PRINCIPAL COMPONENT ANALYSIS (PCA) OF PROTEINS RELATED TO TYPE 2 DIABETES MELLITUS: COMPARATIVE STUDY IN RODENTS AND HUMAN BEINGS

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ABSTRACT

Background: The objective of this study is to examine the relationship between the protein variates and to infer the variation across the 3 species namely man (Homo sapiens), house mouse (Mus Musculus) and Norway rat (Rattus Norvegicus).
Results For this purpose, a dataset of size 639 proteins has been taken representing 213 type 2 diabetes related proteins each belonging to Man, Mouse and Rat. Principal Component Analysis technique is used to reduce the dimensionality of the variables. The results show that the protein variates variation in man differs from those of two species.
Conclusion Principal Component analysis of type 2 diabetes related genes showed that those of house mouse and Norway rat were closer to each other than that of human being.

Keywords: *Principal Component Analysis(PCA), Protein Attributes, Precursors, Nonprecursors, Correlation Matrix, Eigen Values, Factor Loadings*

1. BACKGROUND

With the availability of genomic data of species across life sciences and increasing number of proteins, traditional methods of annotating protein structure and function are becoming difficult. Therefore a confluence of mathematical and computational analysis as an iterative process with traditional biological methods is being employed to infer information from the flood of data. The first step in this annotation, is to identify genes; to define a gene which required a meeting and discussion to arrive at a working definition. ('A locatable region of genomic sequence, corresponding to a unit of inheritance, which is associated with regulatory regions, transcribed regions and/or other functional sequence regions') [1].

Comparative genomics and proteomics allow identification of gene equivalents using known genes as reference, and comparing regions of nucleotides or amino acids of the unknown sequence. The underlying assumption is that conserved sequences and regions are likely to be biologically relevant or important, and may be necessary for critical folding patterns and biochemical reactions. To make meaningful comparisons, choice of comparing life forms is critical, as there are common aspects, still comparisons can be made, as they are separated from one another in evolutionary time. For such cross species analysis with humans, rodents have been employed right from the early years of birth of genetics as a discipline [2].

Earlier studies evaluated difference between amino acids to identify chemical factors that correlate with evolutionary exchangeability of protein residues.

Amino acid side chain properties that correlated with relative substitution frequency included composition, polarity and molecular volume [3]. A correlation was shown between codon relatedness and amino acid substitution rate.

In a more recent report, comparative analysis of genome sequences was performed to unravel the complexities of biological processes by using data mining tools [4]. Using these tools, sequence complexities of amino acids was studied to partition encoded proteins from different genomes into different categories of complexities.

Earlier, mathematical models were used to assess the amino acid sequence complexity in diabetes related proteins from three related species (Homo sapiens, Rattus norvegicus and Mus musculus) [5].

In PCA the dimensionality of the data set is reduced by transforming to a new set of variables (the principal components) to summarize the features of the data [6][7]. One of the main objectives of the principal component analysis is to reduce the dimension of a complex multi-variate problem. The component analysis takes the correlation matrix into account, and produces components which are uncorrelated with each other. Second, the component analysis produces components in descending order of importance – (i.e., the first component explains the maximum amount of variation and the last component the minimum.) It is often found that the first two or three components account for most variation whereas it is lesser in the subsequent components. In this case it is possible to approximately represent a large set of variables in terms of two or three components. The purpose of this study is to confirm the previously established results in a different context. Eight dimensions cannot be visualized and they need to be reduced to two or three and one best.

2. METHODS

The genes affecting type 2 diabetes were found from the site http://www.genecards.org. A total of 213 were available and were obtained. PCA is performed on the 213 sample drawn from each of the 3 species using SPSS 16.0. There were 87 precursors among the 213 genes. Further PCA was independently performed on precursors and nonprecursors. Details of protein attributes are given in Appendix 1.

3. RESULTS

3.1 Correlation Matrix

The correlation matrices of the 8 protein variates for the 3 species are presented in Table 1.

There was a low and positive association between % of acidic amino acids and length of it being relatively high in Homo sapiens when compared to Mus Musculus and Rattus Norvegicus. There was a low and positive association between % of polar amino acids and length of it being relatively low in Homo sapiens when compared to Mus Musculus and Rattus Norvegicus (having almost the same %). Dfixed and Dvarglobular's association with length is more in Homo sapiens when compared to Mus Musculus and Rattus Norvegicus whose values are almost the same. There was a low and negative association between % of Acidic amino acids and % of basic amino acids with % of hydrophobic amino acids it being high in Homo sapiens when compared to Mus Musculus and Rattus Norvegicus. There exists high and significant association in terms of length and Dfixed and Dvarglobular with them being high in Homo sapiens and different and is different from Mus Musculus and Rattus Norvegicus (having equal values) thus showing that Homo sapiens differ from Mus Musculus and Rattus Norvegicus which are similar with respect to the protein variates correlation.

3.2 Eigen Values

The eight protein variates are grouped into three factors in all the three species. The Eigen values i.e. the variances extracted by the factors and the principal components for all the three species are shown in Table 2. The three components taken together have explained more than 78% of the variation among the variables it being similar in Rattus Norvegicus and Mus Musculus and different from Homo sapiens.

3.3 Factor Loadings

The factor loadings which reflect on the relative weights of the variable in the component show that in all the three species the first component is dominated by length, dfixed and dvarglobular, the second component is dominated by %basic and %acidic and the third component is dominated by %hydrophobic and %aromatic.

4. RESULTS OF PRECURSORS VERSUS NONPRECURSORS

There are certain variations in precursors across rat and mouse as opposed to no variation in nonprecursors. Overall sample results match that of nonprecursors. There is variation in precursors due to slight correlation variation across the protein variates. The principal components composition across the 3 species in precursors and nonprecursors is shown in table 10. In Mus Musculus and Rattus Norvegicus, there were 4 principal components in precursors as opposed to 3 in nonprecursors.

The correlation matrices, eigen values and factor loadings are shown in Tables 4 – 9 for precursors and nonprecursors respectively. The eigen values cumulative % variation in overall sample is similar to that of nonprecursors rather than that of precursors.

5. DISCUSSION

Earlier studies have employed principal component analysis for a variety of factors in diabetes mellitus. Principal component analysis of the derived profiles was used to classify any variations and specific metabolites were identified based on their spectral pattern [8]. In another study, the principal component analysis was used to understand correlations between the continuous variables within the clinical database, and to identify principal factors (combinations of variables) and the magnitude of HT in the combinations. In subjects with the metabolic syndrome the principal factors were dominated by blood pressure in both genders with higher loadings in men than in women [9].

In an invivo study, principal component analysis of the metabolite data showed two clusters, corresponding to the cells cultured at 2.8 and 16.7 mM glucose, respectively [10]. Principal components factor analysis revealed 2 meaningful factors in developing a psychological questionnaire for using insulin (Reassurance and Threat) with satisfactory internal consistency (Cronbach' alpha) and adequate test-retest reliability [11]. Based on a first PCA analysis with Varimax Rotation and MA that were performed separately on the SHIP questionnaire filled out at baseline, four items were eliminated as they displayed poor discriminant or convergent validity, had low predictive value, or were not adapted to patients under insulin therapy without OHA [12]. PCA is widely used to classify NMR-derived data. PCA provides good representation for time-related responses in metabolic composition variance as a method of monitoring the progression of toxicity and recovery [13].

In our earlier study we (a) looked for differences in the three using discriminant analysis (b) found the dominant proteins in each species and the attributes in each, using multiple regression and nominal regression (c) identified protein groups by cluster analysis. Analysis from all methods showed that there was a clustering of proteins from humans, which was different from that of mouse and rat; those from the latter two animals clustered together [5]. Here we extend the work by performing principal component analysis (PCA) in these three categories of species to further characterize the relatedness patterns of proteins [4][5].

After the sequencing of the human genome, rodent genome sequencing (mouse and rat) was the next step to offer data for comparative genomics to discover and analyze human genes embedded in the database [14]. The underlying concept was that genes with significant similarity are presumed 'to have evolved from a single ancestral gene and are part of the same gene family' [15]. Proteins tend to show conservation of structure than sequences, thus allowing structure to be inferred from function [16].

Globally the mouse genome is about 14% smaller than the human genome, possibly due to higher rate of deletion in mouse lineage[17]. At the nucleotide level 40% of human genome can be aligned to the mouse genome, with neutral substitutions being twice as many in mouse than humans. Only <1% of mouse genes exist without corresponding human homologs and vice versa. The strong conservation of genes in humans and mice shows evolutionary forces that moulded the development of the two genomes. The two genomes may have diverged about 75Myr ago from a common ancestor. Most mouse and human ortholog pairs have high degree of sequence identity and are under purifying selection. By the year 2002, 687 human disease genes had clear orthologs in mouse [17]. Eighty percent of mouse proteins had strict 1:1 orthologs in human genome. It thus provides a tool to understand biological function. 'Evolution's crucible is a far more sensitive instructor than any other available to modern experimental science.' [17] The rat genome sequence was published shortly thereafter in 2004 [18]. The rat genome was smaller than human, but larger than the mouse. Both however encode a similar number of genes. Almost all human genes known to be associated with disease have rat orthologs. About 30% of rat genome aligns only with the mouse. The two species separated about 12-24 Myr ago. Nearly 39% of euchromatic rat genome aligns in all species (viz rat, mouse and human), which consists of the ancestral core common to all three. It contains 94-95% of known coding exons and regulatory regions. Nearly 90% of rat genes have strict orthologs in both mouse and human genomes. Unique genes in rat are related to rat-specific biologic function such as reproduction, immunity and toxin metabolism [18]. In contrast almost all human disease genes have rat orthologs. This underscores the importance of the rat as an appropriate model organism in experimental studies.

The use of rat and mouse for comparison with human proteins is appropriate because sufficient evolutionary distance exists between rodents and humans, which is optimal for comparative gene prediction [19]. Further availability of completed genome sequences from other species will allow development of new computational gene finding methods[20].

In a recent study to identify novel human genes through simultaneous gene prediction in human, mouse and rat, 3698 gene triplets were found in all three species, which were predicted with exactly the same gene structure[21]. Total number of SLAM human/mouse genes were 29,370, of human/rat genes were 25,427 and identical human, mouse and rat genes were 3698 [21]. The final ortholog set consisted of 924 genes. Using a whole genome multiple alignment of Rat, Mouse and Human, 87% of all human gene-coding areas aligned in both Mouse and Rat [22]. Such available evolutionary distances from different species show conserved, and by inference, important biological features. A comparative genetic expression of Maize, Mouse and Man showed it was possible to correlate 'structure between transcript abundances and classic traits' to identify susceptibility loci for complex diseases [23], [24]. Combination of gene expression, genotype and clinical data can identify rate-limiting steps in drug discovery, and in 'identifying drivers of the pathways underlying those disease subtypes' [23].

An earlier study devised a formula to identify chemical factors in amino acids that correlated with evolutionary exchangeability of protein residues, using the following attributes of amino acids for correlation: composition, polarity and molecular weight [3].

A recent study comparing human and chimpanzee genomes has shown that the number of positively selected genes were fewer in humans than in chimpanzee, lending support to the association between human mendelian disease and past adaptations [25].

In our study, principal component analysis has shown that the parameters variation in Homo sapiens differ from the other two rodent species.

Rodent genomics is simultaneously associated with the development of knock-out models for metabolic syndrome [26]. Such animals carrying specific knock-out genes can help in identifying genes, protein function and their alterations in pathological states, to finally offer leads for development of pharmacological therapies based on a systems approach of physiological processes.

6. CONCLUSION

In conclusion using principal component analysis, protein variates related to diabetes among the three species shows that the protein variates variation in Homo Sapiens differ from the other two species(both being similar). When sequences are being released than can be analyzed it becomes imperative to focus on annotation, by going beyond simple statistics to 'tools and techniques in other scientific fields that routinely deal with analysis of large and complex systems' [27]. Functional annotation, which depends on sequence database search, is being attempted using a variety of techniques [28]. Amino acid runs were examined to look for disease associations [29] and physicochemical properties with identifying protein docking [30]. Similarly, principal component analysis of amino acids has been extended to predict protein structural classes [31]. Therefore principal component analysis could assist in assigning function to diabetes related proteins, which are being identified at an increasing pace.

7. APPENDIX 1

The protein variates are:

Variate 1 is the length (L) of the protein in number of amino acids.

Variate 2 is the percent of basic amino acids in a given protein. The basic amino acids are H, K; R. percent basic is given by

$$\frac{\text{Number of basic amino acids}}{\text{Total number of amino acids}} \times 100$$

Variate 3 is the percent of acidic/amide amino acids in a given protein. The acidic/amide amino acids are D, E, N, and Q. Percent acidic/amide is given by

$$\frac{\text{Number of acidic/amide amino acids}}{\text{Total number of amino acids}} \times 100$$

Variate 4 is the percent of small and medium hydrophobic amino acids in a given protein. The small and medium hydrophobic amino acids are V, L, I, M. Percent hydrophobicity is given by

$$\frac{\text{Number of hydrophobic amino acids}}{\text{Total number of amino acids}} \times 100$$

Variate 5 is the percent of aromatic amino acids in a given protein. The aromatic amino acids are F, Y, and W. Percent aromatic is given by

$$\frac{\text{Number of aromatic amino acids}}{\text{Total number of amino acids}} \times 100$$

Variate 6 is the percent of small/polar amino acids in a given protein. The small/polar amino acids are A, G, S, T, P [32].(Teresa K. Attwood et al 2004). Percent small/polar is given by

$$\frac{\text{Number of small/polar amino acids}}{\text{Total number of amino acids}} \times 100$$

Variate 7 is a measure of distance of a protein sequence from a fixed reference point.

The distance is measured according to the formula:

$$\text{Distance } (D)_{fixed} = \sqrt{\sum_{i=1}^{20}(O_i - E_i)^2}$$

where O_i is the observed number of amino acid of type 'i' in the concerned protein and E_i, the expected number of amino acid of type 'i' in the same protein. E_i is L/20 considering all amino acid to be uniformly distributed in the protein. We refer to this point as the fixed reference point. Dfixed is square root of sum of squares from i=1 to 20 of difference of observed and expected number of amino acids. Here it is considered fixed as Ei = L/20 is a constant for all the amino acids.

Variate 8 is the distance of a protein sequence from a variable reference point. The distance Dvar, globular has the same formula as that in variate 4 but the Ei is calculated according to the formula:

$$Ei = fi \times L$$

where L is the length of the concerned protein in amino acids and fi is the average frequency of occurrence of the ith amino acid in the set of proteins that are of high sequence complexity (Nandi T et al., 2002). Here this is considered variable reference point since fi changes for every amino acid and hence Ei changes.

8. AUTHORS CONTRIBUTIONS

RB conceived the study, performed the analysis. AAR, GRS conceived the study, coordinated it and wrote the paper. All authors read and approved the final manuscript.

9. REFERENCES:

[1] Pearson H. 2006, What is a gene, .Nature, 441:398-401

[2] Guenet JL. 2005, The mouse genome. *Genome Research,* 15:1729-40

[3] Grantham R. 1974, Amino acid difference formula to help explain protein evolution. *Science,* 185: 862-5

[4] Nandi T, Rao CB, Ramachandran S. 2002, Comparative genomics using data mining tools. *J Biosci*, 27 (Suppl 1):15-25

[5] Appa Rao A, Bhramaramba R, Sridhar GR. 2006, Mathematical Analysis of Diabetes Related Proteins Having High Sequence Complexity, 18th IEEE International Conference on Tools with Artificial Intelligence (ICTAI'06), pp. 810-821.

[6] Jiawei Han and Micheline Kamber. 2004, Data Mining Concepts and Techniques, San Francisco :Morgan Kaufmann Publishers, pp.123

[7] Yeung, K. Y. and Ruzzo, W.L. 2001, Principal Component Analysis for Clustering Gene Expression Data. Bioinformatics Vol. 17 no. 9, 763-774.

[8] C. Mallidis, B.D. Green, et al 2007.Metabolic profile changes in the testes of mice with streptozotocin- induced type 1 diabetes mellitus. International Journal of Andrology.

[9] Foucan L, Vaillant J. 2007. Hypertension in the metabolic syndrome among Caribbean non diabetic subjects. Arch Mal Coeur Vaiss. 2007 Aug; 100(8):649-53.

[10] Fernandez C, Fransson U, et al 2008, Metabolomic and proteomic analysis of a clonal insulin-producing beta-cell line, J Proteome Res. 2008 Jan;7(1):400-11

[11] Lawson VL, Bundy C, et al 2007. Development of the Diabetes Health Threat Communication Questionnaire(DHTCQ). Patient Educ Couns. 2007 Jul;67(1-2):117-26

[12] Luc Martinez, Silla M Consoli, et al 2007. Studying the Hurdles of Insulin Prescription (SHIP):development, scoring and initial validation of a new self-administered questionnaire. Health and Quality of Life Outcomes 2007, 5:53

[13] Tadashi Nemoto, Itiro Ando, et al. 2007. NMR metabolic profiling combined with two-step Principal Component Analysis for Toxin-induced Diabetes model rat using urine. The Journal of Toxicological Sciences, 2007, Vol. 32, No.4.429-435

[14] Rubin EM, Barsh GS. 1996, Biological insights through genomics: mouse to man *J Clin Invest* 97: 275-280

[15] Huynen MA, Nimwegen EV.1998, The frequency distribution of gene family sizes in complete genomes. *Mol Biol Evol*, 15:583-9

[16] Marsden RL, Lee D, Maibaum M, Yeats C, et al. 2006, Comprehensive genome analysis of 203 genomes provides structural genomics with new insights into protein family space. *Nucleic Acid Res,* 34:1066-80

[17] Mouse Genome Sequencing Consortium

2002. Initial sequencing and comparative analysis of the mouse genome. *Nature,* 420:520-62

[18] Rat Genome Sequencing Project Consortium 2004**,** Genome sequence of the Brown Norway rat yields insights into mammalian evolution**.** *Nature,* 428:493-521

[19] Zhang L, Pavlovic V, Cantor CR, et al. 2003, Human-mouse gene identification by comparative evidence integration and evolutionary analysis. *Genome Res,* 13:1190-120

[20] Parra G, Agarwal P, Abril JF, et al. 2003, Comparative gene prediction in human and mouse. *Genome Res,* 13:108-17

[21] Deway c, Wu JQ, Cawley S, Alexandersson M. 2004. Accurate Identification of Novel Human Genes Through Simultaneous Gene Prediction in Human, Mouse, and Rat . *Genome Res,* 14:661-4

[22] Brudno M, Poliakov A, Salamov A, et al. 2004**.** Automated Whole-Genome Multiple Alignment of Rat, Mouse, and Human *Genome Res,* 14:685-92.

[23] Schadt EE, Monks SA, Drake TA, et al. 2003,Genetics of gene expression surveyed in maize, mouse and man. *Nature* 422:297-302

[24] Iain A. Eaves, Linda S. Wicker, Ghassan Ghandour. 2002, Combining Mouse Congenic Strains and Microarray Gene Expression Analyses to Study a Complex Trait: The NOD Model of Type 1 Diabetes *Genome Res,*12:232-43

[25] Bakewell MA, Shi P,Zhang J. 2007, More genes underwent positive selection in chimpanzee Evolution than in human evolution**.** *Proc Natl Acad Sci USA*,104:7489-94.

[26] Nandi A, Kitamura Y, Kahn CR, et al. 2004, Mouse models of insulin resistance. *Physiol Rev,* 84:623 - 47

[27] Ye Y, Godzik A. 2004, Comparative analysis of protein domain organization. *Genome Res,* 14:343- 53

[28] Natale DA, Shankavaram UT, Galperin MY, et al. 2000,Towards understanding the first genome sequence of a crenarchaeon by genome annotation using clusters of orthologous groups of proteins (COGs). *Genome biol*,1(5):research0009.1-0009.19

[29] Karlin S, Brocchieri L, Bergman A, et al. 2002, Amino acid runs in eukaryotic proteomes and disease associations. *Proc Natl Acad Sci USA,* 99:333-8

[30] Heuser P,Schomburg D**.** 2006, Optimized amino acid specific weighting factors for unbound protein docking. *BMC Bioinformatics*, 7:344

[31] Du QS, Jiant ZQ, He WZ, et al. 2006. Amino acid principal component analysis (AAPCA) and its applications in protein structural class prediction. *J Biomolecular Structure and Dynamics,* 23:635-40

[32] Teresa K. Attwood et al 2004. Introduction to Bioinformatics, Pearson Education, 61.

Table 1 Correlation matrices of protein variates for the 3 species

Panel A: Homo Sapiens

	Length	%basic	%acidic	%hydroph	%aromatic	%polar	Dfixed	Dvar
Length		-.087	.168	-.185	-.080	.148	.970*	.902*
%basic			.279*	-.293*	-.160	-.361*	-.121	-.149
%acidic				-.360*	-.146	-.441*	.108	.108
%hydroph					.234	-.422*	-.214	-.257*
%aromatic						-.396*	-.184	-.169
%polar							.284*	.301*
Dfixed								.946*
Dvar								

Panel B: Mus Musculus

	Length	% Basic	% Acidic	%Hydroph	%Aromatic	%Polar	Dfixed	Dvar
Length		-.150	.127	-.183	-.039	.206	.959*	.877*
% Basic			.210	-.324*	-.225	-.356*	-.194	-.151
% Acidic				-.403*	-.216	-.375*	.083	.123
%Hydroph					.163	-.381*	-.193	-.271
%Aromatic						-.304*	-.152	-.156
%Polar							.345*	.327*
Dfixed								.939*
Dvar								

Panel C: Rattus Norvegicus

	Length	%Basic	%Acidic	%Hydroph	%Aromatic	%Polar	Dfixed	Dvar
Length		-.147	.145	-.205	-.046	.198	.960*	.877*
%Basic			.237*	-.338*	-.170	-.376*	-.188	-.185
%Acidic				-.388*	-.203	-.406*	.088	.092
%Hydroph					.159	-.354*	-.207	-.270*
%Aromatic						-.314*	-.150	-.146
%Polar							.339*	.362*
Dfixed								.940*
Dvar								

Table 2 Eigen Values and Principal Components for all the 3 species

Panel I: Homo Sapiens

Principal Component	Eigen Value	Cumulative Percentage
1	2.944	36.803
2	1.757	58.771
3	1.715	80.213

Panel II: Mus Musculus

Principal Component	Eigen Value	Cumulative Percentage
1	2.962	37.027
2	1.685	58.088
3	1.617	78.306

Panel III: Rattus Norvegicus

Principal Component	Eigen Value	Cumulative Percentage
1	2.970	37.130
2	1.753	59.043
3	1.569	78.661

Table 3 Factor Loadings of the variables in the sample species

Variable	Homo Sapiens			Mus Musculus			Rattus Norvegicus		
	Component			Component			Component		
	1	2	3	1	2	3	1	2	3
Length	.354	.044	.104	.354	.064	.119	.355	.066	.125
%Basic	-.080	.416	-.140	-.091	.372	-.185	-.090	.384	-.163
%Acidic	.072	.474	-.003	.090	.487	-.020	.090	.475	.005
%Hydrophobic	.026	-.185	.442	.008	-.147	.440	.001	-.192	.430
%Aromatic	.071	-.030	.453	.079	-.001	.466	.088	-.007	.491
%Polar	-.039	-.367	-.438	-.039	-.452	-.454	-.037	-.405	-.468
Dfixed	.338	-.007	.031	.335	-.004	.036	.336	.002	.041
Dvar	.326	-.015	.013	.321	.022	.004	.318	-.002	.003

Table 4 Correlation matrices of protein variates for the 3 species in precursors

Panel A: Homo Sapiens

	Length	%basic	%acidic	%hydroph	%aromatic	%polar	Dfixed	Dvar
Length		-.212	.229	-.050	.237	-.068	.969	.938
%basic			-.077	-.164	-.119	-.297	-.261	-.235
%acidic				-.029	.138	-.579	.207	.280
%hydroph					-.147	-.427	-.016	-.097
%aromatic						-.264	.146	.229
%polar							.014	-.079
Dfixed								.939
Dvar								

Panel B: Mus Musculus

	Length	%basic	%acidic	%hydroph	%aromatic	%polar	Dfixed	Dvar
Length		-.267	.145	-.099	.221	.062	.977	.918
%basic			-.133	-.184	-.307	-.281	-.313	-.276
%acidic				-.071	.052	-.548	.163	.266
%hydroph					-.228	-.370	-.036	-.156
%aromatic						-.112	.152	.195
%polar							.099	.003
Dfixed								.936
Dvar								

Panel C: Rattus Norvegicus

	Length	%basic	%acidic	%hydroph	%aromatic	%polar	Dfixed	Dvar
Length		-.245	.176	-.165	.170	.043	.971	.919
%basic			-.025	-.168	-.188	-.380	-.278	-.263
%acidic				-.099	-.060	-.562	.188	.277
%hydroph					-.167	-.295	-.090	-.211
%aromatic						-.119	.106	.137
%polar							.081	.019
Dfixed								.927
Dvar								

Table 5 Eigen Values and Principal Components for all the 3 species in precursors

Panel I: Homo Sapiens

Principal Component	Eigen Value	Cumulative Percentage
1	3.059	38.237
2	1.796	60.684
3	1.211	75.817

Panel II: Mus Musculus

Principal Component	Eigen Value	Cumulative Percentage
1	2.945	36.815
2	1.606	56.892
3	1.316	73.338
4	1.226	88.659

Panel III: Rattus Norvegicus

Principal Component	Eigen Value	Cumulative Percentage
1	3.054	38.178
2	1.678	59.149
3	1.170	73.771
4	1.108	87.621

Table 6 Factor Loadings of the variables in the sample species in precursors

Variable	Homo Sapiens			Mus Musculus				Rattus Norvegicus			
	Component			Component				Component			
	1	2	3	1	2	3	4	1	2	3	4
Length	.310	.018	.023	.343	-.016	-.068	.002	.318	.009	-.020	-.024
%Basic	-.185	.234	.396	.015	.146	-.621	.340	-.099	.223	-.508	-.260
%Acidic	.021	.408	.054	.020	.512	.072	.098	.083	.453	-.029	-.038
%Hydrophobic	-.005	.099	-.748	.007	.023	.009	-.780	-.036	.107	.763	-.123
%Aromatic	.038	.222	.311	-.133	.145	.653	.276	-.083	.057	-.039	.910
%Polar	.084	-.539	.117	.042	-.567	.057	.108	.061	-.572	-.097	-.122
Dfixed	.322	-.034	-.037	.356	-.039	-.081	-.066	.330	-.004	.043	-.087
Dvar	.306	.029	.047	.334	.048	-.068	.046	.318	.039	-.045	-.039

Table 7 Correlation matrices of protein variates for the 3 species in nonprecursors

Panel A: Homo Sapiens

	Length	%basic	%acidic	%hydroph	%aromatic	%polar	Dfixed	Dvar
Length		-.040	.165	-.247	-.229	.212	.975	.892
%basic			.500	-.374	-.191	-.414	-.092	-.133
%acidic				-.510	-.318	-.367	.104	.073
%hydroph					.460	-.429	-.290	-.325
%aromatic						-.484	-.318	-.340
%polar							.356	.420
Dfixed								.947
Dvar								

Panel B: Mus Musculus

	Length	%basic	%acidic	%hydroph	%aromatic	%polar	Dfixed	Dvar
Length		-.079	.141	-.233	-.201	.249	.959	.873
%basic			.460	-.426	-.156	-.417	-.150	-.108
%acidic				-.577	-.387	-.278	.075	.094
%hydroph					.404	-.393	-.265	-.324
%aromatic						-.439	-.313	-.322
%polar							.420	.424
Dfixed								.939
Dvar								

Panel C: Rattus Norvegicus

	Length	%basic	%acidic	%hydroph	%aromatic	%polar	Dfixed	Dvar
Length		-.098	.141	-.234	-.208	.249	.959	.856
%basic			.423	-.447	-.154	-.383	-.161	-.161
%acidic				-.540	-.328	-.323	.058	.022
%hydroph					.405	-.387	-.265	-.306
%aromatic						-.478	-.323	-.338
%polar							.424	.485
Dfixed								.940
Dvar								

Table 8 Eigen Values and Principal Components for all the 3 species in nonprecursors

Panel I: Homo Sapiens

Principal Component	Eigen Value	Cumulative Percentage
1	2.909	36.365
2	2.010	61.489
3	1.958	85.966

Panel II: Mus Musculus

Principal Component	Eigen Value	Cumulative Percentage
1	2.892	36.147
2	2.047	61.735
3	1.831	84.618

Panel III: Rattus Norvegicus

Principal Component	Eigen Value	Cumulative Percentage
1	2.884	36.047
2	2.032	61.448
3	1.832	84.350

Table 9 Factor Loadings of the variables in the sample species in nonprecursors

Variable	Homo Sapiens			Mus Musculus			Rattus Norvegicus		
	Component			Component			Component		
	1	2	3	1	2	3	1	2	3
Length	.386	.055	.153	.397	.050	-.183	.404	.059	-.195
%Basic	-.039	.417	-.015	-.014	.424	-.083	-.039	.406	-.037
%Acidic	.039	.430	-.022	.025	.414	.024	.055	.430	-.048
%Hydrophobic	.064	-.168	.399	.051	-.226	-.350	.045	-.259	-.332
%Aromatic	.081	-.040	.442	.094	-.063	-.455	.098	-.072	-.464
%Polar	-.085	-.336	-.472	-.093	-.303	.541	-.099	-.274	.546
Dfixed	.358	.002	.071	.356	-.014	-.064	.360	-.003	-.072
Dvar	.326	-.030	.018	.331	-.002	-.030	.318	-.025	-.004

Table 10 Variables in the corresponding principal components of the 3 species across precursors and nonprecursors

Species/principal component	Precursors- variables	Nonprecursors -variables
Human/principal component 1	Length, Dfixed, Dvarglobular	Length, Dfixed, Dvarglobular
Human/principal component 2	% acidic	%basic, %acidic
Human/principal component 3	%basic, %aromatic	%hydrophobic, %aromatic
Mouse/Principal Component 1	Length, Dfixed, Dvarglobular	Length, Dfixed, Dvarglobular
Mouse/Principal Component 2	%acidic	%basic, %acidic
Mouse/Principal Component 3	%aromatic	%polar
Mouse/Principal Component 4	%basic	-------
Rat/Principal Component 1	Length, Dfixed, Dvarglobular	Length, Dfixed, Dvarglobular
Rat/Principal Component 2	%acidic	%basic, %acidic
Rat/Principal Component 3	%hydrophobic	%polar
Rat/Principal Component 4	%aromatic	-------

Table 11 - Type 2 Diabetes related proteins in all the 3 species

S. No.	Protein Abbr.	Name of the protein	Organism	Accession No.
1.	Abcc8	ATP-binding cassette transporter sub-family C member 8	Homo Sapiens	Q09428
	Abcc8	ATP-binding cassette transporter sub-family C member 8	Mus Musculus	NP_035640.2
	Abcc8	ATP-binding cassette transporter sub-family C member 8	Rattus Norvegicus	NP_037171.1
2.	Abl1	Proto-oncogene tyrosine-protein kinase	Homo Sapiens	P00519
	Abl1	Proto-oncogene tyrosine-protein kinase	Mus Musculus	NP_033724.1
	Abl1	Proto-oncogene tyrosine-protein kinase	Rattus Norvegicus	XP_001067860.1
3.	Ace	Angiotensin-converting enzyme, testis-specific isoform	Homo Sapiens	AAR03504
	Ace	Angiotensin-converting enzyme, testis-specific isoform	Mus Musculus	AAH83109
	Ace	Angiotensin-converting enzyme, testis-specific isoform	Rattus Norvegicus	AAG35596
4.	Acp1	acid phosphatase 1	Homo Sapiens	P24666
	Acp1	acid phosphatase 1	Mus Musculus	NP_067305.2
	Acp1	acid phosphatase 1	Rattus Norvegicus	NP_067085.1
5.	Ada	Adenosine deaminase	Homo Sapiens	P00813
	Ada	Adenosine deaminase	Mus Musculus	NP_031424.1
	Ada	Adenosine deaminase	Rattus Norvegicus	NP_569083.1
6.	Adcyap1	Pituitary adenylate cyclase-activating polypeptide precursor	Homo Sapiens	P18509
	Adcyap1	Pituitary adenylate cyclase-activating polypeptide precursor	Mus Musculus	NP_033755.1
	Adcyap1	Pituitary adenylate cyclase-activating polypeptide precursor	Rattus Norvegicus	NP_058685.1
7.	Adipoq	Adiponectin precursor	Homo Sapiens	Q15848
	Adipoq	Adiponectin precursor	Mus Musculus	NP_033735.3
	Adipoq	adiponectin precursor	Rattus Norvegicus	NP_653345.1
8.	Adipor1	adiponectin receptor 1 variant	Homo Sapiens	Q96A54
	Adipor1	adiponectin receptor 1 variant	Mus Musculus	NP_082596.2
	Adipor1	adiponectin receptor 1 variant	Rattus Norvegicus	NP_997470.1
9.	Adipor2	Adiponectin receptor protein 2	Homo Sapiens	Q86V24
	Adipor2	Adiponectin receptor protein 2	Mus	NP_932102.2

			Musculus	
	Adipor2	Adiponectin receptor protein 2	Rattus Norvegicus	NP_001033068.1
10.	Adm	Adrenomedullin precursor	Homo Sapiens	P35318
	Adm	Adrenomedullin precursor	Mus Musculus	NP_033757.1
	Adm	Adrenomedullin precursor	Rattus Norvegicus	NP_036847.1
11.	Adra2b	Alpha-2B adrenergic receptor	Homo Sapiens	P18089
	Adra2b	Alpha-2B adrenergic receptor	Mus Musculus	NP_033763.2
	Adra2b	Alpha-2B adrenergic receptor	Rattus Norvegicus	NP_612514.1
12.	Adrb2	Beta-2 adrenergic receptor	Homo Sapiens	P07550
	Adrb2	Beta-2 adrenergic receptor	Mus Musculus	NP_031446.2
	Adrb2	Beta-2 adrenergic receptor	Rattus Norvegicus	NP_036624.2
13.	Adrb3	Beta-3 adrenergic receptor	Homo Sapiens	P13945
	Adrb3	Beta-3 adrenergic receptor	Mus Musculus	NP_038490.2
	Adrb3	Beta-3 adrenergic receptor	Rattus Norvegicus	NP_037240.1
14.	ager	Advanced glycosylation end product-specific receptor precursor	Homo Sapiens	Q15109
	ager	Advanced glycosylation end product-specific receptor precursor	Mus Musculus	NP_031451.2
	ager	Advanced glycosylation end product-specific receptor precursor	Rattus Norvegicus	NP_445788.1
15.	agrp	Agouti-related protein precursor	Homo Sapiens	O00253
	agrp	Agouti-related protein precursor	Mus Musculus	NP_031453.1
	agrp	Agouti-related protein precursor	Rattus Norvegicus	XP_574228.1
16.	agt	Angiotensinogen	Homo Sapiens	P01019
	agt	Angiotensinogen	Mus Musculus	P11859
	agt	Angiotensinogen	Rattus Norvegicus	NP_602308
17.	Agtr1	Type-1 angiotensin II receptor	Homo Sapiens	P30556
	Agtr1	Type-1 angiotensin II receptor	Mus Musculus	NP_796296.1
	Agtr1	Type-1 angiotensin II receptor	Rattus Norvegicus	NP_112247.2
18.	ahsg	Alpha-2-HS-glycoprotein precursor	Homo Sapiens	P02765
	ahsg	Alpha-2-HS-glycoprotein precursor	Mus Musculus	NP_038493.1

	ahsg	Alpha-2-HS-glycoprotein precursor	Rattus Norvegicus	NP_037030.1
19.	Akr1b1	Aldose reductase	Homo Sapiens	P15121
	Akr1b1	Aldose reductase	Mus Musculus	NP_033788.2
	Akr1b1	Aldose reductase	Rattus Norvegicus	NP_036630.1
20.	Akr1b10	Aldo-keto reductase family 1 member B10	Homo Sapiens	O60218
	Akr1b10	Aldo-keto reductase family 1 member B10	Mus Musculus	NP_765986.3
	Akr1b10	Aldo-keto reductase family 1 member B10	Rattus Norvegicus	NP_001013102.1
21.	Akt1	RAC-alpha serine/threonine-protein kinase	Homo Sapiens	P31749
	Akt1	RAC-alpha serine/threonine-protein kinase	Mus Musculus	AAN04036
	Akt1	RAC-alpha serine/threonine-protein kinase	Rattus Norvegicus	NP_150233
22.	Alms1	Alstrom syndrome protein 1	Homo Sapiens	Q8TCU4
	Alms1	Alstrom syndrome protein 1	Mus Musculus	NP_660258.1
	Alms1	Alstrom syndrome protein 1	Rattus Norvegicus	XP_216189.3
23.	Angptl4	Angiopoietin-related protein 4 precursor	Homo Sapiens	Q9BY76
	Angpt14	Angiopoietin-related protein 4 precursor	Mus Musculus	NP_065606.1
	Angpt14	Angiopoietin-related protein 4 precursor	Rattus Norvegicus	NP_954546.1
24.	Apoa5	Apolipoprotein A-V precursor	Homo Sapiens	Q6Q788
	Apoa5	Apolipoprotein A-V precursor	Mus Musculus	NP_536682.2
	Apoa5	Apolipoprotein A-V precursor	Rattus Norvegicus	NP_542143.1
25.	Apoc3	Apolipoprotein C-III precursor	Homo Sapiens	P02656
	Apoc3	Apolipoprotein C-III precursor	Mus Musculus	NP_075603.1
	Apoc3	Apolipoprotein C-III precursor	Rattus Norvegicus	NP_036633
26.	Apoe	Apolipoprotein E precursor	Homo Sapiens	P02649
	Apoe	Apolipoprotein E precursor	Mus Musculus	NP_033826.1
	Apoe	Apolipoprotein E precursor	Rattus Norvegicus	NP_620183.1
27.	Arnt	Aryl hydrocarbon receptor nuclear translocator	Homo Sapiens	P27540
	Arnt	Aryl hydrocarbon receptor nuclear translocator	Mus Musculus	NP_001032826.1
	Arnt	Aryl hydrocarbon receptor nuclear	Rattus	NP_036912.1

		translocator	Norvegicus	
28.	Asip	Agouti signaling protein precursor	Homo Sapiens	P42127
	Asip	Agouti signaling protein precursor	Mus Musculus	NP_056585.2
	Asip	Agouti signaling protein precursor	Rattus Norvegicus	NP_443211.1
29.	Atp1a1	Sodium/potassium-transporting ATPase alpha-1 chain precursor	Homo Sapiens	P05023
	Atp1a1	Sodium/potassium-transporting ATPase alpha-1 chain precursor	Mus Musculus	NP_659149.1
	Atp1a1	Sodium/potassium-transporting ATPase alpha-1 chain precursor	Rattus Norvegicus	NP_036636.1
30.	Atp1a2	Sodium/potassium-transporting ATPase alpha-2 chain	Homo Sapiens	P50993
	Atp1a2	Sodium/potassium-transporting ATPase alpha-2 chain	Mus Musculus	NP_848492
	Atp1a2	Sodium/potassium-transporting ATPase alpha-2 chain	Rattus Norvegicus	NP_036637
31.	Atp4b	Potassium-transporting ATPase beta chain	Homo Sapiens	P51164
	Atp4b	Potassium-transporting ATPase beta chain	Mus Musculus	NP_033854.1
	Atp4b	Potassium-transporting ATPase beta chain	Rattus Norvegicus	NP_036642.2
32.	B2m	Beta-2-microglobulin precursor	Homo Sapiens	P61769
	B2m	Beta-2-microglobulin precursor	Mus Musculus	NP_033865.2
	B2m	Beta-2-microglobulin precursor	Rattus Norvegicus	NP_036644.1
33.	Bche	Butyrylcholine esterase	Homo Sapiens	P06276
	Bche	Butyrylcholine esterase	Mus Musculus	NP_033868
	Bche	Butyrylcholine esterase	Rattus Norvegicus	NP_075231
34.	Btc	Betacellulin precursor	Homo Sapiens	P35070
	Btc	Betacellulin precursor	Mus Musculus	NP_031594.1
	Btc	Betacellulin precursor	Rattus Norvegicus	NP_071592.1
35.	Capn10	Calpain-10(Calcium-activated neutral proteinase 10)	Homo Sapiens	Q9HC96
	Capn10	Calpain-10(Calcium-activated neutral proteinase 10)	Mus Musculus	AAH10969
	Capn10	Calpain-10(Calcium-activated neutral proteinase 10)	Rattus Norvegicus	Q9ES66
36.	Casq1	Calsequestrin-1 precursor	Homo Sapiens	P31415
	Casq1	Calsequestrin-1 precursor	Mus Musculus	NP_033943.1
	Casq1	Calsequestrin-1 precursor	Rattus Norvegicus	XP_001063867.1

37.	Casr	Extracellular calcium-sensing receptor precursor	Homo Sapiens	P41180
	Casr	Extracellular calcium-sensing receptor precursor	Mus Musculus	NP_038831.1
	Casr	Extracellular calcium-sensing receptor precursor	Rattus Norvegicus	NP_058692.1
38.	Cckar	Cholecystokinin type A receptor	Homo Sapiens	P32238
	Cckar	Cholecystokinin type A receptor	Mus Musculus	AAC07949
	Cckar	Cholecystokinin type A receptor	Rattus Norvegicus	NP_036820
39.	Cckbr	Gastrin/cholecystokinin type B receptor	Homo Sapiens	P32239
	Cckbr	Gastrin/cholecystokinin type B receptor	Mus Musculus	NP_031653
	Cckbr	Gastrin/cholecystokinin type B receptor	Rattus Norvegicus	NP_037297
40.	Ccl2	Small inducible cytokine A2 precursor	Homo Sapiens	P13500
	Ccl2	Small inducible cytokine A2 precursor	Mus Musculus	NP_035461.2
	Ccl2	Small inducible cytokine A2 precursor	Rattus Norvegicus	XP_213425.1
41.	Cd36	Platelet glycoprotein IV	Homo Sapiens	EAL24191
	Cd36	Platelet glycoprotein IV	Mus Musculus	Q08857
	Cd36	Platelet glycoprotein IV	Rattus Norvegicus	AAF25552
42.	Cd40lg	CD40 ligand	Homo Sapiens	P29965
	Cd40lg	CD40 ligand	Mus Musculus	NP_035746.2
	Cd40lg	CD40 ligand	Rattus Norvegicus	NP_445805.1
43.	Cdkn1c	Cyclin-dependent kinase inhibitor 1C	Homo Sapiens	P49918
	Cdkn1c	Cyclin-dependent kinase inhibitor 1C	Mus Musculus	NP_034006.2
	Cdkn1c	Cyclin-dependent kinase inhibitor 1C	Rattus Norvegicus	NP_001028930.1
44.	Clps	Colipase precursor	Homo Sapiens	P04118
	Clps	Colipase precursor	Mus Musculus	NP_079745.1
	Clps	Colipase precursor	Rattus Norvegicus	NP_037271.1
45.	Cma1	Chymase precursor	Homo Sapiens	P23946
	Cma1	Chymase precursor	Mus Musculus	NP_034910.1
	Cma1	Chymase precursor	Rattus Norvegicus	NP_037224.1
46.	Cp	Ceruloplasmin precursor	Homo	P00450

			Sapiens	
	Cp	Ceruloplasmin precursor	Mus Musculus	NP_001036076.1
	Cp	Ceruloplasmin precursor	Rattus Norvegicus	NP_036664.1
47.	Cpb2	Carboxypeptidase B2 precursor	Homo Sapiens	Q96IY4
	Cpb2	Carboxypeptidase B2 precursor	Mus Musculus	NP_062749.2
	Cpb2	Carboxypeptidase B2 precursor	Rattus Norvegicus	NP_446069.1
48.	Cpm	Carboxypeptidase M precursor	Homo Sapiens	P14384
	Cpm	Carboxypeptidase M precursor	Mus Musculus	XP_999707.1
	Cpm	Carboxypeptidase M precursor	Rattus Norvegicus	XP_235168.4
49.	Crp	C-reactive protein precursor	Homo Sapiens	P02741
	Crp	C-reactive protein precursor	Mus Musculus	NP_031794.2
	Crp	C-reactive protein precursor	Rattus Norvegicus	NP_058792.1
50.	Cst3	Cystatin C precursor	Homo Sapiens	P01034
	Cst3	Cystatin C precursor	Mus Musculus	NP_034106.2
	Cst3	Cystatin C precursor	Rattus Norvegicus	NP_036969.1
51.	Ctla4	Cytotoxic T-lymphocyte protein 4 precursor	Homo Sapiens	P16410
	Ctla4	Cytotoxic T-lymphocyte protein 4 precursor	Mus Musculus	NP_033973.2
	Ctla4	Cytotoxic T-lymphocyte protein 4 precursor	Rattus Norvegicus	NP_113862.1
52.	Cxcl12	Stromal cell-derived factor 1 precursor	Homo Sapiens	P48061
	Cxcl12	Stromal cell-derived factor 1 precursor	Mus Musculus	NP_001012495.1
	Cxcl12	Stromal cell-derived factor 1 precursor	Rattus Norvegicus	NP_001029055.1
53.	Cyb5r4	Cytochrome b5 reductase 4	Homo Sapiens	Q7L1T6
	Cyb5r4	Cytochrome b5 reductase 4	Mus Musculus	NP_077157.1
	Cyb5r4	Cytochrome b5 reductase 4	Rattus Norvegicus	NP_596918.2
54.	Cyba	Cytochrome b-245 light chain	Homo Sapiens	P13498
	Cyba	Cytochrome b-245 light chain	Mus Musculus	NP_031832.1
	Cyba	Cytochrome b-245 light chain	Rattus Norvegicus	NP_077074.1
55.	Cyp17a1	Cytochrome P450 17A1	Homo Sapiens	P05093

	Cyp17a1	Cytochrome P450 17A1	Mus Musculus	NP_031835.2
	Cyp17a1	Cytochrome P450 17A1	Rattus Norvegicus	NP_036885.1
56.	Dio2	Type II iodothyronine deiodinase	Homo Sapiens	Q92813
	Dio2	Type II iodothyronine deiodinase	Mus Musculus	NP_034180.1
	Dio2	Type II iodothyronine deiodinase	Rattus Norvegicus	NP_113908.2
57.	Drd2	D(2) dopamine receptor	Homo Sapiens	P14416
	Drd2	D(2) dopamine receptor	Mus Musculus	NP_034207.1
	Drd2	D(2) dopamine receptor	Rattus Norvegicus	NP_036679.1
58.	Enpp1	Ectonucleotide pyrophosphatase/phosphodiesterase 1	Homo Sapiens	P22413
	Enpp1	Ectonucleotide pyrophosphatase/phosphodiesterase 1	Mus Musculus	NP_032839.2
	Enpp1	Ectonucleotide pyrophosphatase/phosphodiesterase 1	Rattus Norvegicus	NP_445987.1
59.	Ensa	Alpha-endosulfine	Homo Sapiens	O43768
	Ensa	Alpha-endosulfine	Mus Musculus	NP_062507.1
	Ensa	Alpha-endosulfine	Rattus Norvegicus	NP_068614.1
60.	Ep300	E1A-associated protein p300	Homo Sapiens	Q09472
	Ep300	E1A-associated protein p300	Mus Musculus	NP_808489.4
	Ep300	E1A-associated protein p300	Rattus Norvegicus	XP_576312.2
61.	F2	Prothrombin precursor	Homo Sapiens	P00734
	F2	Prothrombin precursor	Mus Musculus	NP_034298.1
	F2	Prothrombin precursor	Rattus Norvegicus	NP_075213.1
62.	F5	Coagulation factor V precursor	Homo Sapiens	P12259
	F5	Coagulation factor V precursor	Mus Musculus	NP_032002.1
	F5	Coagulation factor V precursor	Rattus Norvegicus	XP_222831.4
63.	Fabp2	Fatty acid-binding protein, intestinal	Homo Sapiens	P12104
	Fabp2	Fatty acid-binding protein, intestinal	Mus Musculus	NP_032006.1
	Fabp2	Fatty acid-binding protein, intestinal	Rattus Norvegicus	NP_037200.1
64.	Fabp4	Fatty acid-binding protein, adipocyte	Homo Sapiens	P15090
	Fabp4	Fatty acid-binding protein, adipocyte	Mus	NP_077717.1

			Musculus	
	Fabp4	Fatty acid-binding protein, adipocyte	Rattus Norvegicus	NP_445817.1
65.	Fas	Tumor necrosis factor receptor superfamily member 6 precursor	Homo Sapiens	P25445
	Fas	Tumor necrosis factor receptor superfamily member 6 precursor	Mus Musculus	NP_032013.1
	Fas	Tumor necrosis factor receptor superfamily member 6 precursor	Rattus Norvegicus	NP_631933.2
66.	Faslg	Tumor necrosis factor ligand superfamily member 6	Homo Sapiens	P48023
	Faslg	Tumor necrosis factor ligand superfamily member 6	Mus Musculus	NP_034307.1
	Faslg	Tumor necrosis factor ligand superfamily member 6	Rattus Norvegicus	NP_037040.1
67.	Fcgr2a	Low affinity immunoglobulin gamma Fc region receptor II-a precursor	Homo Sapiens	P12318
	Fcgr2a	Low affinity immunoglobulin gamma Fc region receptor II-a precursor	Mus Musculus	NP_034318.1
	Fcgr2a	Low affinity immunoglobulin gamma Fc region receptor II-a precursor	Rattus Norvegicus	NP_446295.2
68.	Foxc2	Forkhead box protein C2	Homo Sapiens	Q99958
	Foxc2	Forkhead box protein C2	Mus Musculus	NP_038547.1
	Foxc2	Forkhead box protein C2	Rattus Norvegicus	NP_001095150
69.	Foxo1a	Forkhead box protein O1A	Homo Sapiens	Q12778
	Foxo1a	Forkhead box protein O1A	Mus Musculus	NP_062713.2
	Foxo1a	Forkhead box protein O1A	Rattus Norvegicus	XP_342245.2
70.	Gal	Galanin precursor	Homo Sapiens	P22466
	Gal	Galanin precursor	Mus Musculus	NP_034383.1
	Gal	Galanin precursor	Rattus Norvegicus	NP_150240.1
71.	Gc	Vitamin D-binding protein precursor	Homo Sapiens	NP_000574
	Gc	Vitamin D-binding protein precursor	Mus Musculus	NP_032122
	Gc	Vitamin D-binding protein precursor	Rattus Norvegicus	P04276
72.	Gcg	Glucagon precursor	Homo Sapiens	P01275
	Gcg	Glucagon precursor	Mus Musculus	NP_032126.1
	Gcg	Glucagon precursor	Rattus Norvegicus	NP_036839.1
73.	Gcgr	Glucagon receptor precursor	Homo Sapiens	P47871
	Gcgr	Glucagon receptor precursor	Mus Musculus	NP_032127.1

	Gcgr	Glucagon receptor precursor	Rattus Norvegicus	NP_742088.1
74.	Gck	Glucokinase	Homo Sapiens	P35557
	Gck	Glucokinase	Mus Musculus	NP_034422
	Gck	Glucokinase	Rattus Norvegicus	NP_036697
75.	Gckr	Glucokinase regulatory protein	Homo Sapiens	Q14397
	Gckr	Glucokinase regulatory protein	Mus Musculus	NP_659158.1
	Gckr	Glucokinase regulatory protein	Rattus Norvegicus	Q07071
76.	Gfpt1	Glucosamine--fructose-6-phosphate aminotransferase [isomerizing] 1	Homo Sapiens	Q06210
	Gfpt1	Glucosamine--fructose-6-phosphate aminotransferase [isomerizing] 1	Mus Musculus	NP_038556.1
	Gfpt1	Glucosamine--fructose-6-phosphate aminotransferase [isomerizing] 1	Rattus Norvegicus	NP_001005879.1
77.	Gfpt2	Glucosamine--fructose-6-phosphate aminotransferase [isomerizing] 2	Homo Sapiens	O94808
	Gfpt2	Glucosamine--fructose-6-phosphate aminotransferase [isomerizing] 2	Mus Musculus	NP_038557.1
	Gfpt2	Glucosamine--fructose-6-phosphate aminotransferase [isomerizing] 2	Rattus Norvegicus	NP_001002819.2
78.	Ghrl	Appetite-regulating hormone precursor	Homo Sapiens	Q9UBU3
	Ghrl	Appetite-regulating hormone precursor	Mus Musculus	NP_067463.2
	Ghrl	Appetite-regulating hormone precursor	Rattus Norvegicus	NP_067701.1
79.	Gip	Gastric inhibitory polypeptide precursor	Homo Sapiens	P09681
	Gip	Gastric inhibitory polypeptide precursor	Mus Musculus	NP_032145.2
	Gip	Gastric inhibitory polypeptide precursor	Rattus Norvegicus	NP_062604.1
80.	Gnb3	Guanine nucleotide-binding protein G(I)/G(S)/G(T) subunit beta 3	Homo Sapiens	P16520
	Gnb3	Guanine nucleotide-binding protein G(I)/G(S)/G(T) subunit beta 3	Mus Musculus	NP_038558.1
	Gnb3	Guanine nucleotide-binding protein G(I)/G(S)/G(T) subunit beta 3	Rattus Norvegicus	NP_068630.1
81.	Gpr35	Probable G-protein coupled receptor 35	Homo Sapiens	Q9HC97
	Gpr35	Probable G-protein coupled receptor 35	Mus Musculus	NP_071715.2
	Gpr35	Probable G-protein coupled receptor 35	Rattus Norvegicus	NP_001032436.1
82.	Gys1	Glycogen [starch] synthase, muscle	Homo Sapiens	P13807
	Gys1	Glycogen [starch] synthase, muscle	Mus Musculus	NP_109603.2
	Gys1	Glycogen [starch] synthase, muscle	Rattus	XP_001076950.1

			Norvegicus	
83.	Hfe	Hereditary hemochromatosis protein precursor	Homo Sapiens	Q30201
	Hfe	Hereditary hemochromatosis protein precursor	Mus Musculus	NP_034554.2
	Hfe	Hereditary hemochromatosis protein precursor	Rattus Norvegicus	NP_445753
84.	Hif1a	Hypoxia-inducible factor 1 alpha	Homo Sapiens	Q16665
	Hif1a	Hypoxia-inducible factor 1 alpha	Mus Musculus	NP_034561.1
	Hif1a	Hypoxia-inducible factor 1 alpha	Rattus Norvegicus	NP_077335.1
85.	Hmox1	Heme oxygenase 1	Homo Sapiens	P09601
	Hmox1	Heme oxygenase 1	Mus Musculus	NP_034572.1
	Hmox1	Heme oxygenase 1	Rattus Norvegicus	NP_036712.1
86.	Hnf4a	hepatocyte nuclear factor 4 alpha	Homo Sapiens	NP_000448
	Hnf4a	hepatocyte nuclear factor 4 alpha	Mus Musculus	AAH39220
	Hnf4a	hepatocyte nuclear factor 4 alpha	Rattus Norvegicus	P22449
87.	Hnf4g	Hepatocyte nuclear factor 4-gamma	Homo Sapiens	Q14541
	Hnf4g	Hepatocyte nuclear factor 4-gamma	Mus Musculus	NP_038948.1
	Hnf4g	Hepatocyte nuclear factor 4-gamma	Rattus Norvegicus	XP_345189.3
88.	Hsd11b1	Corticosteroid 11-beta-dehydrogenase isozyme 1	Homo Sapiens	P28845
	Hsd11b1	Corticosteroid 11-beta-dehydrogenase isozyme 1	Mus Musculus	NP_032314.2
	Hsd11b1	Corticosteroid 11-beta-dehydrogenase isozyme 1	Rattus Norvegicus	NP_058776.2
89.	Hspa1a	Corticosteroid 11-beta-dehydrogenase isozyme 1	Homo Sapiens	P08107
	Hspa1a	Corticosteroid 11-beta-dehydrogenase isozyme 1	Mus Musculus	NP_034608.2
	Hspa1a	Corticosteroid 11-beta-dehydrogenase isozyme 1	Rattus Norvegicus	NP_997669.1
90.	Hspa1b	Heat shock 70 kDa protein 1	Homo Sapiens	P08107
	Hspa1b	Heat shock 70 kDa protein 1	Mus Musculus	NP_034608.2
	Hspa1b	Heat shock 70 kDa protein 1	Rattus Norvegicus	NP_997669.1
91.	Htr1a	5-hydroxytryptamine 1A receptor	Homo Sapiens	P08908
	Htr1a	5-hydroxytryptamine 1A receptor	Mus Musculus	NP_032334.2
	Htr1a	5-hydroxytryptamine 1A receptor	Rattus Norvegicus	NP_036717.1

92.	Iapp	Islet amyloid polypeptide precursor	Homo Sapiens	P10997
	Iapp	Islet amyloid polypeptide precursor	Mus Musculus	NP_034621.1
	Iapp	Islet amyloid polypeptide precursor	Rattus Norvegicus	NP_036718.1
93.	Icam1	Intercellular adhesion molecule-1	Homo Sapiens	P05362
	Icam1	Intercellular adhesion molecule-1	Mus Musculus	AAH08626
	Icam1	Intercellular adhesion molecule-1	Rattus Norvegicus	AAH81837
94.	Ide	Insulin-degrading enzyme	Homo Sapiens	P14735
	Ide	Insulin-degrading enzyme	Mus Musculus	NP_112419.2
	Ide	Insulin-degrading enzyme	Rattus Norvegicus	NP_037291.1
95.	Ifng	Interferon gamma precursor	Homo Sapiens	P01579
	Ifng	Interferon gamma precursor	Mus Musculus	NP_032363.1
	Ifng	Interferon gamma precursor	Rattus Norvegicus	NP_620235.1
96.	Igf1	Insulin-like growth factor IB precursor	Homo Sapiens	P05019
	Igf1	Insulin-like growth factor IB precursor	Mus Musculus	NP_908941.1
	Igf1	Insulin-like growth factor IB precursor	Rattus Norvegicus	NP_849197.1
97.	Igfbp1	Insulin-like growth factor-binding protein 1 precursor	Homo Sapiens	P08833
	Igfbp1	Insulin-like growth factor-binding protein 1 precursor	Mus Musculus	NP_032367.2
	Igfbp1	Insulin-like growth factor-binding protein 1 precursor	Rattus Norvegicus	NP_037276.1
98.	Ihpk1	Inositol hexaphosphate kinase 1	Homo Sapiens	Q92551
	Ihpk1	Inositol hexaphosphate kinase 1	Mus Musculus	NP_038813.2
	Ihpk1	Inositol hexaphosphate kinase 1	Rattus Norvegicus	NP_445768.1
99.	Il10	Interleukin-10 precursor	Homo Sapiens	P22301
	Il10	Interleukin-10 precursor	Mus Musculus	NP_034678.1
	Il10	Interleukin-10 precursor	Rattus Norvegicus	NP_036986.1
100.	Il18	Interleukin-18 precursor	Homo Sapiens	Q14116
	Il18	Interleukin-18 precursor	Mus Musculus	NP_032386.1
	Il18	Interleukin-18 precursor	Rattus Norvegicus	NP_062038.1
101.	Il1b	Interleukin-1 beta precursor	Homo	P01584

			Sapiens	
	Il1b	Interleukin-1 beta precursor	Mus Musculus	NP_032387.1
	Il1b	Interleukin-1 beta precursor	Rattus Norvegicus	NP_113700.1
102.	Il1rn	Interleukin-1 receptor antagonist protein precursor	Homo Sapiens	P18510
	Il1rn	Interleukin-1 receptor antagonist protein precursor	Mus Musculus	NP_001034790.1
	Il1rn	Interleukin-1 receptor antagonist protein precursor	Rattus Norvegicus	NP_071530.1
103.	Il4	Interleukin-4 precursor	Homo Sapiens	P05112
	Il4	Interleukin-4 precursor	Mus Musculus	NP_067258.1
	Il4	Interleukin-4 precursor	Rattus Norvegicus	NP_958427.1
104.	Il6	Interleukin-6 precursor	Homo Sapiens	P05231
	Il6	Interleukin-6 precursor	Mus Musculus	NP_112445.1
	Il6	Interleukin-6 precursor	Rattus Norvegicus	NP_036721.1
105.	Il6r	Interleukin-6 receptor alpha chain precursor	Homo Sapiens	P08887
	Il6r	Interleukin-6 receptor alpha chain precursor	Mus Musculus	NP_034689.2
	Il6r	Interleukin-6 receptor alpha chain precursor	Rattus Norvegicus	NP_058716.1
106.	Inppl1	Inositol polyphosphate 5-phosphatase	Homo Sapiens	O15357
	Inppl1	Inositol polyphosphate 5-phosphatase	Mus Musculus	NP_034697.1
	Inppl1	Inositol polyphosphate 5-phosphatase	Rattus Norvegicus	NP_075233.1
107.	Ins	Insulin precursor	Homo Sapiens	P01308
	Ins	Insulin precursor	Mus Musculus	NP_032413.1
	Ins	Insulin precursor	Rattus Norvegicus	NP_062003.1
108.	Insr	insulin receptor	Homo Sapiens	NP_000199
	Insr	insulin receptor	Mus Musculus	NP_034698
	Insr	insulin receptor	Rattus Norvegicus	NP_058767
109.	Ipf1	Insulin promoter factor 1	Homo Sapiens	P52945
	Ipf1	Insulin promoter factor 1	Mus Musculus	CAA52389
	Ipf1	Insulin promoter factor 1	Rattus Norvegicus	NP_074043
110.	Irs1	Insulin receptor substrate 1	Homo Sapiens	P35568

	Irs1	Insulin receptor substrate 1	Mus Musculus	NP_034700.2
	Irs1	Insulin receptor substrate 1	Rattus Norvegicus	NP_037101.1
111.	Irs2	Insulin receptor substrate 2	Homo Sapiens	Q9Y4H2
	Irs2	Insulin receptor substrate 2	Mus Musculus	NP_001074681.1
	Irs2	Insulin receptor substrate 2	Rattus Norvegicus	XP_573948.2
112.	Itga2	Integrin alpha-2 precursor	Homo Sapiens	P17301
	Itga2	Integrin alpha-2 precursor	Mus Musculus	NP_032422.2
	Itga2	Integrin alpha-2 precursor	Rattus Norvegicus	XP_345157.3
113.	Itga2b	Integrin alpha-IIb precursor	Homo Sapiens	P08514
	Itga2b	Integrin alpha-IIb precursor	Mus Musculus	NP_034705.1
	Itga2b	Integrin alpha-IIb precursor	Rattus Norvegicus	XP_001063315.1
114.	Itgb1	Integrin beta-1 precursor	Homo Sapiens	P05556
	Itgb1	Integrin beta-1 precursor	Mus Musculus	NP_034708.1
	Itgb1	Integrin beta-1 precursor	Rattus Norvegicus	NP_058718.1
115.	Itgb2	Integrin beta-2 precursor	Homo Sapiens	P05107
	Itgb2	Integrin beta-2 precursor	Mus Musculus	NP_032430.2
	Itgb2	Integrin beta-2 precursor	Rattus Norvegicus	XP_001069791.1
116.	Itgb3	Integrin beta-3 precursor	Homo Sapiens	P05106
	Itgb3	Integrin beta-3 precursor	Mus Musculus	NP_058060.1
	Itgb3	Integrin beta-3 precursor	Rattus Norvegicus	NP_714942
117.	Kcnj11	ATP-sensitive inward rectifier potassium channel 11	Homo Sapiens	Q14654
	Kcnj11	ATP-sensitive inward rectifier potassium channel 11	Mus Musculus	NP_034732.1
	Kcnj11	ATP-sensitive inward rectifier potassium channel 11	Rattus Norvegicus	NP_112648.2
118.	Klf7	Krueppel-like factor 7	Homo Sapiens	O75840
	Klf7	Krueppel-like factor 7	Mus Musculus	NP_291041.2
	Klf7	Krueppel-like factor 7	Rattus Norvegicus	XP_343582.2
119.	Lars2	Probable leucyl-tRNA synthetase, mitochondrial precursor	Homo Sapiens	Q15031
	Lars2	Probable leucyl-tRNA synthetase,	Mus	NP_694808.1

		mitochondrial precursor	Musculus	
	Lars2	Probable leucyl-tRNA synthetase, mitochondrial precursor	Rattus Norvegicus	XP_343512.2
120.	Lep	Leptin precursor	Homo Sapiens	P41159
	Lep	Leptin precursor	Mus Musculus	NP_032519.1
	Lep	Leptin precursor	Rattus Norvegicus	NP_037208.1
121.	Lepr	Leptin receptor precursor	Homo Sapiens	P48357
	Lepr	Leptin receptor precursor	Mus Musculus	NP_666258.1
	Lepr	Leptin receptor precursor	Rattus Norvegicus	NP_036728.1
122.	Lipc	Hepatic triacylglycerol lipase precursor	Homo Sapiens	P11150
	Lipc	Hepatic triacylglycerol lipase precursor	Mus Musculus	NP_032306.2
	Lipc	Hepatic triacylglycerol lipase precursor	Rattus Norvegicus	NP_036729.2
123.	Lmna	Lamin-A/C	Homo Sapiens	P02545
	Lmna	Lamin-A/C	Mus Musculus	NP_001002011.1
	Lmna	Lamin-A/C	Rattus Norvegicus	NP_001002016.1
124.	Lpl	lipoprotein lipase	Homo Sapiens	AAH11353
	Lpl	lipoprotein lipase	Mus Musculus	A40570
	Lpl	lipoprotein lipase	Rattus Norvegicus	JH0790
125.	Map4k5	Mitogen-activated protein kinase kinase kinase kinase 5	Homo Sapiens	Q9Y4K4
	Map4k5	Mitogen-activated protein kinase kinase kinase kinase 5	Mus Musculus	NP_077237.2
	Map4k5	Mitogen-activated protein kinase kinase kinase kinase 5	Rattus Norvegicus	XP_578547.2
126.	Mapk14	Mitogen-activated protein kinase 14	Homo Sapiens	Q16539
	Mapk14	Mitogen-activated protein kinase 14	Mus Musculus	NP_036081.1
	Mapk14	Mitogen-activated protein kinase 14	Rattus Norvegicus	NP_112282.2
127.	Mapk8ip1	C-jun-amino-terminal kinase-interacting protein 1	Homo Sapiens	Q9UQF2
	Mapk8ip1	C-jun-amino-terminal kinase-interacting protein 1	Mus Musculus	NP_035292.2
	Mapk8ip1	C-jun-amino-terminal kinase-interacting protein 1	Rattus Norvegicus	NP_446229.1
128.	Mc3r	Melanocortin receptor 3	Homo Sapiens	P41968
	Mc3r	Melanocortin receptor 3	Mus Musculus	NP_032587.1

	Mc3r	Melanocortin receptor 3	Rattus Norvegicus	NP_001020441.2
129.	Mfn2	Transmembrane GTPase	Homo Sapiens	O95140
	Mfn2	Transmembrane GTPase	Mus Musculus	NP_573464.2
	Mfn2	Transmembrane GTPase	Rattus Norvegicus	NP_570964.3
130.	Mgea5	Bifunctional protein NCOAT	Homo Sapiens	O60502
	Mgea5	Bifunctional protein NCOAT	Mus Musculus	NP_076288.1
	Mgea5	Bifunctional protein NCOAT	Rattus Norvegicus	NP_571979.1
131.	Mgst3	Microsomal glutathione S-transferase 3	Homo Sapiens	O14880
	Mgst3	Microsomal glutathione S-transferase 3	Mus Musculus	NP_079845.1
	Mgst3	Microsomal glutathione S-transferase 3	Rattus Norvegicus	XP_213943.2
132.	Mmp2	72 kDa type IV collagenase precursor	Homo Sapiens	P08253
	Mmp2	72 kDa type IV collagenase precursor	Mus Musculus	NP_032636.1
	Mmp2	72 kDa type IV collagenase precursor	Rattus Norvegicus	NP_112316.1
133.	Mmp9	Matrix metalloproteinase-9 precursor	Homo Sapiens	P14780
	Mmp9	Matrix metalloproteinase-9 precursor	Mus Musculus	NP_038627.1
	Mmp9	Matrix metalloproteinase-9 precursor	Rattus Norvegicus	NP_112317.1
134.	Mthfr	Methylenetetrahydrofolate reductase	Homo Sapiens	P42898
	Mthfr	Methylenetetrahydrofolate reductase	Mus Musculus	NP_034970.2
	Mthfr	Methylenetetrahydrofolate reductase	Rattus Norvegicus	XP_342976.2
135.	Mttp	Microsomal triglyceride transfer protein large subunit precursor	Homo Sapiens	P55157
	Mttp	Microsomal triglyceride transfer protein large subunit precursor	Mus Musculus	NP_032668.1
	Mttp	Microsomal triglyceride transfer protein large subunit precursor	Rattus Norvegicus	XP_227765.2
136.	Neurod1	Neurogenic differentiation factor 1	Homo Sapiens	Q13562
	Neurod1	Neurogenic differentiation factor 1	Mus Musculus	NP_035024.1
	Neurod1	Neurogenic differentiation factor 1	Rattus Norvegicus	NP_062091.1
137.	Nfkb1	Nuclear factor NF-kappa-B p105 subunit	Homo Sapiens	P19838
	Nfkb1	Nuclear factor NF-kappa-B p105 subunit	Mus Musculus	NP_032715.2
	Nfkb1	Nuclear factor NF-kappa-B p105 subunit	Rattus	XP_342347.2

			Norvegicus	
138.	Nos2a	Nitric oxide synthase, inducible	Homo Sapiens	P35228
	Nos2a	Nitric oxide synthase, inducible	Mus Musculus	NP_035057.1
	Nos2a	Nitric oxide synthase, inducible	Rattus Norvegicus	NP_036743.2
139.	Nos3	Nitric-oxide synthase, endothelial	Homo Sapiens	P29474
	Nos3	Nitric-oxide synthase, endothelial	Mus Musculus	NP_032739.2
	Nos3	Nitric-oxide synthase, endothelial	Rattus Norvegicus	NP_068610.1
140.	Npy	neuropeptide Y precursor	Homo Sapiens	P01303
	Npy	neuropeptide Y precursor	Mus Musculus	NP_075945.1
	Npy	neuropeptide Y precursor	Rattus Norvegicus	NP_036746.1
141.	Oprm1	opioid receptor, mu 1	Homo Sapiens	P35372
	Oprm1	opioid receptor, mu 1	Mus Musculus	NP_001034741.1
	Oprm1	opioid receptor, mu 1	Rattus Norvegicus	NP_037203.1
142.	P4hb	prolyl 4-hydroxylase, beta polypeptide	Homo Sapiens	AAH14504
	P4hb	prolyl 4-hydroxylase, beta polypeptide	Mus Musculus	P09103
	P4hb	prolyl 4-hydroxylase, beta polypeptide	Rattus Norvegicus	P04785
143.	Pam	peptidylglycine alpha-amidating monooxygenase precursor	Homo Sapiens	P19021
	Pam	peptidylglycine alpha-amidating monooxygenase precursor	Mus Musculus	NP_038654.1
	Pam	peptidylglycine alpha-amidating monooxygenase precursor	Rattus Norvegicus	NP_037132.2
144.	Parl	presenilin associated, rhomboid-like precursor	Homo Sapiens	Q9H300
	Parl	presenilin associated, rhomboid-like precursor	Mus Musculus	NP_001005767.1
	Parl	presenilin associated, rhomboid-like precursor	Rattus Norvegicus	XP_001055224.1
145.	Pax4	paired box gene 4	Homo Sapiens	O43316
	Pax4	paired box gene 4	Mus Musculus	NP_035168.1
	Pax4	paired box gene 4	Rattus Norvegicus	NP_113987.1
146.	Pbef1	pre-B-cell colony-enhancing factor 1	Homo Sapiens	P43490
	Pbef1	pre-B-cell colony-enhancing factor 1	Mus Musculus	NP_067499.1
	Pbef1	pre-B-cell colony-enhancing factor 1	Rattus Norvegicus	NP_808789.1

147.	Pbx1	pre B-cell leukemia transcription factor 1	Homo Sapiens	P40424
	Pbx1	pre B-cell leukemia transcription factor 1	Mus Musculus	NP_899198.1
	Pbx1	pre B-cell leukemia transcription factor 1	Rattus Norvegicus	XP_222911.2
148.	Pcbd1	pterin 4 alpha carbinolamine dehydratase/dimerization cofactor of hepatocyte nuclear factor 1 alpha	Homo Sapiens	P61457
	Pcbd1	pterin 4 alpha carbinolamine dehydratase/dimerization cofactor of hepatocyte nuclear factor 1 alpha	Mus Musculus	NP_079549.1
	Pcbd1	pterin 4 alpha carbinolamine dehydratase/dimerization cofactor of hepatocyte nuclear factor 1 alpha	Rattus Norvegicus	NP_001007602.1
149.	Pck1	phosphoenolpyruvate carboxykinase 1, cytosolic	Homo Sapiens	P35558
	Pck1	phosphoenolpyruvate carboxykinase 1, cytosolic	Mus Musculus	NP_035174.1
	Pck1	phosphoenolpyruvate carboxykinase 1, cytosolic	Rattus Norvegicus	NP_942075.1
150.	Pdhx	pyruvate dehydrogenase complex, component X precursor	Homo Sapiens	O00330
	Pdhx	pyruvate dehydrogenase complex, component X precursor	Mus Musculus	NP_780303.1
	Pdhx	pyruvate dehydrogenase complex, component X precursor	Rattus Norvegicus	XP_230327.3
151.	Pea15	phosphoprotein enriched in astrocytes 15	Homo Sapiens	Q15121
	Pea15	phosphoprotein enriched in astrocytes 15	Mus Musculus	NP_035193.1
	Pea15	phosphoprotein enriched in astrocytes 15	Rattus Norvegicus	NP_001013249.1
152.	Pklr	pyruvate kinase liver and red blood cell	Homo Sapiens	P30613
	Pklr	pyruvate kinase liver and red blood cell	Mus Musculus	NP_038659.1
	Pklr	pyruvate kinase liver and red blood cell	Rattus Norvegicus	NP_036756.2
153.	Pltp	phospholipid transfer protein precursor	Homo Sapiens	P55058
	Pltp	phospholipid transfer protein precursor	Mus Musculus	NP_035255.1
	Pltp	phospholipid transfer protein precursor	Rattus Norvegicus	XP_215939.4
154.	Pnpla2	transport-secretion protein	Homo Sapiens	Q96AD5
	Pnpla2	transport-secretion protein	Mus Musculus	NP_080078.1
	Pnpla2	transport-secretion protein	Rattus Norvegicus	XP_341961.1
155.	Pon1	paraoxonase 1	Homo Sapiens	P27169
	Pon1	paraoxonase 1	Mus Musculus	NP_035264.1

	Pon1	paraoxonase 1	Rattus Norvegicus	NP_114466.1
156.	Ppara	Peroxisome proliferator-activated receptor alpha	Homo Sapiens	Q07869
	Ppara	Peroxisome proliferator-activated receptor alpha	Mus Musculus	NP_035274.2
	Ppara	Peroxisome proliferator-activated receptor alpha	Rattus Norvegicus	NP_037328.1
157.	Ppard	peroxisome proliferator activator receptor delta	Homo Sapiens	Q03181
	Ppard	peroxisome proliferator activator receptor delta	Mus Musculus	NP_035275.1
	Ppard	peroxisome proliferator activator receptor delta	Rattus Norvegicus	NP_037273.1
158.	Pparg	peroxisome proliferative activated receptor gamma	Homo Sapiens	P37231
	Pparg	peroxisome proliferative activated receptor gamma	Mus Musculus	NP_035276
	Pparg	peroxisome proliferative activated receptor gamma	Rattus Norvegicus	NP_037256
159.	Ppargc1a	peroxisome proliferative activated receptor, gamma, coactivator 1 alpha	Homo Sapiens	Q9UBK2
	Ppargc1a	peroxisome proliferative activated receptor, gamma, coactivator 1 alpha	Mus Musculus	NP_032930.1
	Ppargc1a	peroxisome proliferative activated receptor, gamma, coactivator 1 alpha	Rattus Norvegicus	NP_112637.1
160.	Ppargc1b	peroxisome proliferator-activated receptor gamma coactivator 1 beta	Homo Sapiens	Q86YN6
	Ppargc1b	peroxisome proliferator-activated receptor gamma coactivator 1 beta	Mus Musculus	NP_573512.1
	Ppargc1b	peroxisome proliferator-activated receptor gamma coactivator 1 beta	Rattus Norvegicus	NP_788264.1
161.	Ppp1r3a	Peroxisome proliferator-activated receptor gamma coactivator 1-beta	Homo Sapiens	Q16821
	Ppp1r3a	Peroxisome proliferator-activated receptor gamma coactivator 1-beta	Mus Musculus	NP_536712.2
	Ppp1r3a	Peroxisome proliferator-activated receptor gamma coactivator 1-beta	Rattus Norvegicus	XP_575392.1
162.	Prkaa2	5'-AMP-activated protein kinase catalytic subunit alpha-2	Homo Sapiens	P54646
	Prkaa2	5'-AMP-activated protein kinase catalytic subunit alpha-2	Mus Musculus	NP_835279.1
	Prkaa2	5'-AMP-activated protein kinase catalytic subunit alpha-2	Rattus Norvegicus	NP_076481.1
163.	Prkab2	5'-AMP-activated protein kinase subunit beta-2	Homo Sapiens	O43741
	Prkab2	5'-AMP-activated protein kinase subunit beta-2	Mus Musculus	NP_892042.2
	Prkab2	5'-AMP-activated protein kinase subunit beta-2	Rattus Norvegicus	NP_072149.1
164.	Prkcb1	Protein kinase C beta type	Homo Sapiens	P05771
	Prkcb1	Protein kinase C beta type	Mus Musculus	NP_032881.1
	Prkcb1	Protein kinase C beta type	Rattus	NP_036845.2

			Norvegicus	
165.	Prkcz	Protein kinase C zeta type	Homo Sapiens	Q05513
	Prkcz	Protein kinase C zeta type	Mus Musculus	NP_032886.2
	Prkcz	Protein kinase C zeta type	Rattus Norvegicus	NP_071952.1
166.	Ptgs2	Prostaglandin G/H synthase 2 precursor	Homo Sapiens	P35354
	Ptgs2	Prostaglandin G/H synthase 2 precursor	Mus Musculus	NP_035328.2
	Ptgs2	Prostaglandin G/H synthase 2 precursor	Rattus Norvegicus	NP_058928.2
167.	Ptpn1	Tyrosine-protein phosphatase non-receptor type 1	Homo Sapiens	P18031
	Ptpn1	Tyrosine-protein phosphatase non-receptor type 1	Mus Musculus	NP_035331.3
	Ptpn1	Tyrosine-protein phosphatase non-receptor type 1	Rattus Norvegicus	NP_036769.1
168.	Ptprr	Receptor-type tyrosine-protein phosphatase R precursor	Homo Sapiens	Q15256
	Ptprr	Receptor-type tyrosine-protein phosphatase R precursor	Mus Musculus	NP_035347.1
	Ptprr	Receptor-type tyrosine-protein phosphatase R precursor	Rattus Norvegicus	NP_446046.1
169.	Pyy	Peptide YY precursor	Homo Sapiens	P10082
	Pyy	Peptide YY precursor	Mus Musculus	NP_663410.1
	Pyy	Peptide YY precursor	Rattus Norvegicus	NP_001029252.1
170.	Rage	MAPK/MAK/MRK overlapping kinase	Homo Sapiens	Q9UQ07
	Rage	MAPK/MAK/MRK overlapping kinase	Mus Musculus	NP_036103.1
	Rage	MAPK/MAK/MRK overlapping kinase	Rattus Norvegicus	NP_001010965.1
171.	Retn	Resistin precursor	Homo Sapiens	Q9HD89
	Retn	Resistin precursor	Mus Musculus	NP_075360.1
	Retn	Resistin precursor	Rattus Norvegicus	NP_653342.1
172.	Rnpepl1	Arginyl aminopeptidase-like 1	Homo Sapiens	Q9HAU8
	Rnpepl1	Arginyl aminopeptidase-like 1	Mus Musculus	NP_852070.1
	Rnpepl1	Arginyl aminopeptidase-like 1	Rattus Norvegicus	CAB93958
173.	Rorc	Nuclear receptor ROR-gamma	Homo Sapiens	P51449
	Rorc	Nuclear receptor ROR-gamma	Mus Musculus	NP_035411.1
	Rorc	Nuclear receptor ROR-gamma	Rattus Norvegicus	XP_347323.3

174.	Rxrg	Retinoic acid receptor RXR-gamma	Homo Sapiens	P48443
	Rxrg	Retinoic acid receptor RXR-gamma	Mus Musculus	NP_033133.1
	Rxrg	Retinoic acid receptor RXR-gamma	Rattus Norvegicus	NP_113953.1
175.	Saa1	Serum amyloid A protein precursor	Homo Sapiens	P02735
	Saa1	Serum amyloid A protein precursor	Mus Musculus	NP_033143.1
	Saa1	Serum amyloid A protein precursor	Rattus Norvegicus	NP_001009478
176.	Scarb1	Scavenger receptor class B member 1	Homo Sapiens	Q8WTV0
	Scarb1	Scavenger receptor class B member 1	Mus Musculus	NP_058021.1
	Scarb1	Scavenger receptor class B member 1	Rattus Norvegicus	NP_113729.1
177.	Scd	Acyl-CoA desaturase	Homo Sapiens	O00767
	Scd	Acyl-CoA desaturase	Mus Musculus	NP_033153.2
	Scd	Acyl-CoA desaturase	Rattus Norvegicus	NP_631931.1
178.	Sele	selectin, endothelial cell precursor	Homo Sapiens	P16581
	Sele	selectin, endothelial cell precursor	Mus Musculus	NP_035475.1
	Sele	selectin, endothelial cell precursor	Rattus Norvegicus	NP_620234.1
179.	Sell	L-selectin precursor	Homo Sapiens	P14151
	Sell	L-selectin precursor	Mus Musculus	NP_035476.1
	Sell	L-selectin precursor	Rattus Norvegicus	NP_062050.1
180.	Sels	Selenoprotein S	Homo Sapiens	Q9BQE4
	Sels	Selenoprotein S	Mus Musculus	NP_077759.3
	Sels	Selenoprotein S	Rattus Norvegicus	NP_775143.1
181.	Serpine1	Plasminogen activator inhibitor 1 precursor	Homo Sapiens	P05121
	Serpine1	Plasminogen activator inhibitor 1 precursor	Mus Musculus	NP_032897.1
	Serpine1	Plasminogen activator inhibitor 1 precursor	Rattus Norvegicus	NP_036752.1
182.	Shbg	Sex hormone-binding globulin precursor	Homo Sapiens	P04278
	Shbg	Sex hormone-binding globulin precursor	Mus Musculus	NP_035497.1
	Shbg	Sex hormone-binding globulin precursor	Rattus Norvegicus	NP_036782.1
183.	Slc12a3	Solute carrier family 12 member 3	Homo	P55017

			Sapiens	
	Slc12a3	Solute carrier family 12 member 3	Mus Musculus	NP_062288.1
	Slc12a3	Solute carrier family 12 member 3	Rattus Norvegicus	NP_062218.2
184.	Slc2a10	Solute carrier family 2, facilitated glucose transporter member 10	Homo Sapiens	O95528
	Slc2a10	Solute carrier family 2, facilitated glucose transporter member 10	Mus Musculus	NP_569718.1
	Slc2a10	Solute carrier family 2, facilitated glucose transporter member 10	Rattus Norvegicus	XP_345472.3
185.	Slc2a2	solute carrier family 2 (facilitated glucose transporter), member 2	Homo Sapiens	P11168
	Slc2a2	solute carrier family 2 (facilitated glucose transporter), member 2	Mus Musculus	NP_112474
	Slc2a2	solute carrier family 2 (facilitated glucose transporter), member 2	Rattus Norvegicus	NP_036883
186.	Slc2a4	solute carrier family 2 (facilitated glucose transporter), member 4	Homo Sapiens	P14672
	Slc2a4	solute carrier family 2 (facilitated glucose transporter), member 4	Mus Musculus	NP_033230.2
	Slc2a4	solute carrier family 2 (facilitated glucose transporter), member 4	Rattus Norvegicus	NP_036883.1
187.	Smpd1	Sphingomyelin phosphodiesterase precursor	Homo Sapiens	P17405
	Smpd1	Sphingomyelin phosphodiesterase precursor	Mus Musculus	NP_035551.1
	Smpd1	Sphingomyelin phosphodiesterase precursor	Rattus Norvegicus	NP_001006998.1
188.	Socs2	suppressor of cytokine signaling 2	Homo Sapiens	O14508
	Socs2	suppressor of cytokine signaling 2	Mus Musculus	AAN84618
	Socs2	suppressor of cytokine signaling 2	Rattus Norvegicus	NP_478115.1
189.	Sod1	Superoxide dismutase [Cu-Zn]	Homo Sapiens	P00441
	Sod1	Superoxide dismutase [Cu-Zn]	Mus Musculus	NP_035564.1
	Sod1	Superoxide dismutase [Cu-Zn]	Rattus Norvegicus	NP_058746.1
190.	Sod3	Extracellular superoxide dismutase [Cu-Zn] precursor	Homo Sapiens	P08294
	Sod3	Extracellular superoxide dismutase [Cu-Zn] precursor	Mus Musculus	NP_035565.1
	Sod3	Extracellular superoxide dismutase [Cu-Zn] precursor	Rattus Norvegicus	NP_037012.1
191.	Sorbs1	Sorbin and SH3 domain-containing protein 1	Homo Sapiens	Q9BX66
	Sorbs1	Sorbin and SH3 domain-containing protein 1	Mus Musculus	NP_848139.1
	Sorbs1	Sorbin and SH3 domain-containing protein 1	Rattus Norvegicus	XP_001066536.1
192.	Srebf1	Sterol regulatory element-binding protein 1	Homo Sapiens	P36956

	Srebf1	Sterol regulatory element-binding protein 1	Mus Musculus	NP_035610.1
	Srebf1	Sterol regulatory element-binding protein 1	Rattus Norvegicus	XP_213329.4
193.	Tcf1	Hepatocyte nuclear factor 1-alpha	Homo Sapiens	AAF00616
	Tcf1	Hepatocyte nuclear factor 1-alpha	Mus Musculus	NP_033353
	Tcf1	Hepatocyte nuclear factor 1-alpha	Rattus Norvegicus	NP_001007602
194.	Tcf2	Hepatocyte nuclear factor 1-beta	Homo Sapiens	CAG38809
	Tcf2	Hepatocyte nuclear factor 1-beta	Mus Musculus	P27889
	Tcf2	Hepatocyte nuclear factor 1-beta	Rattus Norvegicus	P23899
195.	Tcf7l2	Transcription factor 7-like 2	Homo Sapiens	Q9NQB0
	Tcf7l2	Transcription factor 7-like 2	Mus Musculus	NP_033359.2
	Tcf7l2	Transcription factor 7-like 2	Rattus Norvegicus	XP_001054844.1
196.	Tf	Serotransferrin precursor	Homo Sapiens	P02787
	Tf	Serotransferrin precursor	Mus Musculus	NP_598738.1
	Tf	Serotransferrin precursor	Rattus Norvegicus	NP_001013128.1
197.	Tgfbi	Transforming growth factor-beta-induced protein ig-h3 precursor	Homo Sapiens	Q15582
	Tgfbi	Transforming growth factor-beta-induced protein ig-h3 precursor	Mus Musculus	NP_033395.1
	Tgfbi	Transforming growth factor-beta-induced protein ig-h3 precursor	Rattus Norvegicus	EDL93931
198.	Timp1	Metalloproteinase inhibitor 1 precursor	Homo Sapiens	P01033
	Timp1	Metalloproteinase inhibitor 1 precursor	Mus Musculus	NP_001037849.1
	Timp1	Metalloproteinase inhibitor 1 precursor	Rattus Norvegicus	NP_446271.1
199.	Timp2	Metalloproteinase inhibitor 2 precursor	Homo Sapiens	P16035
	Timp2	Metalloproteinase inhibitor 2 precursor	Mus Musculus	NP_035724.2
	Timp2	Metalloproteinase inhibitor 2 precursor	Rattus Norvegicus	NP_068824.1
200.	Tlr4	Toll-like receptor 4 precursor	Homo Sapiens	O00206
	Tlr4	Toll-like receptor 4 precursor	Mus Musculus	NP_067272.1
	Tlr4	Toll-like receptor 4 precursor	Rattus Norvegicus	NP_062051.1
201.	Tnf	tumor necrosis factor alpha precursor	Homo Sapiens	P01375
	Tnf	tumor necrosis factor alpha precursor	Mus	NP_038721.1

			Musculus	
	Tnf	tumor necrosis factor alpha precursor	Rattus Norvegicus	NP_036807.1
202.	Tnfrsf11b	Tumor necrosis factor receptor superfamily member 11B precursor	Homo Sapiens	O00300
	Tnfrsf11b	Tumor necrosis factor receptor superfamily member 11B precursor	Mus Musculus	NP_032790.3
	Tnfrsf11b	Tumor necrosis factor receptor superfamily member 11B precursor	Rattus Norvegicus	NP_037002.1
203.	Tnfrsf1b	Tumor necrosis factor receptor superfamily member 1B precursor	Homo Sapiens	P20333
	Tnfrsf1b	Tumor necrosis factor receptor superfamily member 1B precursor	Mus Musculus	NP_035740.2
	Tnfrsf1b	Tumor necrosis factor receptor superfamily member 1B precursor	Rattus Norvegicus	NP_569110.1
204.	Txn	Thioredoxin	Homo Sapiens	P10599
	Txn	Thioredoxin	Mus Musculus	NP_035790.1
	Txn	Thioredoxin	Rattus Norvegicus	NP_446252.1
205.	Ucp1	uncoupling protein 1 (mitochondrial, proton carrier)	Homo Sapiens	P25874
	Ucp1	uncoupling protein 1 (mitochondrial, proton carrier)	Mus Musculus	NP_033489.1
	Ucp1	uncoupling protein 1 (mitochondrial, proton carrier)	Rattus Norvegicus	NP_036814.1
206.	Ucp2	uncoupling protein 2 (mitochondrial, proton carrier}	Homo Sapiens	P55851
	Ucp2	uncoupling protein 2 (mitochondrial, proton carrier}	Mus Musculus	NP_035801.2
	Ucp2	uncoupling protein 2 (mitochondrial, proton carrier}	Rattus Norvegicus	NP_062227.1
207.	Ucp3	uncoupling protein 3 (mitochondrial, proton carrier)	Homo Sapiens	P55916
	Ucp3	uncoupling protein 3 (mitochondrial, proton carrier)	Mus Musculus	NP_033490.1
	Ucp3	uncoupling protein 3 (mitochondrial, proton carrier)	Rattus Norvegicus	NP_037299.1
208.	Uts2	Urotensin-2 precursor	Homo Sapiens	O95399
	Uts2	Urotensin-2 precursor	Mus Musculus	NP_036040.1
	Uts2	Urotensin-2 precursor	Rattus Norvegicus	NP_062033.1
209.	Uts2r	Urotensin II receptor	Homo Sapiens	Q9UKP6
	Uts2r	Urotensin II receptor	Mus Musculus	NP_663415.1
	Uts2r	Urotensin II receptor	Rattus Norvegicus	NP_065412.1
210.	Vdr	Vitamin D3 receptor (VDR) (1,25-dihydroxyvitamin D3 receptor)	Homo Sapiens	P11473
	Vdr	Vitamin D3 receptor (VDR) (1,25-dihydroxyvitamin D3 receptor)	Mus Musculus	NP_033530.2

	Vdr	Vitamin D3 receptor (VDR) (1,25-dihydroxyvitamin D3 receptor)	Rattus Norvegicus	NP_058754.1
211.	Vegf	Vascular endothelial growth factor A	Homo Sapiens	P15692
	Vegf	Vascular endothelial growth factor A	Mus Musculus	P48281
	Vegf	Vascular endothelial growth factor A	Rattus Norvegicus	P13053
212.	Wdr42a	WDR42A protein	Homo Sapiens	Q5TAQ9
	Wdr42a	WDR42A protein	Mus Musculus	NP_705783.1
	Wdr42a	WDR42A protein	Rattus Norvegicus	NP_001014253.1
213.	Wnt5b	Protein Wnt-5b precursor	Homo Sapiens	Q9H1J7
	Wnt5b	Protein Wnt-5b precursor	Mus Musculus	NP_033551.1
	Wnt5b	Protein Wnt-5b precursor	Rattus Norvegicus	XP_342748.3