

2025 年度日本政府(文部科学省)奨学金留学生選考試験

QUALIFYING EXAMINATION FOR APPLICANTS FOR THE JAPANESE
GOVERNMENT (MEXT) SCHOLARSHIP 2025

学科試験 問題

EXAMINATION QUESTIONS

(学部留学生)

UNDERGRADUATE STUDENTS

生 物

BIOLOGY

注意 ☆試験時間は 60 分。

PLEASE NOTE: THE TEST PERIOD IS 60 MINUTES.

Biology	Nationality		No.		(2025)	
	Name	(Please print your name, underlining your family name)			Marks	

Answer the subsequent questions (I–III) using the answer sheet.

I. Read the following two passages, (A) and (B), and answer the subsequent questions 1-4.

(A) The bodies of microorganisms, plants, and animals are made up of cells. The number of cells in a human adult is [1]. Each cell contains one [2], which contains DNA that stores genetic information. Cells carry out various activities, such as protein synthesis, and a typical high-energy molecule used for these intracellular activities is [3], which is produced by [4] in the cell. In the cytoplasm, proteins are produced. Protein synthesis involves mRNA, tRNA, and the macromolecular complex known as the [5]. Cells are surrounded by plasma membrane, which is composed of [6]. Embedded in the plasma membrane of animal cells are [7] such as cadherins. Cadherins are bound to actin filaments within cells, forming [8] junctions. Changes in the concentration of Ca ions in cytoplasm induce various cellular responses, and the flow of Ca ions into and out of cells is mediated by active transport by [9] and diffusion through [10]. Muscle contraction is also triggered by [11] of Ca ion concentration in the cytoplasm. In this case, Ca ions are released from the intracellular [12] rather than entering from outside the cell.

1. Fill in the blank [1] – [12] in passage (A) using the most suitable term from the list given below (A-X) and write down the corresponding letters in the designated spaces I-1 (1) to (12) on the answer sheet.

A. 10^{10} - 10^{11}	B. 10^{13} - 10^{14}	C. adherens
D. ADP	E. ATP	F. cell adhesion molecules
G. coherent molecules	H. contact	I. decrease
J. endoplasmic reticulum	K. increase	L. ion channels
M. ion pores	N. large vacuoles	O. lipid bilayer
P. lipid monolayer	Q. mitochondria	R. nucleosome
S. nucleus	T. protein monolayer	U. readout
V. ribosome	W. transcarriers	X. transporters

2. Judge the correctness of the following descriptions (1) – (4), and write down the letter “T” for the correct sentence and the letter “F” for the incorrect one in the designated spaces I-2 (1) to (4) on the answer sheet.

- (1) The average size of an adult animal cell is about one micrometer.
- (2) Mitochondria also contain DNA.
- (3) In general, a cell consumes its most energy to synthesize proteins.
- (4) Acetyl-coenzymes released from motor nerve endings initiate muscle contraction.

(B) All animals develop from fertilized eggs. The fertilized egg is a single cell, and in the case of humans, it divides on average about [1] times to form an adult body. By labeling cells, it is possible to trace from where in early embryo the various tissues and organs will be formed in the future. The resulting spatial representation is commonly referred to as a/an [2]. In many animals, an embryo that has completed its initial cell divisions undergoes gastrulation and forms three germ layers. The three germ layers are [3] that is facing the surface of the embryo, [4] that will become the future digestive tract, and [5] that lies between them. In vertebrates, part of [3] forms the [6], which produces the central nervous system. A part of the digestive tract protrudes to form the [7]. [5] produces various organs, such as the [8]. Embryonic cells differentiate into cells with various functions. This involves gene expression. In red blood cells, [9] gene is specifically expressed and a large amount of [9] protein is produced. In lens cells of the eye, [10] gene is expressed. In nerve cells, [11] genes are activated to generate action potential. Close to the DNA region that encodes the protein sequence of each gene is a DNA sequence called the [12] that controls the expression of the gene.

3. Fill in the blank [1] – [12] in passage (B) using the most suitable term from the list given below (A-Z) and write down the corresponding letters in the designated spaces I-3 (1) to (12) on the answer sheet.

A. 10^1 - 10^2	B. 10^4 - 10^5	C. action channel
D. activation region	E. active channel	F. clearin
G. crystalline	H. ectoderm	I. ectogerm
J. endoderm	K. endogerm	L. fate map
M. hair	N. heart	O. hemoglobin
P. ion channel	Q. lung	R. mesoderm
S. mesogerm	T. myoglobin	U. neural tube
V. redglobin	W. regulatory region	X. sensory tube
Y. tissue map	Z. transparesmin	

4. Judge the correctness of the following descriptions (1) – (5), and write down the letter “T” for the correct sentence and the letter “F” for the incorrect one in the designated spaces I-4 (1) to (5) on the answer sheet.

- (1) Human sperm contain DNA equivalent to 23 chromosomes.
- (2) Human sperm always have a Y chromosome.
- (3) The first large-scale cell migration during embryogenesis occurs during gastrulation.
- (4) Even after the completion of gastrulation process, some cells that are to be inside the body in the future still face the surface of the embryo.
- (5) Differentiated lens cells have lost the genes for proteins that specifically work in red blood cells.

II. Read the following three passages, (A)-(C), and answer the subsequent questions 1-5.

(A) Genetic information of a cell is recorded as nucleotide sequences in the DNA molecule. It is amplified by [1] and transmitted to descendant cells. However, genetic information can change due to damage to the DNA molecule caused by [2] or chemicals, or due to errors in [1], etc. The change is called mutation. Mutation may cause genetic disease or [3], but it is also essential for diversity and evolution of species. Mutations in eukaryotic cells occur at various levels, ranging from large-scale chromosomal abnormalities to [4] mutations that are single nucleotide changes. Chromosomal abnormalities include structural abnormalities such as inversions and translocations, as well as [5], where the number of some chromosomes increases or decreases, and [6], where the number of sets of chromosomes changes. Eukaryotes are basically diploids with two sets of chromosomes, but tetraploids or hexaploids also exist, which are common in well-known crops. The proteins that make up cells are encoded in genes on chromosomes using the genetic code that encodes one amino acid in [7] bases. That information is transferred into mRNA by [8], and proteins are synthesized by [9]. The genetic code in mRNA is called a codon, and in particular termination codes for [9] are called [10] codons. There are a number of mutants in which a codon changes to a [10] codon due to a single [4] mutation in a gene, which leads to a defective gene product and significant changes in the phenotype.

1. Fill in the blank [1] – [10] in passage (A) using the most suitable term from the list given below (A-V) and write down the corresponding letters in the designated spaces II-1 (1) to (10) on the answer sheet.

A. 3	B. 4	C. 6
D. aneuploidy	E. cancer	F. deletion
G. end	H. final	I. homoploidy
J. infrared rays	K. karyotype	L. lipid
M. local	N. point	O. polyploidy
P. radiation	Q. replication	R. stop
S. transcription	T. translation	U. translocation
V. water		

2. From the list given below (A-G), choose a hexaploid crop written in underlined part 1) in passage (A) and write down the corresponding letter in the designated space II-2 on the answer sheet.

A. barley	B. cotton	C. maize (corn)
D. potato	E. rice	F. sorghum
G. wheat		

(B) Angiosperms generally maintain their species by vegetative propagation and sexual reproduction. In vegetative propagation, new plants are produced from vegetative organs such as tubers, bulbs, stolons, and root tubers. During vegetative propagation, cells multiply by somatic cell division so that the resulting new individuals are genetically identical to the original ones. On the other hand, angiosperms have flowers as the place for sexual reproduction. A typical flower has four types of organs: sepals, petals, stamens, and pistils, and their arrangement is determined by homeotic genes. Meiosis occurs in two of these organs, the stamen and the pistil, producing pollen and egg cells, respectively. When pollen is attached to the stigma of the pistil, it extends the pollen tube to the embryo sac where the egg cell is located, and fertilization occurs. The fertilized egg cell undergoes repeated cell division and an embryo is formed.

3. From the list given below (A-I), choose two plants that produce root tubers written in underlined part 2) in passage (B) and write down the corresponding letter in the designated spaces II-3 (1) to (2) on the answer sheet.

A. alfalfa	B. banana	C. cassava
D. date palm	E. fava bean	F. potato
G. strawberry	H. sweet potato	I. taro

4. Judge the correctness of the following descriptions (1) – (4) about fertilization in the flower, and write down the letter “T” for the correct sentence and the letter “F” for the incorrect one in the designated spaces II-4 (1) to (4) on the answer sheet.

- (1) The generative cell of pollen divides and becomes two sperm cells, one of which fertilizes the egg cell and the other fertilizes the central cell. This event is called double fertilization.
- (2) Upon fertilization, the egg cell becomes an embryo and the central cell becomes an endosperm.
- (3) Mature seeds of angiosperms always have endosperms.
- (4) In the case of self-pollination with pollen from the same plant, all the produced new plants have the same genetic traits as their parents.

(C) Genetic recombination is the formation of new gene combinations by cloning genes and connecting them to foreign DNA molecules using restriction enzymes, DNA ligases, etc. Genetic recombination makes it possible to impart new genetic traits into organisms. Genetically modified plants that have been developed include those with enhanced herbicide resistance, pest resistance, virus resistance, drought tolerance, etc., those with increased nutritional value of food, or those with new flower colors.

5. Judge the correctness of the following descriptions (1) – (3) concerning genetic recombination, and write down the letter “T” for the correct sentence and the letter “F” for the incorrect one in the designated spaces II-5 (1) to (3) on the answer sheet.

- (1) Restriction enzymes recognize specific nucleotide sequences and cleave DNA.
- (2) DNA that can multiply cloned genes in host cells is called a transporter.
- (3) A common method for introducing genes into plants is to infect plant cells with *Escherichia coli* carrying the desired gene.

III. Read the following passages (A) and (B) and answer the subsequent questions 1–6.

(A) The wing and body of the peppered moth exhibit two color forms, light and dark, which is genetically controlled by an autosomal locus, in which dark-color allele *D* is dominant over light-color allele *L* that is recessive. 1)Light-colored moths are inconspicuous (cryptic) when they rest on light-colored tree trunks or branches and can escape from bird predation, whereas dark-colored moths do so when they rest on dark-colored backgrounds such as soot-darkened tree trunks. In natural habitats where tree trunks or branches are covered with lightly colored lichens, light-colored moths are common.

2)During the industrial revolution in England, trunks and branches of trees in the industrial area were soot-darkened, and this caused a dramatic increase in the frequency of dark-colored moths, which was rare before the industrial revolution.

3)In a population of the peppered moth, the initial numbers of adult moths with *DD*, *DL*, and *LL* genotypes were 36, 48, and 16, respectively. 4)During the early half of adult period, 14 of 16 *LL* moths were eaten by birds, while the other moths were all surviving.

1. What will be the ratio of the number of dark-colored F2 individuals to the number of light-colored F2 individuals (dark : light) resulting from a cross between F1 individuals from a *DD* female and an *LL* male parental moths? Choose the answer from options A–E given below and write down it in the designated space III-1 on the answer sheet.

A. 1:1 B. 2:1 C. 3:1 D. 1:2 E. 1:3

2. What is the term for the phenomenon that a species resembles background environments or other species as in the underlined part 1)? Choose the answer from options A–E given below and write down it in the designated space III-2 on the answer sheet.

A. commensalism B. coevolution C. sympatry
D. mimicry E. symbiosis

3. What is the most relevant mechanism for the change in color-form frequency in the peppered moth population as described in the underlined part 2)? Choose the answer from options A–E given below and write down it in the designated space III-3 on the answer sheet.

- A. genetic drift B. natural selection C. hybridization
D. mutation E. competitive exclusion

4. Calculate the gene frequency (in percentage) of *D* allele in the adult moths as described in the underlined part 3). Choose the answer from options A–E given below and write down it in the designated space III-4 on the answer sheet.

- A. 6% B. 18% C. 24% D. 48% E. 60%

5. Calculate the gene frequency (in percentage) of *D* allele in the adults that survived bird predation as described in the underlined part 4), rounding it to an integer. Choose the answer from options A–E given below and write down it in the designated space III-5 on the answer sheet.

- A. 40% B. 50% C. 60% D. 70% E. 80%

(B) A biome is a region of the earth's surface characterized by particular physical conditions and community of organisms. Net primary productivity (NPP) and standing crop of producers vary greatly among biomes. In terrestrial ecosystems, two biomes in the tropics, [1] and [2], show similar NPP, but [1] have much larger standing crop than [2] because the major components of [1] are [3], which have accumulated a huge amount of biomass in [4] organs. In general, NPP of terrestrial biomes is greatly affected by [5] and [6]. In forest biomes, there is a latitudinal trend of [7] NPP from [1], through [8], to [9]. In other terrestrial biomes, NPP is small in [10] and [11] (biomes) where [5] and [6] are extremely low, respectively. [11] is found in arctic and alpine zones.

Although oceans cover about two-thirds of the earth's surface, their total NPP accounts for less than half of the total NPP of the world. In [12], NPP is limited by low availability of [13] in the euphotic zone. NPP is relatively high in [14] where [13] are supplied from lands. In marine biomes, the relative amount of standing crop of producers to NPP is rather small compared to that in the terrestrial biomes. This is because the main producer in marine ecosystems are [15].

6. Fill in the blank [1] – [15] of passage (B) above with the most suitable term from the list given below (A–U) and write down the answer in the designated spaces III-6 (1) to (15) on the answer sheet. Choose either photosynthetic (R) or non-photosynthetic (S) for [4] and either increasing (T) or decreasing (U) for [7].

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|---------------------------|----------------------------|-------------------|
| A. annual rainfall | B. bacteria | C. coastal areas |
| D. deserts | E. deep sea | F. fish |
| G. herbs | H. mean annual temperature | I. nutrients |
| J. open oceans | K. phytoplankton | L. savannas |
| M. taiga (boreal forests) | N. temperate forests | O. trees |
| P. tropical rain forests | Q. tundra | R. photosynthetic |
| S. non-photosynthetic | T. increasing | U. decreasing |