2018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 JAPANESE GOVERNMENT（MEXT）SCHOLARSHIPS 2018

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**.

(2018)

BIOLOGY

Nationality		No.	
Name	(Please print full name, underlining family name)		

Marks	

I. Read the following passage and answer the subsequent questions using the answer sheet.

Plants advanced to land during the process of evolution. Pteridophytes such as ferns were able to tolerate dry conditions on the ground thanks to the evolution of their structure. They developed a transportation system called [1], which allowed them to absorb water and nutrition through their roots, which were then provided to the whole plant body through [1]. [1] is tube-structured tissue that forms networks by connecting to each other. Furthermore, pteridophytes developed small holes called [2] on the surfaces of aboveground parts of the plant, and established a system that enabled them to control the water loss by transpiration and provide water and nutrition absorbed through the roots to the aboveground parts through transpiration streams. By establishing a system to tolerate dry conditions on the ground, pteridophytes were able to adapt to this new environment, but 1 the range of their distribution has been limited due to the way the plants reproduces. In [3], which appeared after the evolution of pteridophytes, reproduction under dry conditions became possible. [3] also developed a layer of [4] covering aboveground parts in order to suppress water loss from plant tissues other than [2], and since the Mesozoic Era there had been an expansion of the distributed areas. In [3], there are two groups, the [5] and [6], 2 with different reproductive organs. The [5] have no petals and calyxes in their flowers, exposing [7], whereas the [6] have petals and calyxes in their flowers, with their [7] within the [8].

In a [1], which made it possible for plants to advance to the land, there are 3 two transportation tissues in many [6]. The first one is [9], generally transporting water. The other is [10], transporting nutrition. Both [9] and [10] are major components of [11] and [12], respectively.

1. Fill in the blanks ([1]–[12]) in the above passage from the list given below and record the appropriate letters (A–Z) in the designated spaces (I–1 (1)~(12)) on the answer sheet.

A	algae	B	angiosperms	C	anther
D	bryophytes	E	cortex	F	cuticle
G	dicotyledonous plants	H	epidermis	I	gymnosperms
J	leaf vein	K	lenticels	L	monocotyledonous plants
M	ovaries	N	ovules	O	palisade tissue
P	peduncles	Q	phloem	R	pollen
S	rhizosphere	T	seed plants	U	sieve tubes
V	stigmas	W	stomata	X	vascular bundle
Y	vessels	Z	xylem		

2. Which of the following sentences is incorrect as an explanation of the reproductive system of pteridophytes, as shown in the underlined part 1 above? Record the letter (A–E) indicating the incorrect sentence in the designated space (I–2) on the answer sheet.

A Sporangia are formed on the sporophytes.
B The sporophytes parasitize on the gametophytes.
C Archegonia and antheridia are formed on the prothallus.
D Fertilization occurs during a humid period, such as a rainy day.
E Spores are formed in the prothallus.

3. Which of the following sentences is incorrect as an explanation of the differences between [5] and [6] due to their reproductive organs, as shown in the underlined part 2 above? Record the letter (A–E) for the incorrect sentence in the designated space (I–3) on the answer sheet.

A In [5], many plants have anemophilous (wind-pollinated) flowers.
B In [6], morphologies of flowers are remarkably diversified.
C The fertilization of [5] is generally tolerant to dry conditions.
D In [6], many plants have entomophilous (insect-pollinated) flowers.
E In [6], some plants develop large fruits.

4. Which of the following sentences is inappropriate as an explanation of the two transportation tissues indicated in the underlined part 3 above? Record the letter (A–E) for the inappropriate sentence in the designated space (I–4) on the answer sheet.

A [9] are the continuum of dead cells.
B [10] are the continuum of living cells.
C In [10], plate-like tissues are developed between cells.
D In [9], the structure to divide cells has not been lost.
E If [12], including [10], is eliminated, plants die.

II. Read the following passage and answer the subsequent questions using the answer sheet.

Plant cells are surrounded with [1]s consisting of 1 phospholipid bilayers. On the surface of [1], [2]s are sporadically embedded. [2]s are a kind of [3]s, through which water and nutrients are transported. In plant cells, there are a [4] and various [5]s. A [4] is surrounded by a membrane consisting of phospholipids like [1]s and it has many tiny holes called [6]s. [7], which records genetic information, is stored in a [4]. Based on the genetic information written in [7], 2 diversified [3]s are synthesized. Major [5]s of plant cells include [8]s, [9], [10]s and [11], with their special functions. Except for [8], they are surrounded by a membrane consisting of phospholipids just like a [4]. [8]s have very fine particle structures and are floating in cytoplasm or fixed on the membrane of [11]. 3 [9] and [10]s have their own [7] independent from those stored in a [4]. [10]s are specific to plants and not observed in animals.

Plant cells are further surrounded by very tight and tough tissues called [12]s. Major components of plant [12]s are one of the polysaccharides, [13]. The main functions of [12] are the protection of cells and the maintenance and strengthening of the structure of plant body.

1. Fill in the blanks ([1]–[13]) in the above passage from the list given below and record the appropriate letters (A–Z) in the designated spaces (II–1 (1)~(13)) on the answer sheet.

A	ADP	B	ATP	C	cell membrane
D	cellulose	E	cell wall	F	centrosome
G	channel	H	chloroplast	I	collagen
J	cristae	K	DNA	L	endoplasmic reticula
M	glucose	N	Golgi body	O	lysosome
P	mitochondria	Q	nuclear pore	R	nucleus
S	organelle	T	organic acid	U	protein
V	ribosome	W	RNA	X	stroma
Y	sucrose	Z	thylakoid		

2. Which of the following sentences is incorrect as an explanation of phospholipids, as shown in the underlined part 1 above, and biological membranes like [1] consisting of phospholipids? Record the letter (A−E) indicating the incorrect sentence in the designated space (II−2) on the answer sheet.

A Thin bilayers of phospholipid molecules form the structure of biological membranes.

B Phospholipids have both hydrophobic and hydrophilic properties.

C Biological membranes consisting of phospholipids are soft and flexible.

D Phospholipids of biological membranes are easily permeable to water soluble substances.

E Due to the existence of biological membranes of a [4] and some of [5]s consisting of phospholipids, the inside of the biological membranes can be isolated from cytoplasm rich in moisture.

3. Which statement is incorrect about the biosynthesis of [3], shown in the underlined part 2 above? Record the letter (A−E) for the incorrect sentence in the designated space (II−3) on the answer sheet.

A Genetic information recorded in [7] is shown as the arrangement of the nucleotides.

B Genetic information recorded in [7] is translated to some substances in the [4].

C Genetic information recorded in [7] is transported through [6] to the outside of the [4].

D Based on the genetic information transported to the outside of the [4], [3] are synthesized in [8]s.

E Genetic information recorded in [7] shows the composition of amino acids of the target [3].

4. Which of the following sentences is incorrect about the fact that both [9] and [10]s have their own [7], as described in the underlined part 3 above? Record the letter (A–E) for the incorrect sentence in the designated space (II–4) on the answer sheet.

A The fact that both [9] and [10]s have their own [7] suggests that these two [5]s were originally independent organisms in the past.

B [7] in [9] and [10]s function as genes similarly to [7] in the [4].

C [7] in [9] and [10]s follow the Mendelian laws similarly to [7] in the [4].

D Genetic information recorded in [7] of [9] are transferred only from the maternal parent to the offspring.

E Genetic information recorded in [7] of [10]s are transferred only from the maternal parent to the offspring.

III. Animals possess a mechanism to remove foreign substances when such substances invade the animal body, and this mechanism is called immunity. Read the following passage on the immunity of mammals and answer the subsequent questions 1–4.

1When a foreign substance invades an animal body, [1] and [2] ingest the substance and digest it. This process is called [3]. When a foreign substance is ingested by [1], the information on this substance is passed to a type of lymphocyte, [4]. Then, the 2[4] come to specifically attack the foreign substance, and activate another type of lymphocyte, [5]. An antigen is a molecule capable of inducing a specific immune response. 3 Activated [5] synthesize antibodies specifically binding the antigen, and secrete the antibodies into the blood plasma.

4An antibody is a protein that is synthesized based on an immunoglobulin gene, and has great diversity in its molecular structure. There are several types of antibody, and the most common type is immunoglobulin G (IgG). 5When the same antigen invades again, a stronger immune response is induced.

1. Fill in the blanks ([1]-[5]) in the above passage from the list given below and record the appropriate letters (A-O) in the designated spaces (III–1 (1)~(5)) on the answer sheet.

A acidophils	B antigen-antibody reaction	C apoptosis
D B cells	E basophils	F erythrocytes
G immunological tolerance	H iPS cells	I macrophages
J mastocytes	K mitosis	L neutrophils
M phagocytosis	N stem cells	O T cells

2. Immunity is divided into innate immunity and acquired immunity. Among the underlined parts 1-3 above, which can be categorized as innate immunity? Record the letter (A−E) for the most appropriate response in the designated space (III−2) on the answer sheet.

A underlined part 1
B underlined part 2
C underlined part 3
D underlined parts 1 and 2
E underlined parts 2 and 3

3. Which statements are incorrect about antibody molecules shown in the underlined part 4? Choose the two incorrect sentences from A−E, and record the letters in the designated spaces (III−3(1)~(2)) on the answer sheet.

A An antibody (IgG) consists of 3 polypeptides (2 light chains and 1 heavy chain) that are connected with disulfide (S-S) bonds.
B An antibody (IgG) is Y-shaped, and each of the two arms of the Y binds to an antigen, and therefore many antigens and antibodies connect to form a complex.
C Diversity of antibody molecules depends on variable regions that exist both in light and heavy chains.
D Diversity of antibody molecules is generated by recombination of immunoglobulin genes.
E The number of immunoglobulin genes corresponds to the number of diverse antibody structures.

4. Which statements are incorrect about the immune response shown in the underlined part 5? Choose the two incorrect sentences from A−E, and record the letters in the designated spaces (III−4(1)~(2)) on the answer sheet.

A This response depends on the antigen information memorized in the lymphocytes.

B This response depends on the antigen information memorized in the brain.

C Both vaccine and serum therapy are based on this response.

D This response is called secondary immune response.

E This response is not only strong but also starts promptly.

IV. Read the following passage and answer the subsequent questions 1–4.

The coefficient of relatedness is defined as the probability that two individuals share an allele. In humans, because an individual obtains approximately the same number of genes from its mother and father, the coefficient of relatedness between a parent and a child is assumed to be [a], and that between brothers or sisters with the same parents is assumed to be [b]. In Hymenoptera, including honey bees and [1], a female is diploid developing from a fertilized egg, and a male is haploid developing from an unfertilized egg. Therefore, the coefficient of relatedness between a mother and a daughter is [c], and that between sisters with the same parents is [d].

1 The criterion of eusociality is a division of labor into reproductive and non-reproductive castes. Individuals in the non-reproductive caste help to nurse progeny of other individuals, without producing their own progeny. In Hymenoptera, workers do not reproduce and help to nurse their sisters. Because organisms evolve to produce more progeny in Darwin's theory of evolution, it had long been a mystery that a certain individual never reproduces. However, this was reasonably explained by considering the number of offspring of related individuals.

Although 2 eusociality has been found in Hymenoptera most frequently, it has long been known that [2], in which both females and males are diploid, show eusociality. In recent years, moreover, eusociality was demonstrated in other insects such as aphids, crustaceans, and [3] in mammals also.

1. Fill in the blanks ([a]−[d]) in the above passage with appropriate numeral values and record the values to the second decimal place in the designated spaces (IV−1 (a)~(d)) on the answer sheet.

2. Fill in the blanks ([1]−[3]) in the above passage from the list given below and record the appropriate letters (A−I) in the designated spaces (IV−2 (1)~(3)) on the answer sheet.

A	ants	B	bats	C	butterflies
D	dragonflies	E	flies	F	moles
G	primates	H	rodents	I	termites

3. Which condition is required for evolution of eusociality shown in the underlined part 1? Choose the most appropriate answer from A-D, and record the letter in the designated space (IV−3) on the answer sheet, where the coefficient of relatedness between a mother and a daughter is A, the coefficient of relatedness between sisters is B, the number of offspring when an individual reproduces by itself is M, and the number of offspring of her mother when an individual helps to nurse her sisters is N.

A $A \times N > B \times M$
B $A \times N < B \times M$
C $A \times M > B \times N$
D $A \times M < B \times N$

4. Why has eusociality been found most frequently in Hymenoptera as shown in the underlined statement 2? Choose the most appropriate reason from A-E, and record the letter in the designated space (IV−4) on the answer sheet.

A The higher coefficient of relatedness between sisters than that between a mother and a daughter
B High lifetime fecundity in a female
C Many individuals living together in a nest
D High ability of learning and memory
E High communication ability using chemical substances such as pheromones

V. Choose the most suitable biological item from A–E that matches the following phrases 1–6, and record the corresponding letters in the designated spaces (V–1~6) of the answer sheet.

1 The phenomenon, in which homologous chromosomes stick to each other at the time of meiosis

A adhesion B arrangement C fusion
D pairing E recombination

2 One of the species that first appears in a disturbed environment

A cedar B dandelion C rice
D spruce E wheat

3 Plant hormone generally promoting dormancy

A auxin B abscisic acid C cytokinin
D ethylene E gibberellin

4 An organ that does not derive from mesoderm

A heart B kidney C notochord
D skeletal muscle E spinal cord

5 A reaction that is not induced by adrenalin (epinephrine)

A blood sugar elevation B blood pressure elevation C bronchial dilatation
D cardioacceleration E glycogen synthesis

6 An aerobic process

A acetate fermentation B alcohol fermentation C glycolysis
D lactate fermentation E photosynthesis