2015 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. 次の文章はEssential Cell Biology に記載されているアミノ酸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)

Twenty types of amino acids are commonly found in proteins, each with a different side chain attached to the α -carbon atom. The same 20 amino acids occur over and over again in all proteins, whether they hail from bacteria, plants, or animals. How this precise set of 20 amino acids came to be chosen is one of the mysteries surrounding the evolution of life; there is no obvious chemical reason why other amino acids could not have served just as well. But once the selection had been locked into place, it could not be changed; too much chemistry had evolved to exploit it. Switching the types of amino acids used by cells would require every living creature to retool its entire metabolism to cope with new building blocks.

Like sugars, all amino acids (except glycine) exist as optical isomers in D- and L-forms. But only L-forms are ever found in proteins_① (although D-amino acids occur as part of bacteria cell walls and in some antibiotics). The origin of this exclusive use of L-amino acids to make proteins is another evolutionary mystery.

The chemical versatility that the 20 standard amino acids provide is vitally important to the function of proteins. Five of the 20 amino acids have side chains that can form ions in solution and can therefore carry a charge. The others are uncharged. Some amino acids are polar and hydrophilic, and some are nonpolar and hydrophobic. The collective properties of the amino acid side chains underlie all the diverse and sophisticated functions of proteins.

(hail from, の出身である; evolve, を発達する、進化させる; exploit, を利用する; retool, 設備を一新する; cope with, 対処する; exclusive, 独占の; versatility, 多用途性)

- A) 上記の英文を和訳しなさい。(14点)
- B) 下線部①に関連して、プロテアーゼを構成するアミノ酸配列をそのまますべて対応する D-アミノ酸に置き換えたタンパク質を合成したとする。そのタンパク質はどのような性質を持つか予測し、その理由を含め5行以内で説明しなさい。(7点)
- C) 下線部②に関して、該当する5つのアミノ酸の英語名・3文字表記・1文字表記を それぞれ答え、各アミノ酸の化学構造式を例にならって示しなさい。(7点) (例) CH₃-COOH
- D) 本文で述べられた20種のアミノ酸以外に生体内に存在するアミノ酸あるいは修飾 アミノ酸の例を一つ挙げ、その存在意義について5行以内で説明しなさい。(7点)

問2. 次の文章はEssential Cell Biologyに記載されている転写と翻訳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)

Transcription as a means of information transfer is simple to understand, since DNA and RNA are chemically and structurally similar, and DNA can act as a direct template for the synthesis of RNA through complementary base-pairing. As the term transcription signifies, it is as if a message written out by hand were being converted, say, into a typewritten text. The language itself and the form of the message do not change, and the symbols used are closely related.

In contrast, the conversion of the information in RNA into protein represents a translation of the information into another language that uses quite different symbols. Because there are only 4 different nucleotides in mRNA but 20 different types of amino acids in a protein, this translation cannot be accounted for by a direct one-to-one correspondence between a nucleotide in RNA and an amino acid in protein. The rules by which the nucleotide sequence of a gene, through the medium of mRNA, is translated into the amino acid sequence of a protein are known as the genetic code.

The sequence of nucleotides in the mRNA molecule is read consecutively in groups of three. Because RNA is a linear polymer made of four different nucleotides, there are thus 4 x 4 x 4 = 64 possible combinations of three nucleotides: AAA, AUA, AUG, and so on. However, only 20 different amino acids are commonly found in proteins. Either some nucleotide triplets are never used, or the code is redundant and some amino acids are specified by more than one triplet. The second possibility is, in fact, correct, as shown by the completely deciphered genetic code in Figure 1. Each group of three consecutive nucleotides in RNA is called a codon, and each specifies one amino acid.

	AGA									UUA					AGC AGU					
GCA	CGA						GGA			CUA				CCA	UCA	ACA			GUA	
GCC	CGC						GGC		AUA	CUC				CCC	UCC	ACC			GUC	UA
GCG	CGG	GAC	AAC	UGC	GAA	CAA	GGG	CAC	AUC	CUG	AAA		UUC	CCG	UÇG	ACG		UAC	GUG	UA
GCU	CGU	GAU	AAU	UGU	GAG	CAG	GGU	CAU	AUU	CUU	AAG	AUG	UUU	CCU	UCU	ACU	UGG	UAU	GUU	UG

Figure 1. The nucleotide sequence of an mRNA is translated into the amino acid sequence of a protein via the genetic code.

(signify, 意味する; medium, 媒体; decipher, 解読する; chiefly, 主として; correspondence, 対応; consecutive, 連続した)

- A)上記の英文を和訳しなさい。(ただしFigure 1は除く)(14点)
- B) セントラルドグマはどのような説かを5行以内で説明した上で、セントラルドグマの例外を一つ挙げなさい。 (7点)
- C) 下線部は縮重と呼ばれる。縮重のメカニズムを tRNA の構造と種類から2つに分類して10行以内で説明しなさい。 (7点)

D) 下記はある真核生物の核ゲノムに存在する一つの転写領域である。この領域はGT で始まりAGで終わるイントロンを一つ含み、アミノ酸20個からなるペプチドをコードしている。このペプチドのアミノ酸配列を一文字表記で示しなさい。 (7点)

5'-AGAAGAGAATGACTGACGCGAGCCTAATATGCCCAGGTGATTAACTGAT

CTCTCAGGTGTGCGGTACCATGAATTTCAGTGGAACAAGTAGTTCAATATGA TGAT-3'

問3. 次の文章は Essential Cell Biology に記載されている、細胞周期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 cell-cycle control system governs the cell-cycle machinery by cyclically activating and then inactivating the key proteins and protein complexes that initiate or regulate DNA replication, mitosis, and cytokinesis. Phosphorylation followed by dephosphorylation is one of the most common ways by which cells switch the activity of a protein on and off, and the cell-cycle control system uses this mechanism repeatedly. The phosphorylation reactions that control the cell cycle are carried out by a specific set of protein kinases, while dephosphorylation is performed by a set of protein phosphatases.

The protein kinases at the core of the cell-cycle control system are present in proliferating cells throughout the cell cycle. They are activated, however, only at appropriate times in the cycle, after which they quickly become deactivated again. Thus, the activity of each of these kinases rises and falls in a cyclical fashion. Some of these protein kinases, for example, become active toward the end of G_1 phase and are responsible for driving the cell into S phase; another kinase becomes active just before M phase and is responsible for driving the cell into mitosis.

Switching these kinases on and off at the appropriate times is partly the responsibility of another set of proteins in the control system — the cyclins. Cyclins have no enzymatic activity themselves, but they have to bind to the cell-cycle kinases before the kinases can become enzymatically active. The kinases of the cell-cycle control system are therefore known as cyclin-dependent protein kinases, or Cdks.

(govern, 調節する; initiate, 開始する; proliferate, 増殖する)

- A) 上記の文章を和訳しなさい。(14点)
- B) 真核生物の細胞周期は4つの時期(G1期、S期、G2期、M期)に分けられる。各時期に細胞内で起きる現象を合わせて10行以内で説明しなさい。(7点)
- C) 各種のサイクリン濃度は、細胞周期の特定の時期に減少し、対応するサイクリン依存性キナーゼの活性を低下させる。どのような機構でサイクリンが減少するのか、10 行以内で説明しなさい。(7点)
- D) 細胞周期の G1 期から S 期への移行を阻止する活性をもつタンパク質として、がん 抑制遺伝子産物である網膜芽細胞腫タンパク質(Rb タンパク質)がある。増殖時の 細胞で Rb タンパクが不活性化される機構を 10 行以内で説明しなさい。(7点)