, ALPHA SKELETAL MUSCLE. [MASS=42051
10	**20**	Rattus norvegicus (Rat) NEURAL-CADHERIN PRECURSOR. [MASS=99686
10	**105**	Rattus norvegicus (Rat) TRANSTHYRETIN PRECURSOR. [MASS=15720
10	**11**	Rattus norvegicus (Rat) IMPORTIN BETA-1 SUBUNIT. [MASS=97184
10	**10**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CELLULAR APOPTOSIS SUSCEPTIBILITY PROTEIN. [MASS=110214
10	**11**	Rattus norvegicus (Rat) NUCLEAR AUTOANTIGENIC SPERM PROTEIN. [MASS=84200
10	**11**	Rattus norvegicus (Rat) ISCHEMIA RESPONSIVE 94 KDA PROTEIN. [MASS=94057
10	**10**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RAS GTPASE-ACTIVATING-LIKE PROTEIN IQGAP1. [MASS=196522
10	**11**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO UBIQUITIN CARBOXYL-TERMINAL HYDROLASE 5. [MASS=95779
10	**12**	Rattus norvegicus (Rat) PREDICTED: AMINOPEPTIDASE PUROMYCIN SENSITIVE. [MASS=103344
10	**10**	Rattus norvegicus (Rat) COATOMER SUBUNIT BETA. [MASS=107011
10	**13**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF AGRIN PRECURSOR. [MASS=208646
10	**14**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO GAMMA-FILAMIN. [MASS=290986
10	**10**	Rattus norvegicus (Rat) 284 KDA PROTEIN. [MASS=284430
9	**18**	Rattus norvegicus (Rat) TUBULIN BETA-5 CHAIN. [MASS=49671
9	**11**	Rattus norvegicus (Rat) SERINE PEPTIDASE INHIBITOR, CLADE G, MEMBER 1. [MASS=55611
9	**10**	Rattus norvegicus (Rat) 170 KDA PROTEIN-Glutamyl-prolyl-tRNA synthetase. [MASS=170088
9	**10**	Rattus norvegicus (Rat) PROTEASOME (PROSOME, MACROPAIN) 26S SUBUNIT, NON-ATPASE, 2. [MASS=100188
9	**10**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RNA HELICASE A. [MASS=150362

9	**9**	Rattus norvegicus (Rat) DELETED IN COLORECTAL CANCER. [MASS=158142
9	**10**	Rattus norvegicus (Rat) ALPHA-MANNOSIDASE 2. [MASS=131242
8	**13**	Rattus norvegicus (Rat) VITAMIN D-BINDING PROTEIN PRECURSOR. [MASS=53544
8	**11**	Rattus norvegicus (Rat) IRON-RESPONSIVE ELEMENT-BINDING PROTEIN 1. [MASS=98128
8	**8**	Rattus norvegicus (Rat) ALPHA-2 ANTIPLASMIN. [MASS=46465
8	**13**	Rattus norvegicus (Rat) SP120-Heterogeneous nuclear ribonucleoprotein U. [MASS=87748
8	**8**	Rattus norvegicus (Rat) PREDICTED: MINI CHROMOSOME MAINTENANCE DEFICIENT 6. [MASS=92815
8	**9**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO FIBULIN-1 PRECURSOR. [MASS=78072
8	**8**	Rattus norvegicus (Rat) STAPHYLOCOCCAL NUCLEASE DOMAIN-CONTAINING PROTEIN 1. [MASS=101952
8	**13**	Rattus norvegicus (Rat) APOLIPOPROTEIN E PRECURSOR. [MASS=35753
8	**8**	Rattus norvegicus (Rat) PREDICTED: BRAIN GLYCOGEN PHOSPHORYLASE. [MASS=96738
8	**23**	Rattus norvegicus (Rat) PLASMINOGEN PRECURSOR. [MASS=90536
8	**8**	Rattus norvegicus (Rat) IKAP. [MASS=149171
8	**9**	Rattus norvegicus (Rat) MANNOSE 6-PHOSPHATE/INSULIN-LIKE GROWTH FACTOR II RECEPTOR. [MASS=273608
7	**11**	Rattus norvegicus (Rat) CREATINE KINASE B-TYPE. [MASS=42712
7	**13**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN RGD1305887-TUBULIN BETA CHAIN. [MASS=50059
7	**8**	Rattus norvegicus (Rat) PREDICTED: similar to phosphoribosylformylglycinamidine synthase. [MASS=146178
7	**12**	Rattus norvegicus (Rat) ATP-CITRATE SYNTHASE. [MASS=120781
7	**10**	Rattus norvegicus (Rat) ANGIOTENSINOGEN PRECURSOR. [MASS=51982
7	**10**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CADHERIN-5. [MASS=135230
7	**12**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PHOSPHOLIPID TRANSFER PROTEIN. [MASS=65430
7	**7**	Rattus norvegicus (Rat) SEZ6B. [MASS=105607
7	**8**	Rattus norvegicus (Rat) DYNACTIN-1. [MASS=141930
7	**8**	Rattus norvegicus (Rat) INTER-ALPHA-INHIBITOR H4 HEAVY CHAIN. [MASS=103755
7	**7**	Rattus norvegicus (Rat) SPECTRIN ALPHA CHAIN, BRAIN. [MASS=284713
7	**10**	Rattus norvegicus (Rat) ELONGATION FACTOR 1-ALPHA 1. [MASS=50114
7	**7**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO VERY LARGE G PROTEIN-COUPLED RECEPTOR 1. [MASS=413840
7	**7**	Rattus norvegicus (Rat) PROTEIN KINASE C-BINDING PROTEIN NELL2. [MASS=91334
7	**9**	Rattus norvegicus (Rat) COMPLEMENT INHIBITORY FACTOR H. [MASS=140344
7	**8**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO EUKARYOTIC TRANSLATION INITIATION FACTOR 3, SUBUNIT 10 THETA, 150/170KDA. [MASS=192616
6	**7**	Rattus norvegicus (Rat) ACTIN, CYTOPLASMIC 1. [MASS=41737
6	**9**	Rattus norvegicus (Rat) LUMICAN PRECURSOR. [MASS=38279
6	**6**	Rattus norvegicus (Rat) PREDICTED C-1-TETRAHYDROFOLATE SYNTHASE, CYTOPLASMIC. [MASS=100351

6	**6**	Rattus norvegicus (Rat) VESICLE ASSOCIATED PROTEIN. [MASS=135350
6	**6**	Rattus norvegicus (Rat) HEAT SHOCK COGNATE 71 KDA PROTEIN. [MASS=70871
6	**8**	Rattus norvegicus (Rat) HEAT SHOCK PROTEIN HSP 90-BETA. [MASS=83185
6	**6**	Rattus norvegicus (Rat) MATRIN-3. [MASS=94447
6	**6**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF REELIN PRECURSOR. [MASS=387531
6	**6**	Rattus norvegicus (Rat) PROMININ-1S1 SPLICE VARIANT. [MASS=96632
6	**7**	Rattus norvegicus (Rat) CHLORIDE INTRACELLULAR CHANNEL 6. [MASS=64786
6	**6**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF NEURONAL CELL ADHESION MOLECULE PRECURSOR. [MASS=133912
6	**6**	Rattus norvegicus (Rat) VASCULAR CELL ADHESION PROTEIN 1 PRECURSOR. [MASS=81246
6	**7**	Rattus norvegicus (Rat) PROPROTEIN CONVERTASE SUBTILISIN/KEXIN TYPE 9 PRECURSOR. [MASS=74709
6	**6**	Rattus norvegicus (Rat) MAMA. [MASS=63772
6	**6**	Rattus norvegicus (Rat) TLN PROTEIN. [MASS=161978
6	**8**	Rattus norvegicus (Rat) NESTIN. [MASS=208797
6	**8**	Rattus norvegicus (Rat) ALPHA-2-GLOBIN CHAIN. [MASS=15285
6	**12**	Rattus norvegicus (Rat) PREDICTED: NEURAL PRECURSOR CELL EXPRESSED, DEVELOPMENTALLY DOWN- REGULATED GENE 4A. [MASS=112368
6	**7**	Rattus norvegicus (Rat) 14-3-3 PROTEIN EPSILON. [MASS=29174
6	**7**	Rattus norvegicus (Rat) MICROTUBULE-ASSOCIATED PROTEIN 4. [MASS=110301
6	**6**	Rattus norvegicus (Rat) FAR UPSTREAM ELEMENT-BINDING PROTEIN 2. [MASS=74226
6	**6**	Rattus norvegicus (Rat) JUNCTION PLAKOGLOBIN. [MASS=81801
6	**6**	Rattus norvegicus (Rat) PREDICTED: similar to T-complex protein 1 subunit theta. [MASS=59745
6	**9**	Rattus norvegicus (Rat) SERINE PEPTIDASE INHIBITOR, CLADE F, MEMBER 2. [MASS=54893
6	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ISOLEUCINE-TRNA SYNTHETASE. [MASS=144169
6	**6**	Rattus norvegicus (Rat) VALYL-TRNA SYNTHETASE. [MASS=141275
6	**15**	Rattus norvegicus (Rat) SPLICE ISOFORM HMW OF KININOGEN-1 PRECURSOR. [MASS=70933
5	**6**	Rattus norvegicus (Rat) 14-3-3 PROTEIN ZETA/DELTA. [MASS=27771
5	**5**	Rattus norvegicus (Rat) PREDICTED NUCLEOLIN-RELATED PROTEIN NRP. [MASS=57036
5	**6**	Rattus norvegicus (Rat) PHOSPHOGLYCERATE KINASE 1. [MASS=44423
5	**7**	Rattus norvegicus (Rat) COLLAGEN TYPE A1(XI)7-8. [MASS=45691
5	**6**	Rattus norvegicus (Rat) RAT T-KININOGEN. [MASS=47618
5	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO IMPORTIN 9. [MASS=131739
5	**6**	Rattus norvegicus (Rat) COMPLEMENT C4 PRECURSOR. [MASS=192163
5	**6**	Rattus norvegicus (Rat) NONO/P54NRB HOMOLOG. [MASS=75487
5	**5**	Rattus norvegicus (Rat) KALLISTATIN. [MASS=48021
5	**6**	Rattus norvegicus (Rat) EXPORTIN-1. [MASS=123335

5	**8**	Rattus norvegicus (Rat) PREDICTED-INHIBIN BINDING PROTEIN LONG ISOFORM. [MASS=153224
5	**10**	Rattus norvegicus (Rat) CATHEPSIN B PRECURSOR. [MASS=37470
5	**8**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RAN BINDING PROTEIN 5. [MASS=133476
5	**16**	Rattus norvegicus (Rat) CYSTATIN C PRECURSOR. [MASS=15437
5	**7**	Rattus norvegicus (Rat) LACTADHERIN PRECURSOR. [MASS=47413
5	**6**	Rattus norvegicus (Rat) SPLICE ISOFORM GAMMA-B OF FIBRINOGEN GAMMA CHAIN PRECURSOR. [MASS=50633
5	**6**	Rattus norvegicus (Rat) EPSILON 1 GLOBIN. [MASS=16105
5	**5**	Rattus norvegicus (Rat) TRIPEPTIDYL-PEPTIDASE 2. [MASS=138162
5	**7**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CRB2 PROTEIN. [MASS=138781
5	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALANYL-TRNA SYNTHETASE. [MASS=106811
5	**6**	Rattus norvegicus (Rat) PREDICTED: MINI CHROMOSOME MAINTENANCE DEFICIENT 4 HOMOLOG. [MASS=96685
5	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO VINCULIN. [MASS=116615
5	**6**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF ATTRACTIN PRECURSOR. [MASS=163296
5	**7**	Rattus norvegicus (Rat) GLUCOSE PHOSPHATE ISOMERASE. [MASS=62827
5	**6**	Rattus norvegicus (Rat) SPLICE ISOFORM 2 OF RECEPTOR-TYPE TYROSINE-PROTEIN PHOSPHATASE ZETA PRECURSOR. [MASS=164596
5	**5**	Rattus norvegicus (Rat) HEAT-SHOCK PROTEIN 105 KDA. [MASS=96419
5	**7**	Rattus norvegicus (Rat) PREDICTED similar to Nuclear autoantigenic sperm protein. [MASS=45764
5	**6**	Rattus norvegicus (Rat) LAR RECEPTOR-LINKED TYROSINE PHOSPHATASE. [MASS=181130
4	**5**	Rattus norvegicus (Rat) IG KAPPA CHAIN C REGION, B ALLELE. [MASS=11601
4	**5**	Rattus norvegicus (Rat) CHAPERONIN CONTAINING TCP1, SUBUNIT 2. [MASS=57458
4	**4**	Rattus norvegicus (Rat) PREDICTED: TUMOR REJECTION ANTIGEN GP96. [MASS=92771
4	**4**	Rattus norvegicus (Rat) DREBRIN 1. [MASS=77472
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO DNA REPLICATION LICENSING FACTOR MCM3. [MASS=83429
4	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO IMPORTIN 7. [MASS=119704
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RANBP21. [MASS=136714
4	**4**	Rattus norvegicus (Rat) ALPHA-ACTININ-1. [MASS=102960
4	**4**	Rattus norvegicus (Rat) ARCADLIN. [MASS=103800
4	**4**	Rattus norvegicus (Rat) PROTOCADHERIN GAMMA SUBFAMILY C, 3. [MASS=101038
4	**4**	Rattus norvegicus (Rat) EUKARYOTIC TRANSLATION INITIATION FACTOR 4A, ISOFORM 1. [MASS=46154
4	**4**	Rattus norvegicus (Rat) RIBONUCLEOTIDE REDUCTASE M1. [MASS=90293
4	**7**	Rattus norvegicus (Rat) PREDICTED: RETINOL BINDING PROTEIN 4, PLASMA. [MASS=50139
4	**4**	Rattus norvegicus (Rat) PREDICTED: COMPLEMENT COMPONENT 7. [MASS=90661

4	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CCTETA, ETA SUBUNIT OF THE CHAPERONIN CONTAINING TCP-1. [MASS=75684
4	**4**	Rattus norvegicus (Rat) PREDICTED: COMPLEMENT COMPONENT 5. [MASS=152144
4	**6**	Rattus norvegicus (Rat) NEUROCAN CORE PROTEIN PRECURSOR. [MASS=135545
4	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SEIZURE 6-LIKE PROTEIN PRECURSOR. [MASS=145870
4	**4**	Rattus norvegicus (Rat) HEPARIN COFACTOR 2 PRECURSOR. [MASS=54552
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO DNA REPLICATION LICENSING FACTOR MCM2. [MASS=102272
4	**5**	Rattus norvegicus (Rat) PREDICTED: NIDOGEN. [MASS=138365
4	**7**	Rattus norvegicus (Rat) PEPTIDYLPROLYL ISOMERASE C. [MASS=23009
4	**4**	Rattus norvegicus (Rat) SPLICE ISOFORM 2 OF POLYPYRIMIDINE TRACT-BINDING PROTEIN 2. [MASS=57645
4	**4**	Rattus norvegicus (Rat) TXNRD1 PROTEIN. [MASS=63002
4	**5**	Rattus norvegicus (Rat) TENASCIN (FRAGMENT). [MASS=62473
4	**5**	Rattus norvegicus (Rat) QUIESCIN Q6. [MASS=82412
4	**6**	Rattus norvegicus (Rat) POLY [ADP-RIBOSE] POLYMERASE 1. [MASS=112529
4	**4**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF CULLIN-ASSOCIATED NEDD8-DISSOCIATED PROTEIN 2. [MASS=139673
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO INTER-ALPHA TRYPSIN INHIBITOR, HEAVY CHAIN 1. [MASS=104581
4	**4**	Rattus norvegicus (Rat) MANNOSIDASE 2, ALPHA B1. [MASS=114327
4	**4**	Rattus norvegicus (Rat) STRUCTURAL MAINTENANCE OF CHROMOSOME 3. [MASS=138448
4	**4**	Rattus norvegicus (Rat) DIHYDROPYRIMIDINASE-RELATED PROTEIN 2. [MASS=62278
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO P30 DBC PROTEIN. [MASS=114440
4	**4**	Rattus norvegicus (Rat) 26S PROTEASOME NON-ATPASE REGULATORY SUBUNIT 1. [MASS=105748
4	**4**	Rattus norvegicus (Rat) FAM3C-LIKE PROTEIN. [MASS=24714
4	**4**	Rattus norvegicus (Rat) LEUKEMIA INHIBITORY FACTOR RECEPTOR PRECURSOR. [MASS=122394
4	**4**	Rattus norvegicus (Rat) HAUSP. [MASS=128431
4	**4**	Rattus norvegicus (Rat) COLLAGEN ALPHA-1(I) CHAIN PRECURSOR. [MASS=137886
4	**6**	Rattus norvegicus (Rat) FETUB PROTEIN. [MASS=43169
3	**3**	Rattus norvegicus (Rat) PROTEASOME SUBUNIT ALPHA TYPE 2. [MASS=25795
3	**3**	Rattus norvegicus (Rat) RATSG1. [MASS=49199
3	**4**	Rattus norvegicus (Rat) COFILIN-1. [MASS=24588
3	**5**	Rattus norvegicus (Rat) PEPTIDYL-PROLYL CIS-TRANS ISOMERASE A. [MASS=17743
3	**4**	Rattus norvegicus (Rat) RAB GDP DISSOCIATION INHIBITOR BETA. [MASS=50685
3	**3**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN SA. [MASS=32693
3	**3**	Rattus norvegicus (Rat) PHOSPHATIDYLETHANOLAMINE-BINDING PROTEIN. [MASS=20670
3	**3**	Rattus norvegicus (Rat) SECRETOGRANIN-3 PRECURSOR. [MASS=53183

3	**5**	Rattus norvegicus (Rat) PEROXIREDOXIN-2. [MASS=21652
3	**5**	Rattus norvegicus (Rat) SERINE/CYSTEINE PROTEINASE INHIBITOR, CLADE C, MEMBER 1. [MASS=52234
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO AMYLOID BETA (A4) PRECURSOR-LIKE PROTEIN 1. [MASS=68777
3	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RAN BINDING PROTEIN 5. [MASS=99947
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PROGRAMMED CELL DEATH 6 INTERACTING PROTEIN. [MASS=75806
3	**6**	Rattus norvegicus (Rat) PREDICTED: DYSTROGLYCAN 1. [MASS=96706
3	**3**	Rattus norvegicus (Rat) PREDICTED: similar to Slit-like 2. [MASS=72321
3	**3**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN D0. [MASS=38192
3	**3**	Rattus norvegicus (Rat) NEURAL CELL ADHESION MOLECULE 1, 140 KDA ISOFORM PRECURSOR. [MASS=94658
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PUTATIVE PRE-MRNA SPLICING FACTOR RNA HELICASE. [MASS=90977
3	**3**	Rattus norvegicus (Rat) DNA POLYMERASE ALPHA CATALYTIC SUBUNIT (FRAGMENT). [MASS=165306
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ARX. [MASS=121446
3	**4**	Rattus norvegicus (Rat) FOLLISTATIN-RELATED PROTEIN 1 PRECURSOR. [MASS=34622
3	**4**	Rattus norvegicus (Rat) SPLICE ISOFORM PYBP1 OF POLYPYRIMIDINE TRACT-BINDING PROTEIN 1. [MASS=56937
3	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEAT SHOCK PROTEIN HSP 90-BETA. [MASS=80701
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO DNA REPLICATION LICENSING FACTOR MCM5. [MASS=91577
3	**5**	Rattus norvegicus (Rat) PROFILIN-1. [MASS=14826
3	**3**	Rattus norvegicus (Rat) PREDICTED: CALSYNTENIN 1. [MASS=109351
3	**5**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L18. [MASS=21527
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SPLICING FACTOR 3B, SUBUNIT 3, 130KDA. [MASS=174174
3	**3**	Rattus norvegicus (Rat) SPARC-LIKE PROTEIN 1 PRECURSOR. [MASS=70634
3	**3**	Rattus norvegicus (Rat) EUKARYOTIC TRANSLATION INITIATION FACTOR 4A2. [MASS=46489
3	**5**	Rattus norvegicus (Rat) EXTRACELLULAR SUPEROXIDE DISMUTASE [CU-ZN] PRECURSOR. [MASS=26620
3	**3**	Rattus norvegicus (Rat) CADHERIN-6 PRECURSOR. [MASS=88341
3	**5**	Rattus norvegicus (Rat) RIBOSOMAL PROTEIN S27A. [MASS=17951
3	**3**	Rattus norvegicus (Rat) PREDICTED: NIDOGEN 2. [MASS=173960
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO UBIQUITIN SPECIFIC PROTEASE 9, X-LINKED. [MASS=290681
3	**3**	Rattus norvegicus (Rat) SMC4L1 PROTEIN. [MASS=146806
3	**3**	Rattus norvegicus (Rat) PREDICTED: similar to Heterogeneous nuclear ribonucleoproteins A2/B1. [MASS=32468
3	**3**	Rattus norvegicus (Rat) KINESIN-1 HEAVY CHAIN. [MASS=109531
3	**3**	Rattus norvegicus (Rat) ADAMTS-1 PRECURSOR. [MASS=105719
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PLEXIN-B2 PRECURSOR. [MASS=216119

3	**3**	Rattus norvegicus (Rat) PREDICTED: KINESIN FAMILY MEMBER 4. [MASS=139682
3	**3**	Rattus norvegicus (Rat) NON-ERYTHROCYTE BETA-SPECTRIN. [MASS=251205
3	**3**	Rattus norvegicus (Rat) D-3-PHOSPHOGLYCERATE DEHYDROGENASE. [MASS=56362
3	**3**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF ACETYL-COA CARBOXYLASE 1. [MASS=265421
3	**3**	Rattus norvegicus (Rat) NUCLEOLIN. [MASS=77276
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SEROTRANSFERRIN PRECURSOR. [MASS=76607
3	**4**	Rattus norvegicus (Rat) PREDICTED: HYPOTHETICAL PROTEIN XP_579585. [MASS=275729
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO COLONIC AND HEPATIC TUMOR OVER-EXPRESSED PROTEIN ISOFORM A. [MASS=198456
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO FILAMIN B. [MASS=291469
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CHROMOSOME CONDENSATION PROTEIN G. [MASS=113137
3	**13**	Rattus norvegicus (Rat) AMBP PROTEIN PRECURSOR. [MASS=38851
3	**3**	Rattus norvegicus (Rat) Neogenin precursor. [MASS=156144
3	**3**	Rattus norvegicus (Rat) LEUCYL-TRNA SYNTHETASE. [MASS=134279
3	**3**	Rattus norvegicus (Rat) PREDICTED: THROMBOSPONDIN 4. [MASS=121361
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO TALIN 2. [MASS=273281
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO OLLISTATIN-LIKE 5. [MASS=95918
3	**3**	Rattus norvegicus (Rat) THROMBOSPONDIN 1. [MASS=129671
3	**4**	Rattus norvegicus (Rat) STATHMIN. [MASS=17157
3	**4**	Rattus norvegicus (Rat) PREDICTED: GLYCOPROTEIN-4-BETA-GALACTOSYLTRANSFERASE 2. [MASS=44484
3	**4**	Rattus norvegicus (Rat) HISTONE H1.2. [MASS=21856
3	**3**	Rattus norvegicus (Rat) PEROXIREDOXIN-1. [MASS=22109
2	**3**	Rattus norvegicus (Rat) ALPHA-ENOLASE. [MASS=46997
2	**4**	Rattus norvegicus (Rat) RAB GDP DISSOCIATION INHIBITOR ALPHA. [MASS=50537
2	**2**	Rattus norvegicus (Rat) ANGIOTENSIN-CONVERTING ENZYME, SOMATIC ISOFORM PRECURSOR. [MASS=150908
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALPHA ENOLASE. [MASS=46489
2	**4**	Rattus norvegicus (Rat) PREDICTED similar to HEAT SHOCK PROTEIN 86. [MASS=56953
2	**2**	Rattus norvegicus (Rat) ALPHA ACTININ 4. [MASS=104915
2	**2**	Rattus norvegicus (Rat) SPLICE ISOFORM APP770 OF AMYLOID BETA A4 PROTEIN PRECURSOR (FRAGMENT). [MASS=86704
2	**2**	Rattus norvegicus (Rat) PREDICTED similar to T-KININOGEN 2 PRECURSOR (Fragment). [MASS=72419
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEAT SHOCK 70KDA PROTEIN 4 LIKE. [MASS=136266
2	**4**	Rattus norvegicus (Rat) TUBULIN BETA-3 CHAIN. [MASS=50419
2	**2**	Rattus norvegicus (Rat) EUKARYOTIC TRANSLATION INITIATION FACTOR 5A-1. [MASS=16701
2	**4**	Rattus norvegicus (Rat) PYRUVATE KINASE, MUSCLE. [MASS=57976

2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PEPTIDOGLYCAN RECOGNITION PROTEIN 2. [MASS=39775
2	**2**	Rattus norvegicus (Rat) L-LACTATE DEHYDROGENASE B CHAIN. [MASS=36481
2	**2**	Rattus norvegicus (Rat) IGH-1A PROTEIN. [MASS=51403
2	**4**	Rattus norvegicus (Rat) ALPHA-2-HS-GLYCOPROTEIN PRECURSOR. [MASS=37982
2	**2**	Rattus norvegicus (Rat) SPLICE ISOFORM IIBA OF DYNAMIN-2. [MASS=98246
2	**2**	Rattus norvegicus (Rat) SORTILIN PRECURSOR. [MASS=91169
2	**3**	Rattus norvegicus (Rat) HEMOGLOBIN BETA-1 SUBUNIT. [MASS=15848
2	**2**	Rattus norvegicus (Rat) TRANSLATIONALLY-CONTROLLED TUMOR PROTEIN. [MASS=19462
2	**4**	Rattus norvegicus (Rat) ALPHA 2 MACROGLOBULIN CARDIAC ISOFORM. [MASS=163218
2	**2**	Rattus norvegicus (Rat) RAT ALPHA(1)-INHIBITOR 3, VARIANT I PRECURSOR. [MASS=165326
2	**2**	Rattus norvegicus (Rat) PROTEASOME SUBUNIT BETA TYPE 1. [MASS=26479
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO IMMUNOGLOBULIN HEAVY CHAIN. [MASS=120447
2	**2**	Rattus norvegicus (Rat) SPLICE ISOFORM B OF AP-1 COMPLEX SUBUNIT BETA-1. [MASS=103873
2	**3**	Rattus norvegicus (Rat) GPI-ANCHORED MEMBRANE PROTEIN 1. [MASS=75707
2	**2**	Rattus norvegicus (Rat) T-COMPLEX PROTEIN 1 SUBUNIT DELTA. [MASS=57968
2	**2**	Rattus norvegicus (Rat) PROTECTIVE PROTEIN FOR BETA-GALACTOSIDASE. [MASS=51216
2	**2**	Rattus norvegicus (Rat) PREDICTED similar to Proteasome 26S subunit, ATPase 3. [MASS=50509
2	**2**	Rattus norvegicus (Rat) PREDICTED: ADAPTOR-RELATED PROTEIN COMPLEX 1, GAMMA 1 SUBUNIT. [MASS=91693
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HSPC263. [MASS=37041
2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALPHA NAC/1.9.2. PROTEIN. [MASS=23384
2	**3**	Rattus norvegicus (Rat) ALPHA-ACTININ-4. [MASS=104786
2	**2**	Rattus norvegicus (Rat) PREDICTED: VON WILLEBRAND FACTOR. [MASS=308474
2	**2**	Rattus norvegicus (Rat) FATTY ACID-BINDING PROTEIN, BRAIN. [MASS=14733
2	**2**	Rattus norvegicus (Rat) GM2 GANGLIOSIDE ACTIVATOR PROTEIN. [MASS=21493
2	**2**	Rattus norvegicus (Rat) SSB PROTEIN. [MASS=43926
2	**2**	Rattus norvegicus (Rat) MANNOSIDASE, ALPHA, CLASS 1A, MEMBER 1. [MASS=73125
2	**2**	Rattus norvegicus (Rat) VIGILIN. [MASS=141584
2	**2**	Rattus norvegicus (Rat) PREDICTED-MATRIN-3. [MASS=44733
2	**2**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF FIBRINOGEN ALPHA CHAIN PRECURSOR. [MASS=86686
2	**2**	Rattus norvegicus (Rat) EPITHELIAL-CADHERIN PRECURSOR. [MASS=98715
2	**2**	Rattus norvegicus (Rat) FRUCTOSE-BISPHOSPHATE ALDOLASE C. [MASS=39153

2	**2**	Rattus norvegicus (Rat) TUBULIN BETA CHAIN. [MASS=49963
2	**2**	Rattus norvegicus (Rat) ISOCITRATE DEHYDROGENASE [NADP] CYTOPLASMIC. [MASS=46734
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO EUKARYOTIC TRANSLATION INITIATION FACTOR 4, GAMMA 1 ISOFORM A. [MASS=93472
2	**2**	Rattus norvegicus (Rat) HEAT SHOCK-RELATED 70 KDA PROTEIN 2. [MASS=69528
2	**2**	Rattus norvegicus (Rat) KINESIN-LIKE PROTEIN KIF15. [MASS=159554
2	**2**	Rattus norvegicus (Rat) DAMAGE-SPECIFIC DNA BINDING PROTEIN 1. [MASS=127059
2	**2**	Rattus norvegicus (Rat) HEAT SHOCK 70 KDA PROTEIN 1A/1B. [MASS=70185
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO GLYCERALDEHYDE-3-PHOSPHATE DEHYDROGENASE. [MASS=35200
2	**3**	Rattus norvegicus (Rat) COLLAGEN ALPHA-2(I) CHAIN PRECURSOR. [MASS=129564
2	**2**	Rattus norvegicus (Rat) EPSILON 3 GLOBIN. [MASS=16540
2	**2**	Rattus norvegicus (Rat) HEMOPEXIN PRECURSOR. [MASS=51291
2	**6**	Rattus norvegicus (Rat) COLLAGEN ALPHA-1(V) CHAIN PRECURSOR. [MASS=184610
2	**2**	Rattus norvegicus (Rat) 1-PHOSPHATIDYLINOSITOL-4,5-BISPHOSPHATE PHOSPHODIESTERASE GAMMA 1. [MASS=148548
2	**5**	Rattus norvegicus (Rat) BETA-2-MICROGLOBULIN PRECURSOR. [MASS=13720
2	**3**	Rattus norvegicus (Rat) STRUCTURAL MAINTENANCE OF CHROMOSOME 1-LIKE 1 PROTEIN. [MASS=143205
2	**3**	Rattus norvegicus (Rat) T-CADHERIN. [MASS=78086
2	**2**	Rattus norvegicus (Rat) BETA-2-GLYCOPROTEIN 1 PRECURSOR. [MASS=33197
2	**2**	Rattus norvegicus (Rat) CALCIUM-DEPENDENT SECRETION ACTIVATOR 1. [MASS=146266
2	**2**	Rattus norvegicus (Rat) EUKARYOTIC TRANSLATION INITIATION FACTOR 3 SUBUNIT 9. [MASS=107985
2	**2**	Rattus norvegicus (Rat) ADAPTOR PROTEIN COMPLEX AP-2, ALPHA 2 SUBUNIT. [MASS=104174
2	**4**	Rattus norvegicus (Rat) NUCLEOSOME ASSEMBLY PROTEIN 1-LIKE 1. [MASS=45373
2	**2**	Rattus norvegicus (Rat) PROTHROMBIN PRECURSOR (FRAGMENT). [MASS=70412
2	**2**	Rattus norvegicus (Rat) PREDICTED: CADHERIN 11. [MASS=88036
2	**2**	Rattus norvegicus (Rat) M-CADHERIN. [MASS=85753
2	**2**	Rattus norvegicus (Rat) PREDICTED: similar to ubiquitin-activating enzyme E1. [MASS=117931
2	**2**	Rattus norvegicus (Rat) SPLICEOSOME RNA HELICASE BAT1. [MASS=49035
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RANBP4. [MASS=118926
2	**2**	Rattus norvegicus (Rat) PREDICTED: PROCOLLAGEN, TYPE XII, ALPHA 1. [MASS=367709
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SLIT-ROBO RHO GTPASE-ACTIVATING PROTEIN 1. [MASS=133329
2	**2**	Rattus norvegicus (Rat) PREDICTED: HISTONE DEACETYLASE 6. [MASS=168631
2	**5**	Rattus norvegicus (Rat) DERMCIDIN. [MASS=11284

2	**2**	Rattus norvegicus (Rat) TRIOSEPHOSPHATE ISOMERASE. [MASS=26790
2	**2**	Rattus norvegicus (Rat) GLUCOSAMINE. [MASS=60914
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO N-TERMINAL ACEYLTRANSFERASE 1. [MASS=100994
2	**2**	Rattus norvegicus (Rat) SPLICE ISOFORM 2 OF DNA. [MASS=173853
2	**2**	Rattus norvegicus (Rat) PROTEASOME SUBUNIT BETA TYPE 2. [MASS=22912
2	**4**	Rattus norvegicus (Rat) 14-3-3 PROTEIN THETA. [MASS=27778
2	**2**	Rattus norvegicus (Rat) 14-3-3 PROTEIN BETA/ALPHA. [MASS=27923
2	**2**	Rattus norvegicus (Rat) CALMODULIN. [MASS=16706
2	**2**	Rattus norvegicus (Rat) INSULIN-LIKE GROWTH FACTOR-BINDING PROTEIN COMPLEX ACID LABILE CHAIN PRECURSOR. [MASS=66812
2	**2**	Rattus norvegicus (Rat) PREDICTED: CHROMODOMAIN HELICASE DNA BINDING PROTEIN 4. [MASS=222452
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIBOSOMAL PROTEIN L6. [MASS=32944
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO STABILIN-1. [MASS=288663
2	**2**	Rattus norvegicus (Rat) TENASCIN (FRAGMENT). [MASS=67815
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO LIPOPROTEIN RECEPTOR-RELATED PROTEIN. [MASS=504889
2	**2**	Rattus norvegicus (Rat) ZERO BETA-1 GLOBIN. [MASS=16023
2	**2**	Rattus norvegicus (Rat) GTP-BINDING NUCLEAR PROTEIN RAN, TESTIS-SPECIFIC ISOFORM. [MASS=24451
2	**2**	Rattus norvegicus (Rat) COLLAGEN ALPHA-1(III) CHAIN PRECURSOR. [MASS=138936
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEPATIC MULTIPLE INOSITOL POLYPHOSPHATE PHOSPHATASE. [MASS=54619
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO MUCIN 17. [MASS=189893
2	**9**	Rattus norvegicus (Rat) SERINE (OR CYSTEINE) PROTEINASE INHIBITOR, CLADE A (ALPHA-1 ANTIPROTEINASE, ANTITRYPSIN), MEMBER 6. [MASS=44671
2	**2**	Rattus norvegicus (Rat) FARNESYL PYROPHOSPHATE SYNTHETASE. [MASS=40830
2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEPARAN SULFATE PROTEOGLYCAN 2. [MASS=377284
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ELAV. [MASS=49528
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO TUBULIN-SPECIFIC CHAPERONE D. [MASS=60160
2	**2**	Rattus norvegicus (Rat) COATOMER SUBUNIT BETA'. [MASS=102420
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO EXPRESSED SEQUENCE AI314180. [MASS=203921
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO REGULATOR OF NONSENSE TRANSCRIPTS 1. [MASS=88226
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SORCSB SPLICE VARIANT OF THE VPS10 DOMAIN RECEPTOR SORCS. [MASS=129969
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 40S RIBOSOMAL PROTEIN S19. [MASS=16172
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CYFIP1 PROTEIN. [MASS=144933
2	**2**	Rattus norvegicus (Rat) PREDICTED similar to FIBRINOGEN, GAMMA POLYPEPTIDE. [MASS=49121

2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO LAMININ B1. [MASS=228429
2	**2**	Rattus norvegicus (Rat) URIDINE MONOPHOSPHATE SYNTHETASE. [MASS=52379
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PROTOCADHERIN 18 PRECURSOR. [MASS=123552
2	**2**	Rattus norvegicus (Rat) ASCC3L1 PROTEIN. [MASS=244875
2	**2**	Rattus norvegicus (Rat) PROLIFERATION-ASSOCIATED 2G4, 38KDA. [MASS=43657
2	**2**	Rattus norvegicus (Rat) T-COMPLEX PROTEIN 1 SUBUNIT ALPHA. [MASS=60360
2	**2**	Rattus norvegicus (Rat) INOSINE MONOPHOSPHATE DEHYDROGENASE 2. [MASS=55799
2	**2**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L7A. [MASS=29864
2	**2**	Rattus norvegicus (Rat) LOW-DENSITY LIPOPROTEIN RECEPTOR PRECURSOR. [MASS=96622
2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO NISCHARIN. [MASS=148481
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO GTPASE ACTIVATING PROTEIN AND VPS9 DOMAINS 1. [MASS=160359
2	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALDEHYDE DEHYDROGENASE FAMILY 7, MEMBER A1. [MASS=58749
2	**2**	Rattus norvegicus (Rat) NUCLEOSIDE DIPHOSPHATE KINASE B. [MASS=17283
2	**2**	Rattus norvegicus (Rat) COMPLEMENT COMPONENT C6 PRECURSOR. [MASS=105114
2	**2**	Rattus norvegicus (Rat) PREDICTED: TYROSINE KINASE RECEPTOR 1. [MASS=125210
2	**4**	Rattus norvegicus (Rat) HEMOGLOBIN ALPHA-1/2 SUBUNIT. [MASS=15197
2	**2**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S18. [MASS=17719
2	**2**	Rattus norvegicus (Rat) SPLICE ISOFORM V0 OF VERSICAN CORE PROTEIN PRECURSOR (FRAGMENT). [MASS=300008
2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO MAM DOMAIN CONTAINING 2. [MASS=68019
2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PUTATIVE E3 LIGASE. [MASS=526904
2	**2**	Rattus norvegicus (Rat) INSULIN-LIKE GROWTH FACTOR 1 RECEPTOR PRECURSOR. [MASS=155524
2	**2**	Rattus norvegicus (Rat) GLUCOSIDASE, ALPHA; ACID. [MASS=106207
2	**2**	Rattus norvegicus (Rat) COMPLEMENT COMPONENT 1, S SUBCOMPONENT. [MASS=77713
2	**3**	Rattus norvegicus (Rat) SPLICE ISOFORM 2 OF TROPOMYOSIN BETA CHAIN. [MASS=32958
2	**2**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN ALDOAL1. [MASS=39492
2	**2**	Rattus norvegicus (Rat) DNA POLYMERASE DELTA CATALYTIC SUBUNIT. [MASS=123601
2	**4**	Rattus norvegicus (Rat) AC2-008. [MASS=26204
2	**2**	Rattus norvegicus (Rat) PRX IV. [MASS=31007

Table 1.8. Protein matches E17.5 LV second analysis

Protein matches E17.5 LV second analysis	Molecular Weight
14-3-3 protein beta/alpha	28037
14-3-3 protein epsilon	29345
14-3-3 protein gamma	28342
14-3-3 protein theta	28063
14-3-3 protein zeta/delta	27942
18 kDa protein	18663
20 kDa protein	20033
21 kDa protein	21585
26S protease regulatory subunit 8	45797
29 kDa protein	29540
31 kDa protein	31415
32 kDa protein	32525
32 kDa protein	32833
33 kDa protein	32943
35 kDa protein	35005
35 kDa protein	35717
35 kDa protein	35586
38 kDa protein	38434
38 kDa protein	38434
38 kDa protein	38510
39 kDa protein	39428
40S ribosomal protein S11	18602
40S ribosomal protein S3	26845
40S ribosomal protein S3a	30042
40S ribosomal protein S4, X isoform	29694
40S ribosomal protein S5	22918
40S ribosomal protein S6	28851
40S ribosomal protein S7	22127
40S ribosomal protein S8	24359
40S ribosomal protein SA	32807
42 kDa protein	42846
43 kDa protein	45093
45 kDa protein	44917
45 kDa protein	45796
45 kDa protein	45796
45 kDa protein	45796
46 kDa protein	46534
47 kDa heat shock protein precursor	46631
50 kDa protein	50675
50 kDa protein	50450
51 kDa protein	51503
60S acidic ribosomal protein P0	34386
60S ribosomal protein L11	20349
60S ribosomal protein L15	24129
60S ribosomal protein L5	34555
60S ribosomal protein L7	30386
90 kDa protein	90936

Aa1064	538071
Ab2-076	104278
Ab2-379	62360
Ac1873	87398
Actin, alpha skeletal muscle	42393
Actin, gamma-enteric smooth muscle	42276
Adenine phosphoribosyltransferase	20049
Adenosylhomocysteinase	47920
ADP-ribosylation factor 3	20526
ADP-ribosylation factor 4	20379
ADP-ribosylation factor 6	20065
Alcohol dehydrogenase	36602
Aldose reductase	36122
Alpha-1-antiproteinase precursor	46306
Alpha-2 antiplasmin	46522
Alpha-2-globin chain	15456
Alpha-2-HS-glycoprotein precursor	38781
AMBP protein precursor	39763
Angiotensin II type 1A receptor associated protein	57615
Angiotensinogen precursor	52209
APEX	32752
Apolipoprotein A-I	30119
Apolipoprotein A-II precursor	11496
Apolipoprotein A-IV precursor	44456
Apolipoprotein E precursor	35810
Apolipoprotein M precursor	21855
Ba1-667	109614
Beta-1,3-N-acetylglucosaminyltransferase lunatic fringe	42471
Beta-2-glycoprotein I precursor	34338
Beta-2-microglobulin precursor	13834
Calcyclin binding protein	26655
cAMP-dependent protein kinase type I-alpha regulatory subunit	43191
Carbonic anhydrase 2	29153
Casein kinase II, alpha chain	45187
Cathepsin B, preproprotein	38457
Cathepsin L precursor	38231
Cathepsin Z precursor	34879
Cd81 protein	26589
Cell division control protein 2 homolog	34191
Cfh protein	46732
Cofilin-1	25102
Collagen alpha 1(V) chain precursor	185292
Collagen alpha 1(XI) chain precursor	171893
Collagen alpha 2(I) chain precursor	130076
Collagen alpha 2(I) chain precursor	130076
Collagen alpha1	138912
Complement C1q subcomponent, B chain precursor	26817
Complement C1q subcomponent, C chain precursor	25971

Connective tissue growth factor precursor	39981
Creatine kinase B-type	42997
Cystatin C	15665
Cytosolic malate dehydrogenase	36654
DJ-1 protein	20202
EGF-containing fibulin-like extracellular matrix protein 2	46847
Elongation factor 1-alpha 1	50456
Epsilon 1 globin	16161
Epsilon-sarcoglycan	50239
Eukaryotic translation initiation factor 2 subunit 1	36262
Eukaryotic translation initiation factor 3, subunit 3 gamma, 40kDa	40076
Extracellular superoxide dismutase [Cu-Zn] precursor	27019
FAM3C-like protein	24999
Fatty acid-binding protein, brain	15018
Fetuin-B precursor	42388
Fructose-bisphosphate aldolase A	39677
Fructose-bisphosphate aldolase C	39551
Galactokinase 1	42832
Gelsolin	86856
Glutathione S-transferase P	23536
Glyceraldehyde-3-phosphate dehydrogenase	36079
GTP-binding nuclear protein Ran	24594
GTP-binding nuclear protein Ran, testis-specific isoform	24622
Guanine nucleotide-binding protein beta subunit 2-like 1	35875
Guanine nucleotide-binding protein G(I)/G(S)/G(T) beta subunit 1	38044
Hemoglobin alpha-1 and alpha-2 chains	15368
Hemoglobin beta chain, major-form	15962
Hemoglobin beta chain, minor-form	15965
Heterogeneous nuclear ribonucleoprotein A1	34252
Heterogeneous nuclear ribonucleoprotein C	32914
Heterogeneous nuclear ribonucleoprotein F	46072
Hypothetical LOC315594	32346
Hypothetical LOC316842	35039
Hypothetical LOC363644	33553
Hypothetical protein	59591
Hypothetical protein	37353
Hypothetical protein	34736
Hypothetical protein LOC311078	34748
Hypothetical protein RGD1308228_predicted	33918
HYRAC	32094
Ig lambda-2 chain C region	25750
Insulin-like growth factor binding protein 2 precursor	33966
Insulin-like growth factor binding protein 4 precursor	28886
Insulin-like growth factor II precursor	20542
Isocitrate dehydrogenase [NADP] cytoplasmic	47076
Lactadherin precursor	48553
LIM and SH3 domain protein 1	30369
L-lactate dehydrogenase A chain	36735

L-lactate dehydrogenase B chain	36766
LOC367586 protein	51633
LOC500183 protein	26034
LRRGT00147	108859
Lysozyme	17186
Mannose-binding protein associated serine protease-1	81703
Masp1 protein	45168
Matrix Gla-protein precursor	12208
Metalloproteinase inhibitor 1 precursor	24478
Metalloproteinase inhibitor 2 precursor	25041
Multifunctional protein ADE2	47706
Neurexin-2-alpha precursor	187392
Neutrophil antibiotic peptide NP-4 precursor	10452
NG,NG-dimethylarginine dimethylaminohydrolase 1	31694
Nuclear migration protein nudC	38412
Pancreatic triacylglycerol lipase precursor	52181
Peptidyl-prolyl cis-trans isomerase A	17971
Peptidyl-prolyl cis-trans isomerase B precursor	23859
Peptidylprolyl isomerase C	23066
Peroxiredoxin 1	22337
Peroxiredoxin 2	21823
Phosphatidylethanolamine-binding protein	20784
Phosphoglycerate kinase 1	44937
Phosphoglycerate kinase 2	45409
Phosphoglycerate mutase 1	28571
Phosphoglycerate mutase 2	28795
Phosphoserine aminotransferase 1	40969
Plasma glutathione peroxidase precursor	25678
Platelet-activating factor acetylhydrolase IB alpha subunit	47109
PREDICTED: ATPase, H+ transporting, lysosomal accessory protein 2	66492
PREDICTED: dystroglycan 1	97048
PREDICTED: eukaryotic translation elongation factor 1 gamma	73357
PREDICTED: Glycoprotein-4-beta-galactosyltransferase 2	44883
PREDICTED: multiple inositol polyphosphate histidine phosphatase 1	73188
PREDICTED: nidogen 2 (predicted)	176810
PREDICTED: procollagen type XI alpha 1	182884
PREDICTED: proteasome (prosome, macropain) subunit, beta type 5	37413
PREDICTED: retinol binding protein 4, plasma	50766
PREDICTED: serine (or cysteine) proteinase inhibitor, clade F, member 2 (predicted)	62084
PREDICTED: similar to 25 kDa FK506-binding protein	25236
PREDICTED: similar to 40S ribosomal protein S9	22761
PREDICTED: similar to 60S ribosomal protein L7	25560
PREDICTED: similar to 60S ribosomal protein L8	28385
PREDICTED: similar to 60S ribosomal protein L9	21971
PREDICTED: similar to Ab2-076	79786
PREDICTED: similar to actin related protein 2/3 complex subunit 2	39999
PREDICTED: similar to Actin, cytoplasmic 2 (Gamma-actin)	62610

PREDICTED: similar to alpha 3 type VI collagen isoform 1 precursor	370838
PREDICTED: similar to Alpha enolase (2-phospho-D-glycerate hydro-lyase) (Non-neural enolase) (NNE)	47602
PREDICTED: similar to Alpha enolase (2-phospho-D-glycerate hydro-lyase) (Non-neural enolase) (NNE)	46831
PREDICTED: similar to alpha NAC/1.9.2. protein	23384
PREDICTED: similar to Alpha-centractin (Centractin) (Centrosome-associated actin homolog) (Actin-RP	51683
PREDICTED: similar to Apolipoprotein C2	10695
PREDICTED: similar to cofilin	18823
PREDICTED: similar to collagen alpha 2(IV) chain precursor - mouse	194644
PREDICTED: similar to ELAV (embryonic lethal, abnormal vision, Drosophila)-like 1 (Hu antigen R)	49756
PREDICTED: similar to Glyceraldehyde-3-phosphate dehydrogenase (GAPDH)	38691
PREDICTED: similar to glyceraldehyde-3-phosphate dehydrogenase (phosphorylating) (EC 1.2.1.12) - m	22732
PREDICTED: similar to glycosyltransferase 28 domain containing 1	54235
PREDICTED: similar to heparan sulfate proteoglycan 2 (perlecan)	506188
PREDICTED: similar to heterogeneous nuclear ribonucleoprotein A0	102890
PREDICTED: similar to heterogeneous nuclear ribonucleoprotein D-like	46478
PREDICTED: similar to heterogeneous nuclear ribonucleoprotein H3 isoform a	40077
PREDICTED: similar to Heterogeneous nuclear ribonucleoproteins A2/B1 (hnRNP A2 / hnRNP B1)	37486
PREDICTED: similar to High mobility group protein 1 (HMG-1) (Amphoterin) (Heparin-binding protein p	25049
PREDICTED: similar to IGFBP-like protein	29708
PREDICTED: similar to immunoglobulin light chain	26598
PREDICTED: similar to keratin 6 alpha	64111
PREDICTED: similar to mKIAA1631 protein	151853
PREDICTED: similar to myosin-VIIb	307380
PREDICTED: similar to OTTHUMP00000060196	298228
PREDICTED: similar to OTTHUMP00000065631	650022
PREDICTED: similar to Phosphoglycerate kinase 1	43632
PREDICTED: similar to poly(rC) binding protein 2	35269
PREDICTED: similar to Poly(rC)-binding protein 1 (Alpha-CP1) (hnRNP-E1)	38011
PREDICTED: similar to procollagen, type IX, alpha 1	117067
PREDICTED: similar to Proteasome subunit alpha type 7-like	34868
PREDICTED: similar to purine-nucleoside phosphorylase	32587
PREDICTED: similar to pyrophosphatase	33227
PREDICTED: similar to RAB5B protein	35237
PREDICTED: similar to ribosomal protein L14	18522
PREDICTED: similar to RIKEN cDNA 4732495G21 gene	42305
PREDICTED: similar to Tubulin alpha-2 chain (Alpha-tubulin 2)	50964
PREDICTED: similar to tubulin, beta, 2	44993
PREDICTED: similar to Vesicular integral-membrane protein VIP36 precursor (Lectin, mannose-binding	40735

PREDICTED: thrombospondin 4	124213
Proliferating cell nuclear antigen	29091
Proliferation-associated 2G4, 38kDa	43999
ProProtein convertase subtilisin/kexin tyPe 9	82452
Proteasome (Prosome, macroPain) subunit, beta tyPe 4	25908
Proteasome subunit alpha type 2	25909
Proteasome subunit alpha type 3-like	28639
Proteasome subunit alpha type 4	29783
Proteasome subunit alpha type 6	27856
Proteasome subunit beta type 1	26707
Proteasome subunit beta type 2	23083
Proteasome subunit beta type 6-like	25532
Proteasome subunit beta type 7 precursor	30269
Protein arginine N-methyltransferase 1	43063
Prothrombin precursor	71837
Ras-related protein Rab-10	23086
Ras-related protein Rab-11B	24471
Ras-related protein Rab-14	24155
Ras-related protein Rab-8B	23774
Rho GDP dissociation inhibitor (GDI) alpha	23464
Ribose-phosphate pyrophosphokinase I-like	35319
Serine/threonine protein phosphatase 2A, catalytic subunit, alpha isoform	36178
Serine/threonine protein phosphatase PP1-alpha catalytic subunit	38253
Serum albumin precursor	70715
Similar to Ras-related protein Rab-1B	22348
Soluble calcium-activated nucleotidase 1	45715
SPARC precursor	35297
Splice Isoform 1 of Alpha-fetoprotein precursor	70211
Splice Isoform 1 of Fibronectin precursor	276159
Splice Isoform 1 of Heterogeneous nuclear ribonucleoprotein D0	38363
Splice Isoform 1 of Sex hormone-binding globulin precursor	44875
Splice Isoform 3 of Agrin precursor	214603
Splice Isoform Long of Hyaluronan and proteoglycan link protein 1 precursor	40889
Splice Isoform RC6-IL of Proteasome subunit alpha type 7	28497
Spliceosome RNA helicase Bat1	49491
Spp-24	23455
Stathmin	17157
Syntenin-1	32651
TGF-beta receptor type III precursor	95072
Thrombospondin 1	133664
Transcobalamin II precursor	47876
Transforming protein RhoA	22124
Translationally controlled tumor protein	19576
Transthyretin precursor	15834
Triosephosphate isomerase	27303
Tubb3 protein	50875

Tubulin alpha-1 chain	50820
Tubulin alpha-3 chain	50644
Tubulin beta-5 chain	50127
Tubulin, beta, 2	50257
Type A/B hnRNP p38	30967
Ubiquitin carboxyl-terminal hydrolase isozyme L1	25180
Ubiquitin-like 1	38969
Vascular endothelial cell specific protein 11	41763
Vimentin	53658
Vitamin D-binding protein precursor	55141
Zero beta-1 globin	16079

Table 1.9. Adult Rat CSF Proteome

Unique peptides	Total peptides	Name of protein from adult rat CSF	Present in Embryonic CSF
18	26	COMPLEMENT C3 PRECURSOR (FRAGMENT).	Yes
16	42	BA1-667 - Transferrin.	Yes
15	54	SERUM ALBUMIN PRECURSOR.	Yes
15	21	CONTACTIN-1 PRECURSOR.	Yes
15	19	ALPHA-2-MACROGLOBULIN PRECURSOR.	Yes
13	17	ISOFORM 1 OF FIBRONECTIN PRECURSOR.	Yes
12	19	APOLIPOPROTEIN E PRECURSOR.	Yes
12	19	GPI-ANCHORED CERULOPLASMIN.	Yes
10	13	ALPHA-1-MACROGLOBULIN PRECURSOR.	Yes
9	22	ALPHA-1-INHIBITOR 3 PRECURSOR.	Yes
9	19	Ectonucleotide pyrophosphatase/phosphodiesterase 2	Yes
9	10	COMPLEMENT C4 PRECURSOR.	Yes
9	9	INTER-ALPHA-INHIBITOR H4 HEAVY CHAIN.	Yes
8	12	CLUSTERIN PRECURSOR.	Yes
8	9	APOLIPOPROTEIN A-IV PRECURSOR.	Yes
7	16	GELSOLIN PRECURSOR.	Yes
7	10	"ACTIN, ALPHA SKELETAL MUSCLE."	Yes
7	7	SIMILAR TO AMYLOID-LIKE PROTEIN 1 PRECURSOR.	Yes
6	10	LOC367586 PROTEIN.	Yes
6	9	ALPHA-1-ANTIPROTEINASE PRECURSOR.	Yes
6	7	FETUB PROTEIN.	Yes
6	6	SPARC-LIKE PROTEIN 1 PRECURSOR.	Yes
5	9	HEMOPEXIN PRECURSOR.	Yes
5	8	ISOFORM APP770 OF AMYLOID BETA A4 PROTEIN PRECURSOR (FRAGMENT).	Yes
5	8	"NEURAL CELL ADHESION MOLECULE 1, 140 KDA ISOFORM PRECURSOR."	Yes
5	6	COMPLEMENT COMPONENT 2.	Yes
5	5	SERINE PROTEASE INHIBITOR A3N PRECURSOR.	Yes
5	5	SERINE PROTEASE INHIBITOR A3L PRECURSOR.	Yes
5	5	COLLAGEN ALPHA-1(I) CHAIN PRECURSOR.	Yes
4	8	ISOFORM 1 OF MURINOGLOBULIN-1 PRECURSOR.	Yes
4	6	TRANSTHYRETIN PRECURSOR.	Yes
4	5	PLASMA PROTEASE C1 INHIBITOR PRECURSOR.	
4	5	SIMILAR TO FIBULIN-1 PRECURSOR.	Yes
4	5	CREATINE KINASE M-TYPE.	
4	4	"SERINE (OR CYSTEINE) PEPTIDASE INHIBITOR, CLADE C (ANTITHROMBIN),MEMBER 1."	Yes
4	4	CORTICOSTEROID-BINDING GLOBULIN PRECURSOR.	Yes
4	4	FRUCTOSE-BISPHOSPHATE ALDOLASE.	Yes
4	4	CREATINE KINASE B-TYPE.	Yes
4	4	LUMICAN PRECURSOR.	Yes
4	4	COLLAGEN ALPHA-2(I) CHAIN PRECURSOR.	Yes

4	4	SIMILAR TO COMPLEMENT COMPONENT 7 PRECURSOR.	Yes
3	5	CARBOXYPEPTIDASE E PRECURSOR.	
3	4	115 KDA PROTEIN.	
3	4	ANGIOTENSINOGEN PRECURSOR.	Yes
3	4	LIVER CARBOXYLESTERASE 1 PRECURSOR.	Yes
3	4	MAMA.	Yes
3	4	ISOFORM M1 OF PYRUVATE KINASE ISOZYMES M1/M2.	Yes
3	3	SECRETOGRANIN-3 PRECURSOR.	Yes
3	3	IGH-1A PROTEIN.	Yes
3	3	SERINE PROTEASE INHIBITOR A3K PRECURSOR.	
3	3	ISOFORM 1 OF TUBULIN BETA-5 CHAIN.	Yes
3	3	CONTACTIN-2 PRECURSOR.	Yes
3	3	ISOFORM 1 OF ALPHA-1B-GLYCOPROTEIN PRECURSOR.	Yes
3	3	PLASMINOGEN PRECURSOR.	Yes
3	3	DA1-24 Complement Factor B.	Yes
3	3	PROTHROMBIN PRECURSOR (FRAGMENT).	Yes
3	3	ISOFORM 1 OF NEURONAL CELL ADHESION MOLECULE PRECURSOR.	Yes
3	3	COMPLEMENT INHIBITORY FACTOR H.	Yes
3	3	"PHOSPHOLIPASE A2, GROUP VII."	
2	7	ISOFORM SHORT OF ANNEXIN A2.	
2	3	T-KININOGEN 1 PRECURSOR.	Yes
2	3	102 KDA PROTEIN.	
2	2	DIPEPTIDYL-PEPTIDASE 2 PRECURSOR.	
2	2	13 KDA PROTEIN.	
2	2	"SIMILAR TO IG GAMMA-1, CHAIN C REGION."	
2	2	ISOFORM 1 OF SULFHYDRYL OXIDASE 1 PRECURSOR.	
2	2	LACTADHERIN PRECURSOR.	Yes
2	2	ISOFORM 1 OF LIMBIC SYSTEM-ASSOCIATED MEMBRANE PROTEIN PRECURSOR.	
2	2	78 KDA GLUCOSE-REGULATED PROTEIN PRECURSOR.	
2	2	SIMILAR TO CELL ADHESION MOLECULE WITH HOMOLOGY TO L1CAM.	
2	2	SECRETOGRANIN-1 PRECURSOR.	
2	2	ACTIN, CYTOPLASMIC 1.	Yes
2	2	NUCLEOBINDIN-1 PRECURSOR.	
2	2	APOLIPOPROTEIN A-I PRECURSOR.	Yes
2	2	KALLISTATIN.	Yes
2	2	SIMILAR TO FILAMIN-C (GAMMA-FILAMIN) (FILAMIN-2) (PROTEIN FLNC)(ACTIN-BINDING-LIKE PROTEIN) (ABP-L) (ABP-280-LIKE PROTEIN) ISOFORM 2.	
2	2	PHOSPHOGLYCERATE KINASE 1.	Yes

Table 1.10. Additional proteins identified in E14.5 LV CSF.

Unique peptides	Total peptides	Additional proteins identified in E14.5 LV
57	**161**	Rattus norvegicus (Rat) 165 KDA PROTEIN. [MASS=165356
13	**43**	Rattus norvegicus (Rat) GLYCERALDEHYDE-3-PHOSPHATE DEHYDROGENASE. [MASS=35794
11	**13**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CCTETA, ETA SUBUNIT OF THE CHAPERONIN CONTAINING TCP-1. [MASS=75684
10	**12**	Rattus norvegicus (Rat) 170 KDA PROTEIN. [MASS=170088
10	**11**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO DNA REPLICATION LICENSING FACTOR MCM3. [MASS=83429
9	**9**	Rattus norvegicus (Rat) 46 KDA PROTEIN. [MASS=45764
9	**9**	Rattus norvegicus (Rat) TLN PROTEIN. [MASS=161978
9	**12**	Rattus norvegicus (Rat) TUBULIN BETA-3 CHAIN. [MASS=50419
8	**42**	Rattus norvegicus (Rat) 57 KDA PROTEIN. [MASS=57338
8	**11**	Rattus norvegicus (Rat) HEAT-SHOCK PROTEIN 105 KDA. [MASS=96419
8	**14**	Rattus norvegicus (Rat) HISTONE H4. [MASS=11236
8	**20**	Rattus norvegicus (Rat) HYDROXYMETHYLGLUTARYL-COA SYNTHASE, CYTOPLASMIC. [MASS=57434
8	**8**	Rattus norvegicus (Rat) PREDICTED: MICROTUBULE-ASSOCIATED PROTEIN 1B. [MASS=269643
8	**8**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO FILAMIN B. [MASS=291469
8	**10**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO MKIAA0002 PROTEIN. [MASS=59745
8	**8**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO NOVEL PROTEIN. [MASS=146178
8	**9**	Rattus norvegicus (Rat) PROLIFERATING CELL NUCLEAR ANTIGEN. [MASS=28749
8	**8**	Rattus norvegicus (Rat) PROTEIN DISULFIDE-ISOMERASE A3 PRECURSOR. [MASS=57079
8	**15**	Rattus norvegicus (Rat) PROTEIN DJ-1. [MASS=19974
8	**10**	Rattus norvegicus (Rat) T-COMPLEX PROTEIN 1 SUBUNIT DELTA. [MASS=57968
8	**9**	Rattus norvegicus (Rat) TROPOMYOSIN ALPHA-4 CHAIN. [MASS=28379
8	**13**	Rattus norvegicus (Rat) UBIQUITIN CARBOXYL-TERMINAL HYDROLASE ISOZYME L1. [MASS=24838
8	**8**	Rattus norvegicus (Rat) VALYL-TRNA SYNTHETASE. [MASS=141275
7	**7**	Rattus norvegicus (Rat) 100 KDA PROTEIN. [MASS=100351
7	**9**	Rattus norvegicus (Rat) 51 KDA PROTEIN. [MASS=50509
7	**10**	Rattus norvegicus (Rat) ALPHA-ACTININ-1. [MASS=102960
7	**11**	Rattus norvegicus (Rat) FARNESYL PYROPHOSPHATE SYNTHETASE. [MASS=40830
7	**9**	Rattus norvegicus (Rat) NSFL1 COFACTOR P47. [MASS=40680
7	**10**	Rattus norvegicus (Rat) PEROXIREDOXIN-6. [MASS=24687
7	**10**	Rattus norvegicus (Rat) PREDICTED: COLLAGEN, TYPE V, ALPHA 2. [MASS=141406
7	**19**	Rattus norvegicus (Rat) PREDICTED: PROTEASOME (PROSOME, MACROPAIN) SUBUNIT, BETA TYPE 5. [MASS=37128

7	**7**	Rattus norvegicus (Rat) PROTEIN ARGININE N-METHYLTRANSFERASE 1. [MASS=42436
7	**12**	Rattus norvegicus (Rat) RHO GDP DISSOCIATION INHIBITOR (GDI) ALPHA. [MASS=23407
7	**7**	Rattus norvegicus (Rat) VASCULAR ENDOTHELIAL CELL SPECIFIC PROTEIN 11. [MASS=41593
6	**7**	Rattus norvegicus (Rat) 156 KDA PROTEIN. [MASS=156144
6	**9**	Rattus norvegicus (Rat) 21 KDA PROTEIN. [MASS=20941
6	**10**	Rattus norvegicus (Rat) ADP-RIBOSYLATION FACTOR 2. [MASS=20746
6	**6**	Rattus norvegicus (Rat) ALPHA-ACTININ-4. [MASS=104786
6	**8**	Rattus norvegicus (Rat) ATAXIN-10. [MASS=53727
6	**7**	Rattus norvegicus (Rat) CARBONIC ANHYDRASE 2. [MASS=28983
6	**12**	Rattus norvegicus (Rat) CATHEPSIN L PRECURSOR. [MASS=37660
6	**9**	Rattus norvegicus (Rat) CELL DIVISION CONTROL PROTEIN 2 HOMOLOG. [MASS=34135
6	**11**	Rattus norvegicus (Rat) GLUTATHIONE S-TRANSFERASE P. [MASS=23308
6	**8**	Rattus norvegicus (Rat) HEMOGLOBIN BETA-1 SUBUNIT. [MASS=15848
6	**9**	Rattus norvegicus (Rat) ISOCITRATE DEHYDROGENASE [NADP] CYTOPLASMIC. [MASS=46734
6	**6**	Rattus norvegicus (Rat) PREDICTED: NUCLEAR MITOTIC APPARATUS PROTEIN 1. [MASS=248574
6	**18**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 25 KDA FK506-BINDING PROTEIN. [MASS=25179
6	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO GLYCERALDEHYDE-3-PHOSPHATE DEHYDROGENASE. [MASS=35200
6	**8**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO P59 IMMUNOPHILIN. [MASS=80396
6	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RAB5C PROTEIN. [MASS=23426
6	**11**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RAN BINDING PROTEIN 5. [MASS=133476
6	**8**	Rattus norvegicus (Rat) PROTEASEOME. [MASS=29506
6	**6**	Rattus norvegicus (Rat) PROTEASOME SUBUNIT ALPHA TYPE 3-LIKE. [MASS=28354
6	**14**	Rattus norvegicus (Rat) PROTEASOME SUBUNIT BETA TYPE 2. [MASS=22912
6	**9**	Rattus norvegicus (Rat) PROTEASOME SUBUNIT BETA TYPE 3. [MASS=22965
6	**7**	Rattus norvegicus (Rat) RETINOL-BINDING PROTEIN I, CELLULAR. [MASS=15703
6	**10**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF PROTEIN SET. [MASS=33406
6	**9**	Rattus norvegicus (Rat) SPLICE ISOFORM 2 OF TROPOMYOSIN BETA CHAIN. [MASS=32958
6	**10**	Rattus norvegicus (Rat) SPLICE ISOFORM GAMMA-B OF FIBRINOGEN GAMMA CHAIN PRECURSOR. [MASS=50633
6	**7**	Rattus norvegicus (Rat) SSB PROTEIN. [MASS=43926
5	**5**	Rattus norvegicus (Rat) 139 KDA PROTEIN. [MASS=138706
5	**16**	Rattus norvegicus (Rat) 14 KDA PROTEIN. [MASS=13890
5	**8**	Rattus norvegicus (Rat) 14-3-3 PROTEIN BETA/ALPHA. [MASS=27923
5	**5**	Rattus norvegicus (Rat) 150 KDA OXYGEN-REGULATED PROTEIN PRECURSOR. [MASS=111289
5	**6**	Rattus norvegicus (Rat) 21 KDA PROTEIN. [MASS=21033

5	**5**	Rattus norvegicus (Rat) 26S PROTEASE REGULATORY SUBUNIT 8. [MASS=45626
5	**6**	Rattus norvegicus (Rat) 26S PROTEASOME NON-ATPASE REGULATORY SUBUNIT 1. [MASS=105748
5	**13**	Rattus norvegicus (Rat) 32 KDA PROTEIN. [MASS=32468
5	**5**	Rattus norvegicus (Rat) 57 KDA PROTEIN. [MASS=57036
5	**29**	Rattus norvegicus (Rat) 75 KDA PROTEIN. [MASS=75381
5	**8**	Rattus norvegicus (Rat) 99 KDA PROTEIN. [MASS=98968
5	**13**	Rattus norvegicus (Rat) APOLIPOPROTEIN A-II PRECURSOR. [MASS=11439
5	**16**	Rattus norvegicus (Rat) APOLIPOPROTEIN M PRECURSOR. [MASS=21513
5	**5**	Rattus norvegicus (Rat) CALCYCLIN BINDING PROTEIN. [MASS=26541
5	**6**	Rattus norvegicus (Rat) CALPONIN-3. [MASS=36435
5	**5**	Rattus norvegicus (Rat) COATOMER SUBUNIT BETA. [MASS=107011
5	**5**	Rattus norvegicus (Rat) DREBRIN 1. [MASS=77472
5	**6**	Rattus norvegicus (Rat) GLUTATHIONE PEROXIDASE 1. [MASS=22258
5	**7**	Rattus norvegicus (Rat) HEMATOLOGICAL AND NEUROLOGICAL EXPRESSED 1-LIKE PROTEIN. [MASS=20070
5	**8**	Rattus norvegicus (Rat) MACROPHAGE MANNOSE RECEPTOR 2 PRECURSOR. [MASS=167022
5	**5**	Rattus norvegicus (Rat) MANNOSIDASE, ALPHA, CLASS 1A, MEMBER 1. [MASS=73125
5	**6**	Rattus norvegicus (Rat) NUCLEOSOME ASSEMBLY PROTEIN 1-LIKE 4. [MASS=47304
5	**16**	Rattus norvegicus (Rat) PHOSPHATIDYLETHANOLAMINE-BINDING PROTEIN. [MASS=20670
5	**5**	Rattus norvegicus (Rat) PHOSPHOPROTEIN ENRICHED IN ASTROCYTES 15. [MASS=15040
5	**7**	Rattus norvegicus (Rat) PREDICTED: EUKARYOTIC TRANSLATION ELONGATION FACTOR 1 GAMMA. [MASS=72445
5	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 6-PHOSPHOGLUCONOLACTONASE. [MASS=30821
5	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO CAB39 PROTEIN. [MASS=39873
5	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO M2 RIBONUCLEOTIDE REDUCTASE. [MASS=45023
5	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PROTEIN KINASE C INHIBITOR. [MASS=13776
5	**5**	Rattus norvegicus (Rat) PROTEASOME ACTIVATOR COMPLEX SUBUNIT 1. [MASS=29200
5	**6**	Rattus norvegicus (Rat) PROTEASOME, 26S, NON-ATPASE REGULATORY SUBUNIT 6. [MASS=45598
5	**5**	Rattus norvegicus (Rat) PROTECTIVE PROTEIN FOR BETA-GALACTOSIDASE. [MASS=51216
5	**11**	Rattus norvegicus (Rat) SPLICE ISOFORM GAMMA-B OF FIBRINOGEN GAMMA CHAIN PRECURSOR. [MASS=50633
5	**5**	Rattus norvegicus (Rat) SPLICE ISOFORM RC6-IL OF PROTEASOME SUBUNIT ALPHA TYPE 7. [MASS=28326
5	**5**	Rattus norvegicus (Rat) THIOREDOXIN DOMAIN CONTAINING 7. [MASS=48760
5	**7**	Rattus norvegicus (Rat) TRANSGELIN 2. [MASS=23443
5	**5**	Rattus norvegicus (Rat) TRANSLATION ELONGATION FACTOR 1-DELTA SUBUNIT. [MASS=28766

5	**7**	Rattus norvegicus (Rat) UBIQUITIN-CONJUGATING ENZYME E2 N. [MASS=17124
4	**4**	Rattus norvegicus (Rat) 14-3-3 PROTEIN ETA. [MASS=28081
4	**7**	Rattus norvegicus (Rat) 34 KDA PROTEIN. [MASS=33656
4	**4**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S4, X ISOFORM. [MASS=29467
4	**5**	Rattus norvegicus (Rat) 72 KDA PROTEIN. [MASS=72321
4	**4**	Rattus norvegicus (Rat) 93 KDA PROTEIN. [MASS=93472
4	**4**	Rattus norvegicus (Rat) ADENINE PHOSPHORIBOSYLTRANSFERASE. [MASS=19764
4	**5**	Rattus norvegicus (Rat) APEX (FRAGMENT). [MASS=32353
4	**4**	Rattus norvegicus (Rat) ASPARTYL-TRNA SYNTHETASE. [MASS=57126
4	**4**	Rattus norvegicus (Rat) COLLAGEN TYPE A1(XI)6B-7. [MASS=171268
4	**4**	Rattus norvegicus (Rat) DYNACTIN-1. [MASS=141930
4	**4**	Rattus norvegicus (Rat) EUKARYOTIC TRANSLATION INITIATION FACTOR 2 SUBUNIT 1. [MASS=35977
4	**5**	Rattus norvegicus (Rat) GROWTH/DIFFERENTIATION FACTOR 8 PRECURSOR. [MASS=42829
4	**4**	Rattus norvegicus (Rat) HAUSP. [MASS=128431
4	**4**	Rattus norvegicus (Rat) HEMATOLOGICAL AND NEUROLOGICAL EXPRESSED 1 PROTEIN. [MASS=15854
4	**7**	Rattus norvegicus (Rat) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN F. [MASS=45730
4	**4**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN RGD1310116. [MASS=25833
4	**5**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN. [MASS=32502
4	**6**	Rattus norvegicus (Rat) KINESIN-1 HEAVY CHAIN. [MASS=109531
4	**4**	Rattus norvegicus (Rat) KINESIN-LIKE PROTEIN KIF15. [MASS=159554
4	**4**	Rattus norvegicus (Rat) MALATE DEHYDROGENASE, MITOCHONDRIAL PRECURSOR. [MASS=35656
4	**5**	Rattus norvegicus (Rat) METALLOPROTEINASE INHIBITOR 2 PRECURSOR. [MASS=24356
4	**5**	Rattus norvegicus (Rat) NUCLEAR MIGRATION PROTEIN NUDC. [MASS=38412
4	**12**	Rattus norvegicus (Rat) NUCLEOSIDE DIPHOSPHATE KINASE B. [MASS=17283
4	**4**	Rattus norvegicus (Rat) PHOSPHOSERINE AMINOTRANSFERASE 1. [MASS=40627
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALPHA 3 TYPE VI COLLAGEN ISOFORM 1 PRECURSOR. [MASS=369017
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO COLONIC AND HEPATIC TUMOR OVER-EXPRESSED PROTEIN ISOFORM A. [MASS=198456
4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO EUKARYOTIC TRANSLATION INITIATION FACTOR 3, SUBUNIT 10 THETA, 150/170KDA. [MASS=192616
4	**8**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN A1. [MASS=45242
4	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN A3. [MASS=32075
4	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO IMPORTIN 7. [MASS=119704
4	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO KIAA0166. [MASS=249294

4	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PYROPHOSPHATASE. [MASS=32771
4	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PYRUVATE KINASE 3. [MASS=84928
4	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SPLICING FACTOR 3B, SUBUNIT 3, 130KDA. [MASS=174174
4	**5**	Rattus norvegicus (Rat) PROTEASOME SUBUNIT ALPHA TYPE 1. [MASS=29518
4	**6**	Rattus norvegicus (Rat) PROTEASOME SUBUNIT ALPHA TYPE 6. [MASS=27399
4	**5**	Rattus norvegicus (Rat) RAS-RELATED C3 BOTULINUM TOXIN SUBSTRATE 1 PRECURSOR. [MASS=21450
4	**7**	Rattus norvegicus (Rat) RAS-RELATED PROTEIN RAB-8B. [MASS=23603
4	**5**	Rattus norvegicus (Rat) ROUNDABOUT HOMOLOG 1 PRECURSOR. [MASS=180748
4	**4**	Rattus norvegicus (Rat) RUVB-LIKE 2. [MASS=51147
4	**5**	Rattus norvegicus (Rat) SERUM AMYLOID P-COMPONENT PRECURSOR. [MASS=26176
4	**5**	Rattus norvegicus (Rat) SOLUBLE CALCIUM-ACTIVATED NUCLEOTIDASE 1. [MASS=45659
4	**5**	Rattus norvegicus (Rat) SPLICE ISOFORM 2 OF POLYPYRIMIDINE TRACT-BINDING PROTEIN 2. [MASS=57645
4	**5**	Rattus norvegicus (Rat) SPLICE ISOFORM B OF AP-1 COMPLEX SUBUNIT BETA-1. [MASS=103873
4	**15**	Rattus norvegicus (Rat) SUPEROXIDE DISMUTASE. [MASS=15780
4	**10**	Rattus norvegicus (Rat) TRANSLATIONALLY-CONTROLLED TUMOR PROTEIN. [MASS=19462
4	**5**	Rattus norvegicus (Rat) TXNRD1 PROTEIN. [MASS=63002
4	**4**	Rattus norvegicus (Rat) UDP-N-ACETYLGLUCOSAMINE--PEPTIDE N-ACETYLGLUCOSAMINYLTRANSFERASE 110 KDA SUBUNIT. [MASS=116954
4	**4**	Rattus norvegicus (Rat) VESICLE ASSOCIATED PROTEIN. [MASS=135350
3	**4**	Rattus norvegicus (Rat) 17 KDA PROTEIN. [MASS=16799
3	**5**	Rattus norvegicus (Rat) 17 KDA PROTEIN. [MASS=16815
3	**5**	Rattus norvegicus (Rat) 26S PROTEASE REGULATORY SUBUNIT 4. [MASS=49185
3	**3**	Rattus norvegicus (Rat) 28 KDA HEAT- AND ACID-STABLE PHOSPHOPROTEIN. [MASS=20605
3	**7**	Rattus norvegicus (Rat) 32 KDA PROTEIN. [MASS=32482
3	**5**	Rattus norvegicus (Rat) 33 KDA PROTEIN. [MASS=32913
3	**4**	Rattus norvegicus (Rat) 33 KDA PROTEIN. [MASS=33149
3	**4**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S3. [MASS=26674
3	**3**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S7. [MASS=22127
3	**3**	Rattus norvegicus (Rat) 40S RIBOSOMAL PROTEIN S8. [MASS=24074
3	**4**	Rattus norvegicus (Rat) 45 KDA PROTEIN. [MASS=44518
3	**3**	Rattus norvegicus (Rat) 49 KDA PROTEIN. [MASS=49121
3	**3**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L17. [MASS=21266
3	**4**	Rattus norvegicus (Rat) 72 KDA PROTEIN. [MASS=72419
3	**3**	Rattus norvegicus (Rat) AB2-450. [MASS=163792
3	**3**	Rattus norvegicus (Rat) ADP-RIBOSYLATION FACTOR-LIKE PROTEIN 1. [MASS=20726

3	**3**	Rattus norvegicus (Rat) ATP SYNTHASE ALPHA CHAIN, MITOCHONDRIAL PRECURSOR. [MASS=59754
3	**3**	Rattus norvegicus (Rat) BLEOMYCIN HYDROLASE. [MASS=52452
3	**3**	Rattus norvegicus (Rat) CALRETININ. [MASS=31405
3	**3**	Rattus norvegicus (Rat) CALUMENIN PRECURSOR. [MASS=36997
3	**7**	Rattus norvegicus (Rat) CHLORIDE INTRACELLULAR CHANNEL 1. [MASS=26981
3	**8**	Rattus norvegicus (Rat) COLLECTIN SUB-FAMILY MEMBER 12. [MASS=86551
3	**4**	Rattus norvegicus (Rat) CYSTEINE AND GLYCINE-RICH PROTEIN 2. [MASS=20809
3	**3**	Rattus norvegicus (Rat) DELTA-AMINOLEVULINIC ACID DEHYDRATASE. [MASS=36032
3	**3**	Rattus norvegicus (Rat) DNA LIGASE 1. [MASS=102482
3	**4**	Rattus norvegicus (Rat) EF HAND DOMAIN CONTAINING 2. [MASS=26759
3	**7**	Rattus norvegicus (Rat) ENDOPLASMIC RETICULUM PROTEIN ERP29 PRECURSOR. [MASS=28575
3	**4**	Rattus norvegicus (Rat) EPHRIN-B1 PRECURSOR. [MASS=37951
3	**3**	Rattus norvegicus (Rat) EPSILON-SARCOGLYCAN. [MASS=49840
3	**3**	Rattus norvegicus (Rat) EWSR1 PROTEIN. [MASS=68366
3	**3**	Rattus norvegicus (Rat) FK506-BINDING PROTEIN 1A. [MASS=11791
3	**4**	Rattus norvegicus (Rat) GALACTOKINASE 1. [MASS=42376
3	**4**	Rattus norvegicus (Rat) GENERAL TRANSCRIPTION FACTOR II I. [MASS=110215
3	**3**	Rattus norvegicus (Rat) GLUCOSAMINE. [MASS=60914
3	**3**	Rattus norvegicus (Rat) GUANINE NUCLEOTIDE-BINDING PROTEIN BETA SUBUNIT 2-LIKE 1. [MASS=35419
3	**3**	Rattus norvegicus (Rat) HIGH MOBILITY GROUP PROTEIN B1. [MASS=24763
3	**5**	Rattus norvegicus (Rat) HSC70-INTERACTING PROTEIN. [MASS=41280
3	**6**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN RGD1307010. [MASS=33268
3	**3**	Rattus norvegicus (Rat) INOSITOL MONOPHOSPHATASE. [MASS=30511
3	**3**	Rattus norvegicus (Rat) INTEGRIN BETA 4 BINDING PROTEIN. [MASS=26571
3	**3**	Rattus norvegicus (Rat) KALLISTATIN. [MASS=48021
3	**3**	Rattus norvegicus (Rat) LARGE PROLINE-RICH PROTEIN BAT3. [MASS=114647
3	**4**	Rattus norvegicus (Rat) LEUCINE AMINOPEPTIDASE 3. [MASS=56150
3	**4**	Rattus norvegicus (Rat) LOC296126 PROTEIN. [MASS=244875
3	**3**	Rattus norvegicus (Rat) LOC311078 PROTEIN. [MASS=34577
3	**5**	Rattus norvegicus (Rat) MICROTUBULE-ASSOCIATED PROTEIN RP/EB FAMILY MEMBER 1. [MASS=29873
3	**3**	Rattus norvegicus (Rat) MULTIFUNCTIONAL PROTEIN ADE2. [MASS=46965
3	**3**	Rattus norvegicus (Rat) O-GLCNACASE. [MASS=102918
3	**3**	Rattus norvegicus (Rat) PHOSPHOGLYCERATE MUTASE 2. [MASS=28624
3	**6**	Rattus norvegicus (Rat) PREDICTED: HYPOTHETICAL PROTEIN XP_579384. [MASS=186324
3	**3**	Rattus norvegicus (Rat) PREDICTED: MINI CHROMOSOME MAINTENANCE DEFICIENT 4 HOMOLOG. [MASS=96685
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 2610301G19RIK PROTEIN. [MASS=114440
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 4933425L03RIK PROTEIN. [MASS=393744

3	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 60S RIBOSOMAL PROTEIN L37A. [MASS=11339
3	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO AB2-162. [MASS=26879
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ACTIN RELATED PROTEIN 2/3 COMPLEX SUBUNIT 2. [MASS=39714
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ACTIN RELATED PROTEIN 2/3 COMPLEX, SUBUNIT 4. [MASS=19667
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ADENYLOSUCCINATE SYNTHETASE, NON MUSCLE. [MASS=50085
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO DNA REPLICATION LICENSING FACTOR MCM2. [MASS=102272
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ELAV. [MASS=49528
3	**7**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ENO1 PROTEIN. [MASS=47532
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ERYTHROID DIFFERENTIATION-RELATED FACTOR. [MASS=11707
3	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HIGH MOBILITY GROUP PROTEIN HOMOLOG HMG4. [MASS=27570
3	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HSPC263. [MASS=37041
3	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HUNTINGTIN INTERACTING PROTEIN 2. [MASS=22407
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HYPOTHETICAL UPF0080 PROTEIN KIAA0186. [MASS=22931
3	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO IMMUNOGLOBULIN HEAVY CHAIN. [MASS=120447
3	**7**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO INOSINE TRIPHOSPHATASE. [MASS=21927
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO MKIAA1631 PROTEIN. [MASS=150885
3	**6**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO OTTHUMP00000065631. [MASS=639647
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PEPTIDYLPROLYL ISOMERASE D. [MASS=40711
3	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PSMC6 PROTEIN. [MASS=45797
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIKEN CDNA 1110025F24. [MASS=34423
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIKEN CDNA 2010005A06. [MASS=138914
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIKEN CDNA 5730469D23. [MASS=117931
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SPLICING FACTOR 3A, SUBUNIT 1. [MASS=88588
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO TRANSCRIPTION ELONGATION REGULATOR 1. [MASS=121851
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO TYPE XV COLLAGEN. [MASS=177129
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO U2 SMALL NUCLEAR RIBONUCLEOPROTEIN POLYPEPTIDE A. [MASS=28317
3	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ZINC FINGER PROTEIN 483. [MASS=80394
3	**3**	Rattus norvegicus (Rat) PROTEASOME 26S NON-ATPASE SUBUNIT 12. [MASS=52936

3	**6**	Rattus norvegicus (Rat) PROTEASOME SUBUNIT BETA TYPE 4 PRECURSOR. [MASS=29228
3	**4**	Rattus norvegicus (Rat) PRX IV. [MASS=31007
3	**4**	Rattus norvegicus (Rat) RAS-RELATED PROTEIN RAB-1B. [MASS=22163
3	**3**	Rattus norvegicus (Rat) RAS-RELATED PROTEIN RAB-2A. [MASS=23536
3	**4**	Rattus norvegicus (Rat) RAS-RELATED PROTEIN RAB-7. [MASS=23504
3	**3**	Rattus norvegicus (Rat) RIBONUCLEASE INHIBITOR. [MASS=49974
3	**5**	Rattus norvegicus (Rat) RIBOSE-PHOSPHATE PYROPHOSPHOKINASE I-LIKE. [MASS=34806
3	**3**	Rattus norvegicus (Rat) RNA-BINDING MOTIF PROTEIN 8 (FRAGMENT). [MASS=19889
3	**4**	Rattus norvegicus (Rat) RNA-BINDING PROTEIN MUSASHI HOMOLOG 1. [MASS=39134
3	**3**	Rattus norvegicus (Rat) SERINE/THREONINE KINASE RECEPTOR ASSOCIATED PROTEIN. [MASS=38626
3	**6**	Rattus norvegicus (Rat) SERINE/THREONINE-PROTEIN PHOSPHATASE 2A CATALYTIC SUBUNIT BETA ISOFORM. [MASS=35575
3	**3**	Rattus norvegicus (Rat) SMC4L1 PROTEIN. [MASS=146806
3	**5**	Rattus norvegicus (Rat) S-PHASE KINASE-ASSOCIATED PROTEIN 1A. [MASS=18541
3	**3**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF CULLIN-ASSOCIATED NEDD8-DISSOCIATED PROTEIN 2. [MASS=139673
3	**3**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF PORPHOBILINOGEN DEAMINASE. [MASS=39361
3	**3**	Rattus norvegicus (Rat) SPLICE ISOFORM 2 OF THIOREDOXIN-LIKE 2 PROTEIN. [MASS=31361
3	**3**	Rattus norvegicus (Rat) SPLICE ISOFORM GAMMA-1 OF SERINE/THREONINE-PROTEIN PHOSPHATASE PP1- GAMMA CATALYTIC SUBUNIT. [MASS=36984
3	**5**	Rattus norvegicus (Rat) SPLICE ISOFORM PYBP1 OF POLYPYRIMIDINE TRACT-BINDING PROTEIN 1. [MASS=56937
3	**3**	Rattus norvegicus (Rat) TRANSCOBALAMIN-2 PRECURSOR. [MASS=47420
3	**5**	Rattus norvegicus (Rat) TROPOMYOSIN. [MASS=28720
3	**3**	Rattus norvegicus (Rat) UDP-GLUCOSE 6-DEHYDROGENASE. [MASS=54892
3	**3**	Rattus norvegicus (Rat) VACUOLAR PROTEIN SORTING PROTEIN 25. [MASS=20762
3	**3**	Rattus norvegicus (Rat) ZW10 INTERACTOR. [MASS=30142
2	**2**	Rattus norvegicus (Rat) 12 KDA PROTEIN. [MASS=11958
2	**3**	Rattus norvegicus (Rat) 120 KDA PROTEIN. [MASS=119992
2	**2**	Rattus norvegicus (Rat) 13 KDA PROTEIN. [MASS=12619
2	**2**	Rattus norvegicus (Rat) 14 KDA PROTEIN. [MASS=13946
2	**3**	Rattus norvegicus (Rat) 15 KDA PROTEIN. [MASS=15253
2	**2**	Rattus norvegicus (Rat) 17 KDA PROTEIN. [MASS=16644
2	**3**	Rattus norvegicus (Rat) 18 KDA PROTEIN. [MASS=17669
2	**2**	Rattus norvegicus (Rat) 21 KDA PROTEIN. [MASS=20709
2	**2**	Rattus norvegicus (Rat) 21 KDA PROTEIN. [MASS=21108
2	**2**	Rattus norvegicus (Rat) 25 KDA PROTEIN. [MASS=24543
2	**2**	Rattus norvegicus (Rat) 25 KDA PROTEIN. [MASS=25109
2	**3**	Rattus norvegicus (Rat) 25 KDA PROTEIN. [MASS=25304
2	**2**	Rattus norvegicus (Rat) 26S PROTEASE REGULATORY SUBUNIT 6B. [MASS=47408

2	**2**	Rattus norvegicus (Rat) 32 KDA PROTEIN. [MASS=32043
2	**2**	Rattus norvegicus (Rat) 34 KDA PROTEIN. [MASS=33605
2	**2**	Rattus norvegicus (Rat) 34 KDA PROTEIN. [MASS=33925
2	**3**	Rattus norvegicus (Rat) 34 KDA PROTEIN. [MASS=33959
2	**3**	Rattus norvegicus (Rat) 36 KDA PROTEIN. [MASS=35608
2	**2**	Rattus norvegicus (Rat) 37 KDA PROTEIN. [MASS=37064
2	**2**	Rattus norvegicus (Rat) 42 KDA PROTEIN. [MASS=42051
2	**2**	Rattus norvegicus (Rat) 43 KDA PROTEIN. [MASS=42562
2	**3**	Rattus norvegicus (Rat) 49 KDA PROTEIN. [MASS=48776
2	**2**	Rattus norvegicus (Rat) 53 KDA PROTEIN. [MASS=52691
2	**2**	Rattus norvegicus (Rat) 57 KDA PROTEIN. [MASS=56953
2	**2**	Rattus norvegicus (Rat) 60 KDA HEAT SHOCK PROTEIN, MITOCHONDRIAL PRECURSOR. [MASS=60955
2	**4**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L10. [MASS=24473
2	**4**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L11. [MASS=20121
2	**2**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L23. [MASS=14865
2	**2**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L7. [MASS=30329
2	**2**	Rattus norvegicus (Rat) 60S RIBOSOMAL PROTEIN L7A. [MASS=29864
2	**2**	Rattus norvegicus (Rat) 63 KDA PROTEIN. [MASS=62568
2	**2**	Rattus norvegicus (Rat) 73 KDA PROTEIN. [MASS=73144
2	**2**	Rattus norvegicus (Rat) 80 KDA PROTEIN. [MASS=79853
2	**2**	Rattus norvegicus (Rat) 90 KDA PROTEIN. [MASS=89765
2	**3**	Rattus norvegicus (Rat) 92 KDA PROTEIN. [MASS=91714
2	**2**	Rattus norvegicus (Rat) AA2-050. [MASS=67817
2	**2**	Rattus norvegicus (Rat) ACID PHOSPHATASE 1, SOLUBLE. [MASS=18152
2	**2**	Rattus norvegicus (Rat) ACTIN-LIKE PROTEIN 2. [MASS=44734
2	**2**	Rattus norvegicus (Rat) ACYL-COA-BINDING PROTEIN. [MASS=9896
2	**6**	Rattus norvegicus (Rat) ADAMTS-1 PRECURSOR. [MASS=105719
2	**2**	Rattus norvegicus (Rat) ADENOMATOUS POLYPOSIS COLI PROTEIN. [MASS=310533
2	**2**	Rattus norvegicus (Rat) ADENOSINE DEAMINASE. [MASS=39768
2	**3**	Rattus norvegicus (Rat) ADENYLATE KINASE ISOENZYME 1. [MASS=21602
2	**4**	Rattus norvegicus (Rat) ADENYLATE KINASE ISOENZYME 2, MITOCHONDRIAL. [MASS=26248
2	**2**	Rattus norvegicus (Rat) ADP-RIBOSYLATION FACTOR 4. [MASS=20265
2	**4**	Rattus norvegicus (Rat) ADP-RIBOSYLATION FACTOR-LIKE PROTEIN 3. [MASS=20457
2	**2**	Rattus norvegicus (Rat) ADP-RIBOSYLATION FACTOR-LIKE PROTEIN 8B. [MASS=21539
2	**2**	Rattus norvegicus (Rat) ALCOHOL DEHYDROGENASE. [MASS=36375
2	**3**	Rattus norvegicus (Rat) ALG-2 INTERACTING PROTEIN 1. [MASS=22241
2	**7**	Rattus norvegicus (Rat) APOLIPOPROTEIN D PRECURSOR. [MASS=21635
2	**2**	Rattus norvegicus (Rat) APOLIPOPROTEIN N. [MASS=28233
2	**3**	Rattus norvegicus (Rat) BASIC TRANSCRIPTION FACTOR 3. [MASS=22110
2	**2**	Rattus norvegicus (Rat) BWK-1. [MASS=26779
2	**2**	Rattus norvegicus (Rat) CALMODULIN-LIKE 3. [MASS=16803
2	**2**	Rattus norvegicus (Rat) CALRETICULIN PRECURSOR. [MASS=47995
2	**2**	Rattus norvegicus (Rat) CAP, ADENYLATE CYCLASE-ASSOCIATED PROTEIN 1. [MASS=51589
2	**3**	Rattus norvegicus (Rat) CARBOXYPEPTIDASE E PRECURSOR. [MASS=53309

2	**2**	Rattus norvegicus (Rat) CATHEPSIN D PRECURSOR. [MASS=44681
2	**2**	Rattus norvegicus (Rat) CATHEPSIN Z PRECURSOR. [MASS=34194
2	**2**	Rattus norvegicus (Rat) CD81 ANTIGEN. [MASS=25889
2	**7**	Rattus norvegicus (Rat) CELL DIVISION CYCLE 42. [MASS=21259
2	**2**	Rattus norvegicus (Rat) CELL DIVISION CYCLE ASSOCIATED 1. [MASS=54556
2	**2**	Rattus norvegicus (Rat) CELL DIVISION PROTEIN KINASE 4. [MASS=33799
2	**2**	Rattus norvegicus (Rat) CHONDROITIN SULFATE PROTEOGLYCAN 4 PRECURSOR. [MASS=251909
2	**2**	Rattus norvegicus (Rat) CLEAVAGE AND POLYADENYLATION SPECIFICITY FACTOR 5. [MASS=26240
2	**2**	Rattus norvegicus (Rat) C-MYC-RESPONSIVE PROTEIN RCL. [MASS=17781
2	**2**	Rattus norvegicus (Rat) COMPLEMENT C1Q SUBCOMPONENT SUBUNIT A PRECURSOR. [MASS=25917
2	**2**	Rattus norvegicus (Rat) COP9 SIGNALOSOME COMPLEX SUBUNIT 8. [MASS=23236
2	**2**	Rattus norvegicus (Rat) COPPER-TRANSPORTING ATPASE 1. [MASS=162093
2	**3**	Rattus norvegicus (Rat) CORE BINDING FACTOR BETA. [MASS=21517
2	**3**	Rattus norvegicus (Rat) CYTOCHROME C, SOMATIC. [MASS=11474
2	**2**	Rattus norvegicus (Rat) DAZ ASSOCIATED PROTEIN 1. [MASS=43214
2	**2**	Rattus norvegicus (Rat) D-DOPACHROME DECARBOXYLASE. [MASS=13002
2	**2**	Rattus norvegicus (Rat) DEAD END HOMOLOG 1. [MASS=57360
2	**3**	Rattus norvegicus (Rat) DEOXYURIDINE 5'-TRIPHOSPHATE NUCLEOTIDOHYDROLASE. [MASS=22003
2	**2**	Rattus norvegicus (Rat) DESMOCOLLIN 2. [MASS=100036
2	**2**	Rattus norvegicus (Rat) DIMETHYLARGININE DIMETHYLAMINOHYDROLASE 2. [MASS=29688
2	**2**	Rattus norvegicus (Rat) DNA PRIMASE LARGE SUBUNIT. [MASS=58603
2	**2**	Rattus norvegicus (Rat) DNA TOPOISOMERASE 2-ALPHA. [MASS=173221
2	**2**	Rattus norvegicus (Rat) DNAJ HOMOLOG SUBFAMILY A MEMBER 1. [MASS=44868
2	**2**	Rattus norvegicus (Rat) ENDOTHELIAL CELL-SELECTIVE ADHESION MOLECULE PRECURSOR. [MASS=41936
2	**2**	Rattus norvegicus (Rat) EUKARYOTIC TRANSLATION INITIATION FACTOR 3, SUBUNIT 6. [MASS=52221
2	**5**	Rattus norvegicus (Rat) EUKARYOTIC TRANSLATION INITIATION FACTOR 5. [MASS=48954
2	**2**	Rattus norvegicus (Rat) FATTY ACID-BINDING PROTEIN, EPIDERMAL. [MASS=14928
2	**13**	Rattus norvegicus (Rat) FERM DOMAIN-CONTAINING PROTEIN 6. [MASS=71905
2	**2**	Rattus norvegicus (Rat) FIBROBLAST GROWTH FACTOR 15. [MASS=25207
2	**2**	Rattus norvegicus (Rat) GALACTOSAMINE. [MASS=58302
2	**2**	Rattus norvegicus (Rat) GLUTATHIONE TRANSFERASE OMEGA-1. [MASS=27669
2	**2**	Rattus norvegicus (Rat) GM2 GANGLIOSIDE ACTIVATOR PROTEIN. [MASS=21493
2	**3**	Rattus norvegicus (Rat) HEMOGLOBIN BETA-2 SUBUNIT. [MASS=15851
2	**4**	Rattus norvegicus (Rat) HEPATOCYTE GROWTH FACTOR ACTIVATOR. [MASS=70737
2	**3**	Rattus norvegicus (Rat) HEPATOMA-DERIVED GROWTH FACTOR. [MASS=26488

2	**2**	Rattus norvegicus (Rat) HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN D-LIKE. [MASS=35294
2	**6**	Rattus norvegicus (Rat) HISTONE H2A. [MASS=14189
2	**4**	Rattus norvegicus (Rat) HNRPK PROTEIN. [MASS=51028
2	**2**	Rattus norvegicus (Rat) HYPOTHETICAL LOC316842. [MASS=34468
2	**6**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN ALDOAL1. [MASS=39492
2	**2**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN MGC112851. [MASS=18095
2	**2**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN RGD1307747. [MASS=47421
2	**2**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN RGD1359539. [MASS=51699
2	**23**	Rattus norvegicus (Rat) HYPOTHETICAL PROTEIN. [MASS=59249
2	**2**	Rattus norvegicus (Rat) HYPOXANTHINE-GUANINE PHOSPHORIBOSYLTRANSFERASE. [MASS=24477
2	**2**	Rattus norvegicus (Rat) IG KAPPA CHAIN C REGION, A ALLELE. [MASS=11732
2	**2**	Rattus norvegicus (Rat) INSULIN-DEGRADING ENZYME. [MASS=117710
2	**2**	Rattus norvegicus (Rat) INSULIN-LIKE GROWTH FACTOR II PRECURSOR. [MASS=20086
2	**3**	Rattus norvegicus (Rat) INSULIN-LIKE GROWTH FACTOR-BINDING PROTEIN 4 PRECURSOR. [MASS=27745
2	**2**	Rattus norvegicus (Rat) ITCH E3 UBIQUITIN LIGASE. [MASS=98806
2	**2**	Rattus norvegicus (Rat) LEUCINE ZIPPER AND CTNNBIP1 DOMAIN CONTAINING. [MASS=38792
2	**2**	Rattus norvegicus (Rat) LEUCINE ZIPPER TRANSCRIPTION FACTOR-LIKE 1. [MASS=34638
2	**2**	Rattus norvegicus (Rat) LRRGT00186. [MASS=105933
2	**4**	Rattus norvegicus (Rat) MACROPHAGE MIGRATION INHIBITORY FACTOR. [MASS=12346
2	**9**	Rattus norvegicus (Rat) MARCKS-RELATED PROTEIN. [MASS=19716
2	**2**	Rattus norvegicus (Rat) MOESIN. [MASS=67608
2	**3**	Rattus norvegicus (Rat) MYOSIN REGULATORY LIGHT CHAIN 2-B, SMOOTH MUSCLE ISOFORM. [MASS=19707
2	**2**	Rattus norvegicus (Rat) NEURONAL CALCIUM SENSOR 1. [MASS=21748
2	**2**	Rattus norvegicus (Rat) NON-POU DOMAIN-CONTAINING OCTAMER-BINDING PROTEIN. [MASS=54925
2	**2**	Rattus norvegicus (Rat) NON-SPECIFIC DIPEPTIDASE. [MASS=52693
2	**2**	Rattus norvegicus (Rat) NUCLEOLIN. [MASS=77276
2	**2**	Rattus norvegicus (Rat) NUDIX-TYPE MOTIF 5. [MASS=24117
2	**2**	Rattus norvegicus (Rat) P55. [MASS=55249
2	**2**	Rattus norvegicus (Rat) PEST-CONTAINING NUCLEAR PROTEIN. [MASS=20195
2	**2**	Rattus norvegicus (Rat) PHENYLALANINE-TRNA SYNTHETASE-LIKE, ALPHA SUBUNIT. [MASS=57720
2	**3**	Rattus norvegicus (Rat) PHOSPHOLIPASE A2, GROUP VII. [MASS=49491
2	**2**	Rattus norvegicus (Rat) PINCHER. [MASS=61468
2	**2**	Rattus norvegicus (Rat) PLATELET-ACTIVATING FACTOR ACETYLHYDROLASE IB GAMMA SUBUNIT. [MASS=25863
2	**2**	Rattus norvegicus (Rat) PREDICTED: A DISINTEGRIN AND METALLOPEPTIDASE WITH THROMBOSPONDIN MOTIFS 4. [MASS=165869

2	**2**	Rattus norvegicus (Rat) PREDICTED: CADHERIN 3, TYPE 1, P-CADHERIN. [MASS=85806
2	**3**	Rattus norvegicus (Rat) PREDICTED: HISTONE DEACETYLASE 6. [MASS=168631
2	**2**	Rattus norvegicus (Rat) PREDICTED: PHOSPHORIBOSYLGLYCINAMIDE FORMYLTRANSFERASE. [MASS=107580
2	**2**	Rattus norvegicus (Rat) PREDICTED: RETINOIC ACID INDUCIBLE IN NEUROBLASTOMA CELLS 1. [MASS=283507
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 14 KDA PHOSPHOHISTIDINE PHOSPHATASE. [MASS=14011
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO 26S PROTEASOME NON-ATPASE REGULATORY SUBUNIT 7. [MASS=44411
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALDEHYDE DEHYDROGENASE FAMILY 7, MEMBER A1. [MASS=58749
2	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALDOSE REDUCTASE. [MASS=35901
2	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALPHA ENOLASE. [MASS=27286
2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ALPHA-CENTRACTIN. [MASS=51341
2	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ANKYRIN REPEAT DOMAIN 29. [MASS=33170
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO APOA-I BINDING PROTEIN. [MASS=80533
2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO BASIC TRANSCRIPTION FACTOR 3. [MASS=51095
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO BULLOUS PEMPHIGOID ANTIGEN 1-B. [MASS=1252880
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO DEAD/H BOX POLYPEPTIDE 36 PROTEIN. [MASS=113843
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO DNA REPLICATION LICENSING FACTOR MCM5. [MASS=91577
2	**4**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO DRCTNNB1A. [MASS=57155
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO DUAL SPECIFICITY PROTEIN PHOSPHATASE 3. [MASS=28920
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO EIF3S1 PROTEIN. [MASS=29187
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ESTERASE D/FORMYLGLUTATHIONE HYDROLASE. [MASS=36719
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO EXPRESSED SEQUENCE AI314180. [MASS=203921
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO GLUTATHIONE S-TRANSFERASE, THETA 3. [MASS=27275
2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HEAT SHOCK 70KDA PROTEIN 4 LIKE. [MASS=136266
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HETEROGENEOUS NUCLEAR RIBONUCLEOPROTEIN A0. [MASS=102453
2	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO HYPOTHETICAL PROTEIN A. [MASS=23737
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO IMMUNOGLOBULIN LIGHT CHAIN. [MASS=25971

2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO INTERLEUKIN ENHANCER BINDING FACTOR 2. [MASS=65347
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO KIAA0315. [MASS=216119
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO METHIONINE-TRNA SYNTHETASE. [MASS=101582
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO MKIAA0051 PROTEIN. [MASS=196522
2	3	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO NEUROGENIC LOCUS NOTCH HOMOLOG PROTEIN 2 PRECURSOR. [MASS=131698
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO NUCLEAR PORE COMPLEX-ASSOCIATED INTRANUCLEAR COILED-COIL PROTEIN TPR. [MASS=279947
2	3	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO PUTATIVE PROTEIN KINASE. [MASS=53530
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RAB5B PROTEIN. [MASS=34895
2	4	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RAC GTPASE-ACTIVATING PROTEIN. [MASS=69919
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RAN-BINDING PROTEIN 16. [MASS=125025
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RAN-SPECIFIC GTPASE-ACTIVATING PROTEIN. [MASS=23596
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RCK. [MASS=54301
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIBONUCLEASE T2 PRECURSOR. [MASS=37683
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIBOSOMAL PROTEIN L14. [MASS=18408
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIKEN CDNA 2410030K01. [MASS=22615
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIKEN CDNA 2610029G23. [MASS=22424
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIKEN CDNA 2900010J23. [MASS=18147
2	3	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO RIKEN CDNA 4732495G21 GENE. [MASS=41963
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SEPT11 PROTEIN. [MASS=65110
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SID3177P. [MASS=33078
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SMALL NUCLEAR RIBONUCLEOPROTEIN D1. [MASS=13282
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SMALL NUCLEAR RIBONUCLEOPROTEIN POLYPEPTIDE D2. [MASS=13527
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SMC2 PROTEIN. [MASS=134280
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SORCSB SPLICE VARIANT OF THE VPS10 DOMAIN RECEPTOR SORCS. [MASS=129969
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SPERM ASSOCIATED ANTIGEN 7. [MASS=26021
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO SSA2 PROTEIN. [MASS=63886
2	2	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO TRANSLATION FACTOR SUI1 HOMOLOG. [MASS=12824

2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO TRYPTOPHANYL-TRNA SYNTHETASE. [MASS=54144
2	**5**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO TUBULIN ALPHA-2 CHAIN. [MASS=50280
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO TUBULIN, ALPHA-LIKE 3. [MASS=53860
2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO TUMOR PROTEIN, TRANSLATIONALLY-CONTROLLED 1. [MASS=19537
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO U1 SNRNP-SPECIFIC PROTEIN C. [MASS=14841
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO U6 SNRNA-ASSOCIATED SM-LIKE PROTEIN LSM8. [MASS=10403
2	**3**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO UBIQUITIN-CONJUGATING ENZYME E2M. [MASS=20900
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO VACUOLAR PROTEIN SORTING 28. [MASS=25468
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO ZINC FINGER PROTEIN 509. [MASS=99935
2	**2**	Rattus norvegicus (Rat) PREDICTED: SIMILAR TO. [MASS=155644
2	**2**	Rattus norvegicus (Rat) PREDICTED: SPLICING FACTOR 3B, SUBUNIT 1. [MASS=152445
2	**2**	Rattus norvegicus (Rat) PREDICTED: SWI/SNF RELATED, MATRIX ASSOCIATED, ACTIN DEPENDENT REGULATOR OF CHROMATIN, SUBFAMILY A, MEMBER 4. [MASS=184784
2	**2**	Rattus norvegicus (Rat) PREDICTED: THROMBOSPONDIN 4. [MASS=121361
2	**3**	Rattus norvegicus (Rat) PROSAAS PRECURSOR. [MASS=27414
2	**2**	Rattus norvegicus (Rat) PROTEIN-L-ISOASPARTATE (D-ASPARTATE) O-METHYLTRANSFERASE 1. [MASS=24641
2	**2**	Rattus norvegicus (Rat) QUINONE OXIDOREDUCTASE. [MASS=34975
2	**2**	Rattus norvegicus (Rat) RAB, MEMBER OF RAS ONCOGENE FAMILY-LIKE 2A. [MASS=25509
2	**2**	Rattus norvegicus (Rat) RAS-RELATED PROTEIN RAB-8A. [MASS=23668
2	**2**	Rattus norvegicus (Rat) RAS-RELATED PROTEIN RAL-A. [MASS=23553
2	**3**	Rattus norvegicus (Rat) RATTUS NORVEGICUS UTROPHIN. [MASS=391075
2	**2**	Rattus norvegicus (Rat) REPLICATION FACTOR C 2. [MASS=38657
2	**2**	Rattus norvegicus (Rat) RIBONUCLEASE HI LARGE SUBUNIT. [MASS=33286
2	**3**	Rattus norvegicus (Rat) SECRETED PHOSPHOPROTEIN 24 PRECURSOR. [MASS=23170
2	**3**	Rattus norvegicus (Rat) SEPTIN-7. [MASS=50508
2	**2**	Rattus norvegicus (Rat) SERINE/THREONINE-PROTEIN KINASE WNK4. [MASS=132833
2	**4**	Rattus norvegicus (Rat) SIMILAR TO RIKEN CDNA 2810409H07. [MASS=44535
2	**3**	Rattus norvegicus (Rat) SKELETAL MUSCLE-SPECIFIC ALPHA-ACTININ 3. [MASS=103013
2	**2**	Rattus norvegicus (Rat) SMALL INDUCIBLE CYTOKINE SUBFAMILY E, MEMBER 1. [MASS=34574
2	**2**	Rattus norvegicus (Rat) SMALL NUCLEAR RIBONUCLEOPROTEIN-ASSOCIATED PROTEIN B. [MASS=22837
2	**2**	Rattus norvegicus (Rat) SPECTRIN ALPHA CHAIN, BRAIN. [MASS=284713
2	**2**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF 40S RIBOSOMAL PROTEIN S24. [MASS=15423

2	**2**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF ARCHAEMETZINCIN-2. [MASS=41379
2	**2**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF CYTOSOLIC ACYL COENZYME A THIOESTER HYDROLASE. [MASS=37561
2	**2**	Rattus norvegicus (Rat) SPLICE ISOFORM 1 OF PROTEIN PICCOLO. [MASS=552716
2	**2**	Rattus norvegicus (Rat) SPLICE ISOFORM 2 OF AP-2 COMPLEX SUBUNIT BETA-1. [MASS=105692
2	**3**	Rattus norvegicus (Rat) SPLICE ISOFORM 2 OF DREBRIN-LIKE PROTEIN. [MASS=48341
2	**23**	Rattus norvegicus (Rat) SPLICE ISOFORM 2 OF SEROTRANSFERRIN PRECURSOR. [MASS=54493
2	**2**	Rattus norvegicus (Rat) SPLICE ISOFORM MEMBRANE ALPHA OF APOPTOSIS REGULATOR BAX, MEMBRANE ISOFORM ALPHA. [MASS=21351
2	**2**	Rattus norvegicus (Rat) STRUCTURAL MAINTENANCE OF CHROMOSOME 1-LIKE 1 PROTEIN. [MASS=143205
2	**2**	Rattus norvegicus (Rat) STRUCTURAL MAINTENANCE OF CHROMOSOME 3. [MASS=138448
2	**2**	Rattus norvegicus (Rat) TGF-BETA RECEPTOR TYPE III PRECURSOR. [MASS=94103
2	**3**	Rattus norvegicus (Rat) THIOREDOXIN. [MASS=11542
2	**2**	Rattus norvegicus (Rat) TRANSCRIPTION ELONGATION FACTOR B POLYPEPTIDE 2. [MASS=13170
2	**4**	Rattus norvegicus (Rat) TRANSGELIN-3. [MASS=24712
2	**2**	Rattus norvegicus (Rat) TUBULIN COFACTOR A. [MASS=12744
2	**2**	Rattus norvegicus (Rat) UBIQUITIN CARBOXYL-TERMINAL HYDROLASE ISOZYME L3. [MASS=26124
2	**2**	Rattus norvegicus (Rat) UBIQUITIN-LIKE 1. [MASS=38513
2	**2**	Rattus norvegicus (Rat) UDP-GLUCOSE:GLYCOPROTEIN GLUCOSYLTRANSFERASE 1 PRECURSOR. [MASS=176589
2	**2**	Rattus norvegicus (Rat) VACUOLAR ATP SYNTHASE SUBUNIT B, BRAIN ISOFORM. [MASS=56551
2	**2**	Rattus norvegicus (Rat) VASCULAR PROTEIN TYROSINE PHOSPHATASE 1. [MASS=134276
2	**8**	Rattus norvegicus (Rat) ZETA-GLOBIN (FRAGMENT). [MASS=4596
2	**2**	Rattus norvegicus (Rat) ZINC-ALPHA-2-GLYCOPROTEIN PRECURSOR. [MASS=35002