2014 年 4 月入学　第 2 回
長浜バイオ大学大学院　バイオサイエンス研究科
博士課程前期課程　一般入学試験（筆記）

【注意事項】

1. 試験開始の合図があるまで、問題冊子には手を触れないこと。

2. 問題 1 部、解答用紙 2 枚を配付する。解答用紙下部には事前に受験番号が記入されているので、確認すること。あらためて科目名、受験番号、氏名を記入する必要はない。

3. 問題の印刷不鮮明、解答用紙の不足等に気付いた場合は、手を挙げて監督者に知らせること。

4. 大問 3 問のうち、2 問を選択して解答すること。

5. 解答の際には、必ず選択した問題の番号を記入すること。

6. 解答用紙はホッチキスどめをしているので、外さないこと。

7. 試験時間は、10:00～12:00（120 分）とする。

8. 電子辞書等の持ち込み、および試験時間中の途中退室は不可とする。

9. 入学試験終了後は、解答用紙のみ回収する。

問 1.　次の英文を読んで、以下の問いに答えなさい。（35 点）

Gene expression can be regulated at many of the steps in the pathway from DNA to RNA to protein

If differences among the various cell types of an organism depend on the particular genes that the cells express, at what level is the control of gene expression exercised? There are many steps in the pathway leading from DNA to protein, and all of them can in principle be regulated. Thus a cell can control the proteins it makes by (1)controlling when and how often a given gene is transcribed, (2)controlling how an RNA transcript is spliced or otherwise processed, (3)selecting which mRNAs are exported from the nucleus to the cytosol, (4)selectively degrading certain mRNA molecules, (5)selecting which mRNAs are translated by ribosomes, or (6)selectively activating or inactivating proteins after they have been made.

Gene expression can be regulated at each of these steps, and we will describe some of the key control points along their pathway from DNA to protein. For most genes, however, the control of transcription is paramount. This makes sense because only transcriptional control can ensure that no unnecessary intermediates are synthesized. So it is the regulation of transcription — and the DNA and protein components that determine which genes a cell transcribes into RNA — that we address first.

（paramount, 最も大切な）

A) 上記の英文を和訳しなさい。（14 点）

B) 原核生物と真核生物の遺伝子の転写について、転写工程や転写産物の構造の違いが分かるようにそれぞれ 5 行以内で説明しなさい。（7 点）

C) 上記下線部分に関連して、一般に転写を調節するタンパク分子には特徴的な DNA 結合モチーフがみられる。真核生物の例を 2 つ挙げ、それぞれの特徴を 5 行以内で説明しなさい。（7 点）

D) 大腸菌のラクトースオペロンやヒト肝細胞のグルココルチコイド受容体は複数の遺伝子を協調して発現させる転写調節機構として知られている。それぞれどのように複数の遺伝子発現を協調させているか、両者の違いが分かるように 5 行程度で説明しなさい。（7 点）

問 2.　次の文章は Essential Cell Biology に記載されている遺伝的多型に関する文章である。この文章を読んで、以下の問いに答えなさい。（35 点）

With the exception of identical twins, no two people have exactly the same genome. When the same region of the genome from two different humans is compared, the nucleotide sequences typically differ by about 0.1%. That might seem an insignificant degree of variation, but considering the size of the human genome, that amounts to some 3 million genetic differences in each maternal or paternal chromosome set between one person and the next. Detailed analysis of the data on human genetic variation suggests that the bulk of this variation was already present early in our evolution, perhaps 100,000 years ago, when the human population was still small. This means that a great deal of the genetic variation we possess today was inherited from our early human ancestors.

Most of the genetic variation in the human genome takes the form of single base changes called single-nucleotide polymorphisms (SNPs). These polymorphisms are simply points in the genome that differ in nucleotide sequence between one portion of the population and another—positions where one large fraction of the population has a G-C nucleotide pair, for example, while another has an A-T. Two human genomes chosen at random from the world's population will differ by approximately 2.5×10^6 SNPs that are scattered throughout the genome. Because SNPs are present at such a high density, they provide useful markers in genetic analyses in which one attempts to link a specific trait (such as disease susceptibility) with a particular pattern of SNPs. This type of analysis should lead to improvements in health care by allowing doctors to determine whether an individual is susceptible to a disease, such as heart disease, long before he or she shows any symptoms. The person can then change his or her behavior to help prevent the disease before it arises.

(variation, 変異; maternal, 母親由来の; paternal, 父親由来の; population, 集団; polymorphism, 多型; trait, 形質; susceptibility, 感受性（易罹患性）; symptom, 症状)

A)　上記の英文を和訳しなさい。（14 点）

B)　SNP 座位の塩基を他人と比較した時、塩基の異なる座位数をおよそ 2.5 × 106 とすると、親（母あるいは父）と異なる SNP の数はいくつか記しなさい。また、姉妹・兄弟との比較の場合、およそいくつ異なるか推定値を記しなさい。（7 点）

C)　SNP による塩基の違いのほとんどは、表現型に差を生じないと考えられている。SNP の中でどのような塩基置換が表現型や遺伝子機能に影響を及ぼす可能性が高いのか、5 行以内で説明しなさい。（7 点）

D)　遺伝的疾患の原因である塩基置換を同定するために、遺伝的関連解析が行われている。その際に重要となるハプロタイプとは何か、5 行程度で具体的に説明しなさい。（7 点）

問 3.　次の文章は Essential Cell Biology の中にある膜輸送に関する文章である。この文章を読んで、以下の問いに答えなさい。(35 点)

The hydrophobic interior of the lipid bilayer creates a barrier to the passage of most hydrophilic molecules, including ions. They are as reluctant to enter a fatty environment as hydrophobic molecules are reluctant to enter water. But given enough time, virtually any molecule will diffuse across a lipid bilayer. The rate at which it diffuses, however, varies enormously depending on the size of the molecule and its solubility properties. In general, the smaller the molecule and the more soluble it is in oil (that is, the more hydrophobic, or nonpolar, it is), the more rapidly it will diffuse across. Thus:

1. Small nonpolar molecules, such as molecular oxygen (O_2, molecular mass 32 daltons) and carbon dioxide (44 daltons), readily dissolve in lipid bilayers and therefore rapidly diffuse across them; indeed, cells require this permeability to gases for the cell respiration processes.
2. Uncharged polar molecules (molecules with an uneven distribution of electric charge) also diffuse rapidly across a bilayer, if they are small enough. Water (18 daltons) and ethanol (46 daltons), for example, cross fairly rapidly; glycerol (92 daltons) crosses less rapidly; and glucose (180 daltons) crosses hardly at all.
3. In contrast, lipid bilayers are highly impermeable to all ions and charged molecules, no matter how small. The molecules' charge and their strong electrical attraction to water molecules inhibit them from entering the hydrocarbon phase of the bilayer. Thus, synthetic bilayers are a billion (10^9) times more permeable to water than they are to even such small ions as Na^+ or K^+.

   (interior, 内部; reluctant, 嫌う; virtually, ほとんど; diffuse, 拡散する; permeability, 透過性; respiration, 呼吸)

A)　上記の英文を和訳しなさい。(14 点)

B)　次の物質について脂質二重層を透過しやすい順に並べなさい。(7 点)
エタノール、DNA、グリセロール、CO_2、K^+

C)　膜透過性の低い物質を効率よく輸送するために channel や transporter と呼ばれる膜輸送タンパクが必要となるが、それらの特徴、相違点について 5 行程度で説明しなさい。(7 点)

D)　細胞は Ca^{2+}を細胞内シグナル伝達に用い、Na^+や K^+のようなイオンを用いないのは何故かを 5 行程度で述べなさい。(7 点)