2017 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（MONBUKAGAKUSHO）SCHOLARSHIPS 2017

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**.

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

Higher plants have two systems of hybridization, [1] and [2]. [1] plants are self-compatible and generally accept their own pollen. Among agricultural crops, rice, [3] and tomatoes are representative examples. Many [2] plants are $_1$ self-incompatible, and basically accept the pollen of other plants. Among agricultural crops, [4], cabbage and many fruit trees are in this category. [2] plants have $_2$ diversified mechanisms in order to avoid accepting their own pollen so that they only accept the pollen of other plants.

It is a very important method for plant breeding to select good [5] among offspring after artificial hybridizations. At present, many crop varieties are $_3$ F1 hybrid varieties, which have been specifically developed. The first generation of a hybrid plant derived from artificial hybridization between excellent parents is used as a F1 hybrid variety, utilizing [6]. Therefore, artificial hybridization is a very useful means for breeding good varieties. Under natural conditions, [1] crops accept their own pollen, and special methods like [7] are necessary to make artificial hybridization. Since rice plants have very small flowers, artificial hybridization is difficult, and one rice flower produces only two seeds from one artificial hybridization, making production costly. Thus, F1 hybrid varieties of rice had not been developed for many years. However, the utilization of [8] characters, in which pollen viability is lost, enabled the development of F1 hybrid rice varieties and they are now used all over the world. Rice has wind-pollinated flowers and the utilization of [8] lines makes artificial pollination unnecessary. In order to use [8] lines for breeding, it is desirable that [8] character is controlled by [9] genes. In case of [10] genes, it is difficult for a [8] character to stably evolve, because this character could be separated in the progenies. In rice F1 hybrid variety breeding, [8] lines controlled by [9] genes are used.

1. Fill in the blanks ([1]−[10]) in the above passage from the list given below and record the appropriate letters (A−Y) in the designated spaces (I−1 (1)~(10)) on the answer sheet.

A	anther	B	common mushroom	C	defoliation
D	diversity	E	double hybridization	F	emasculation
G	extranuclear	H	female sterile	I	genotype
J	Golgi body	K	heterosis	L	inbreeding

M	inbreeding depression	N	lethal	O	male sterile
P	maize	Q	mitosis	R	nuclear
S	outcrossing	T	pruning	U	style
V	thinning	W	wheat	X	vacuole
Y	xenia				

2. Which of the following sentences is correct as an explanation of self-incompatibility, as shown in the underlined part 1 above? Record the letter (A−E) indicating the correct sentence in the designated space (I−2) on the answer sheet.

A Self-incompatibility is observed only in plants with androgynous flowers.
B Self-compatible plants cannot be propagated by seeds and only vegetative propagation is possible.
C Self-incompatibility contributes to maintaining diversity in a species.
D Pollens of self-incompatible plants are sterile.
E Pistils of self-incompatible plants display sterile characteristics.

3. As shown in the underlined part 2 above, in addition to self-incompatibility [2] plants have various mechanisms to avoid their accepting own pollen. Which statement is incorrect as a mechanism for [2] plants to avoid accepting their own pollen? Record the letter (A−E) for the incorrect sentence in the designated space (I−3) on the answer sheet.

A One plant bears both male and female flowers.
B There are both male and female plants in a species.
C Stamens are longer than the pistil.
D Pollens mature later than the pistil.
E A pistil matures later than pollen.

4. Which of the following sentences is incorrect as an explanation of differences between F1 hybrid varieties, described in the underlined part 3 above, and conventional (non-F1 hybrid) varieties? Record the letter (A−E) for the incorrect sentence in the designated space (I−4) on the answer sheet.

A Harvested seeds can generally be used for the next generation in conventional varieties.

B Conventional varieties always show segregation in the next generation when harvested seeds are used.

C Farmers should purchase seeds of F1 hybrid varieties every year.

D F1 hybrid varieties are generally more expensive than conventional varieties.

E In many cases, F1 hybrid varieties show higher productivity than conventional varieties.

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

Photosynthesis is an important means for plants to obtain energy and we categorize plants into three types according to their method of [1] fixation. [2] plants are the most numerous higher plants on this planet. [2] plants fix absorbed [1] through the synthesis of five-carbon sugar [3] and two molecules of [4] containing three carbon atoms. Then, fixed [1] is incorporated into a metabolic pathway called the [5] cycle and during the process of circulating this cycle, carbohydrates are synthesized using light energy fixed by $_1$ [6]. $_2$[7] plants fix [1] at [8] cells by [9] and synthesized [10] containing four carbon atoms. Synthesized [10] are then transported to [11] cells, and [1] is generated through decarboxylation, which is fixed again by [3] and carbohydrates are synthesized by the [5] cycle. This is the second type.

The third type is called $_3$[12] plants. [12] plants fix [1] by [9] similarly to [7] plants, but [12] plants fix [1] at night, and synthesized [10] are stored in cells. During the daytime of the following day, [1] released by decarboxylation is fixed by [3] and carbohydrates are synthesized by the [5] cycle. The reason why [12] plants fix [1] at night is because by absorbing [1] through open [13] during a low temperature period at night it is possible to reduce [14] loss.

1. Fill in the blanks ([1]−[14]) in the above passage from the list given below and record the appropriate letters (A−Z) in the designated spaces (II−1 (1)〜(14)) on the answer sheet.

A	3-PGA	B	alcohol	C	ATP
D	bundle sheath	E	Calvin	F	CAM
G	cellulose	H	C_4	I	CO_2
J	C_3	K	dark reaction	L	epidermis

M	heat	N	H_2	O	hydrophyte
P	light reaction	Q	mesophyll	R	mesophyte
S	organic acids	T	O_2	U	PEP
V	RuBP	W	stomata	X	stroma
Y	TCA	Z	water		

2. Which of the following sentences is incorrect as an explanation of [6], as shown in the underlined part 1 above? Record the letter (A−E) of the incorrect sentence in the designated space (II−2) on the answer sheet.

A Water is decomposed by light.
B [6] of photosynthesis does not occur at night.
C Light energy is converted into chemical energy.
D NADPH, oxidative power, synthesized in [6] of photosynthesis, is provided to the [5] cycle.
E Chemical energy is produced by light phosphorylation.

3. Which statement is incorrect as an explanation of [7] plants, as 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 Generally photorespiration is not observed.
B Many [7] plants originated in the tropics.
C [1] compensation point is low.
D Light saturation point is low.
E Light use efficiency is high.

4. Which areas are appropriate for the distribution areas of [12] plants, as shown in the underlined part 3 above? Record the letters (A−F) for 2 appropriate areas in the designated space (II−3) on the answer sheet.

A	lowland forest	B	marine coast	C	mountain forest
D	tropical rain forest	E	tropical savanna	F	wetland

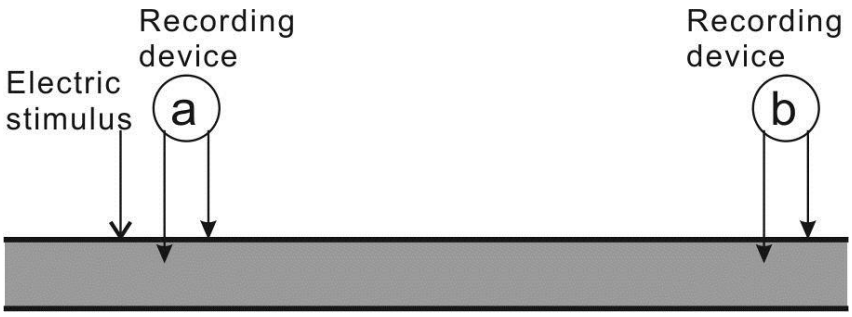
III. Read the following passage and answer the subsequent questions 1–3.

A fundamental unit of the nervous system is a neuron, which has unique morphology and function. A neuron consists of a soma (cell body), [1], and [2]. The [1] and [2] extrude from the soma and work as input and output regions, respectively. A major functional characteristic of neurons is to show [3], generating $_{1}$<u>action potential</u>. An action current originating from the soma propagates along the [2] to reach a [4] at the terminal site. In a [4] a [5] is released and then the adjacent neuron shows [3].

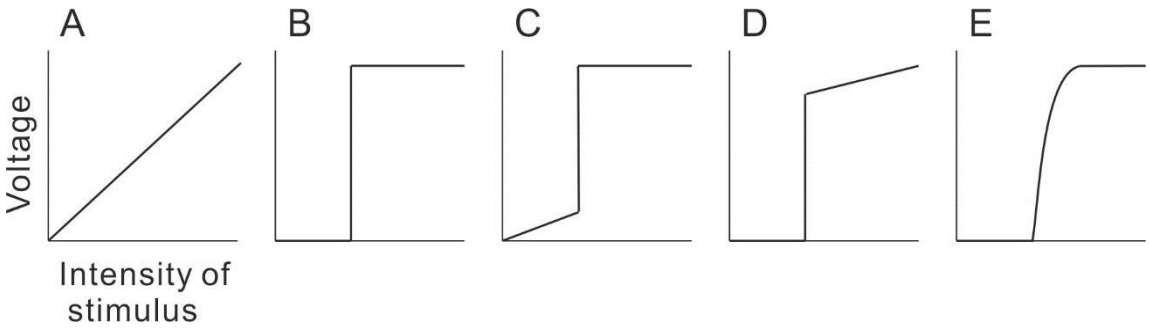
1. Fill in the blanks ([1]-[5]) in the above passage from the list given below and record the appropriate letters (A-O) in the designated spaces (III–1 (1)~(5)) on the answer sheet.

A	actin	B	axon	C	calcium ion
D	contraction	E	dendrite	F	excitation
G	flagellum	H	neurilemma	I	neurotransmitter
J	microtubule	K	mitochondrion	L	myelin
M	node of Ranvier	N	pulsation	O	synapse

2. To clarify the characteristics of action potential, shown in the underlined part 1 of the above passage, changes in membrane potential by a single electrical stimulus were observed in a squid giant neuron. As shown in the upper panel of the figure below, changes in the difference of electrical potential across the membrane were recorded close to the site where the stimulus was given using recording device **a**, and apart from the site by using recording device **b**. Then, the changes were graphically shown (the lower panel of the figure below); the abscissa shows the intensity of the electrical stimulus and the ordinate shows the maximum difference of electrical potential across the membrane produced by the stimulus. The results were different between recording devices **a** and **b**. Among the graphs A-E, choose the most appropriate representations that would be obtained by using recording devices **a** and **b**, and record the letters in the designated spaces (III-2) on the answer sheet.



Squid giant neuron



3. A frog sciatic nerve is a bundle of many neurons. In a frog sciatic nerve, changes in electrical potential as a result of a single electrical stimulus were observed. As shown in the figure below, the changes in electrical potential were recorded outside the nerve, apart from the site where the stimulus was given, using a recording device. From the graphs A-E in the figure above, choose the most appropriate one to represent the recording obtained by the recording device, and record the letter in the designated space (III-3) on the answer sheet.

Frog sciatic nerve

IV. Read the following passage and answer the subsequent questions 1–3.

In animal development, a fertilized egg repeats cell divisions to obtain specific morphology and function. This process is called differentiation.

In 1962, [1] $_1$exposed an unfertilized egg to ultraviolet light and implanted a nucleus extirpated from an embryo or larva (tadpole) into the egg in the African clawed frog, *Xenopus laevis*. When a nucleus extirpated from an early embryo was implanted, the egg developed to a larva in most cases. When a nucleus extirpated from an intestinal epithelium cell of a developed (swimming) larva was implanted, however, the egg stopped development in an early stage in most cases. Nevertheless, a small proportion of eggs with nucleus from developed larvae also developed to normal larvae.

An individual developed from an egg employing nucleus transplantation is genetically identical with the individual from which the nucleus was extirpated. Such a genetically identical organism group is called a [2]. A human uniovular twin and a population proliferated by [3] in an aphid, which occurs naturally, are also called a [2] in terms of genetic identity.

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

A	asexual reproduction	B	clone	C	Hans Spemann
D	homology	E	James Watson	F	John Gurdon
G	meiosis	H	oviposition	I	parthenogenesis
J	pure line	K	Shinya Yamanaka	L	sibling

2. Which is the major purpose of the exposure to ultraviolet light shown by the underlined part 1 above? Record the letter (A−E) for the appropriate phrase in the designated space (IV−2) on the answer sheet.

A To sterilize the egg surface to avoid infection by microorganisms during the experimental period.
B To activate embryonic development by the UV stimulus.
C To supply energy required for development to the egg.
D To make a pore in the cell membrane for nucleus transplantation.
E To eliminate the genetic information in the unfertilized egg by destroying

DNA in the nucleus.

3. What can be clarified by this experiment? Among the sentences A-E, choose the two that are appropriate, and record their letters in the designated spaces (IV–3 (1)~(2)) on the answer sheet.

A Cells differentiate by splitting genetic information of a fertilized egg with cell divisions.
B Cells differentiate by discarding unnecessary genetic information of a fertilized egg.
C Both a fertilized egg and a differentiated cell possess the same genetic information.
D The ability of a cell to differentiate into every cell is lost during development.
E Genetic information necessary for development localizes mainly in the cytoplasm.

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 Plants whose ovules are exposed without being covered by carpels

A barley B carnation C cypress
D eucalyptus E oak

2 A taxon that lives symbiotically with fungi in lichen

A algae B bacteria C bryophytes D fern
E flagellates

3 The diploid multicellular phase in the life cycle of a plant or algae

A gametophyte B halophyte C spore
D sporophyte E thallus

4 Gas that is not known as a greenhouse effect gas

A argon B chlorofluorocarbon C CO_2
D methane E N_2O

5 Mechanism or behavior that is not related to the figure-eight dance of honey bees

A circadian clock B foraging behavior C mating behavior
D polarized light perception E sun compass

6 Hormone that lowers blood sugar

A adrenalin (epinephrine) B glucagon C glucocorticoid
D growth hormone E insulin