

2009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 2009

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.	
Name	(Please print full name, underlining family name)		Marks

I The following passage describes muscle contraction in vertebrates. Choose the most suitable terms that match the blanks in the passage from the choices listed below, and put the letters in the designated spaces (I-1~11) of the answer sheet.

Movements of vertebrates are caused by contraction of skeletal muscles that are attached to the bone by bands of fibrous connective tissue called [1]. A skeletal muscle microscopically shows a specific pattern, and thus, is also called [2] muscle. A skeletal muscle is a bundle of long fibers running the length of the muscle. Each fiber is a single cell, and is itself a bundle of smaller [3] arranged longitudinally. The [3], in turn, are composed of two kinds of filaments; thin or [4] filaments and thick or [5] filaments. According to the [6] filament model, neither the thin filaments nor the thick filaments change in length when the muscle contracts; rather, the filaments move each other longitudinally, so that the degree of overlap of the thin and thick filaments [7].

Contraction of a muscle requires energy which is supplied by the breakdown of ATP into [8] and inorganic phosphate. Anaerobic [9] breakdown and fermentation quickly generate ATP, and sustained exercise requires aerobic respiration.

Stimulation of a single muscle fiber by a motor neuron results in an all-or-none contraction, a [10]. If a second action potential is triggered before the response to the first is over, then the tension will sum to produce a greater re-

sponse. And if the rate of stimulation is fast enough, then [10]s blur into one smooth and sustained contraction called [11].

Choices :

- | | | |
|-------------|----------------------|----------------|
| A actin | B ADP | C AMP |
| D cartilage | E contracting | F copula |
| G creatine | H creatine phosphate | I creatinine |
| J decreases | K extending | L gliding |
| M increases | N jerk | O lactate |
| P myofibers | Q myofibrils | R myofilaments |
| S myosin | T pyruvate | U pulling |
| V relaxing | W sliding | X smooth |
| Y spotted | Z striated | AA striped |
| BB tendons | CC tonus | DD tetanus |
| EE twitch | | |

II Read the following passage and answer the subsequent questions 1-5.

Plants show characteristic responses to submergence. When plants and soils are submerged by water as shown in Figure 1, the air in the gaseous space in the soil is quickly replaced with water. Plant roots generally obtain oxygen from the gaseous space in the soil. Thus, when this space is filled with water, plant roots rapidly fall into oxygen deficiency, leading to the retardation of the absorption of water and nutrients, which then adversely affects the growth and development of the aboveground parts. Characteristic responses of plants when submerged are leaf epinasty (increased growth on the upper surface of a leaf, causing it to bend downward), thickening of the stem base and the development of adventitious roots. Although the ecological significance of leaf epinasty is not well known, thickening of the stem base and the development of adventitious roots are considered to be adaptive responses of plants to water submergence. The

thickening of the stem base is caused by the development of aerenchyma (air spaces in plants) in the stem, which helps the transport of oxygen from above-ground to underground parts. Adventitious roots play the role of dead or low-functioning roots damaged by water submergence. ²Hygrophytes are plants adapted to marshland, which is generally submerged in water. Most of them develop aerenchyma in the stem, which enables the efficient transport of air from aboveground to underground parts, in order to adapt their roots to anaerobic conditions.

Salt accumulation in the soil (soil salinity) adversely affects plants. Various salts accumulate in the soil and the most problematic ones are chlorine and sodium ions. For animals, both chlorine and sodium are indispensable for their lives, but for plants they are not prerequisite and over-absorption often induces toxic effects on cells, such as the retardation of various enzymatic reactions. The toxic effects of these ions are one of the causes of plant damage by soil salinity. ³Halophytes, which are adapted to saline soils in the coast or dry area, can protect themselves from the toxic effects of ⁴chlorine and sodium ions absorbed in their bodies. The other cause of plant damage by soil salinity is the blockage of water absorption. ⁵When salts are accumulated in the soil, the water absorption of roots is retarded, even though sufficient water is in the soil.

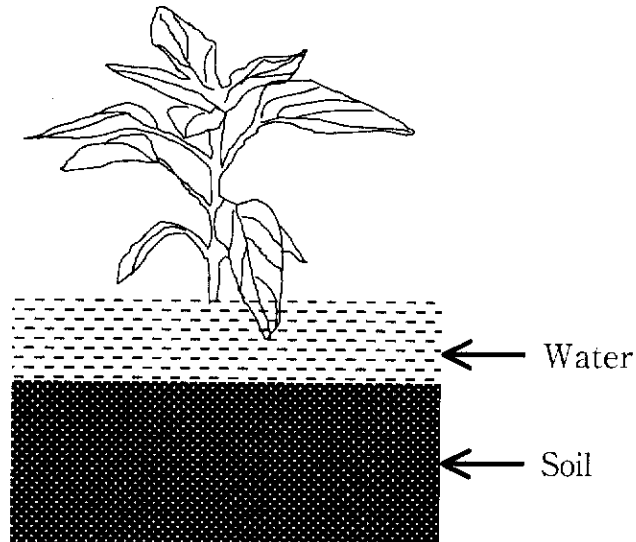


Figure 1

1. It is believed that a phytohormone is responsible for these characteristic responses of plants to submergence as shown in the underlined part 1. This phytohormone also accelerates fruit ripening. What is this phytohormone? Choose the proper one among A–E and put its letter in the designated space (II–1) of the answer sheet.

- | | | |
|-----------------|---------------|-------------|
| A abscisic acid | B auxin | C cytokinin |
| D ethylene | E gibberellin | |

2. Choose 2 hygrophytes as defined in the underlined part 2 among A–F and put their letters in the designated space (II–2) of the answer sheet.

- | | | |
|-----------|-------------|---------|
| A cactus | B dandelion | C maize |
| D papyrus | E rice | F wheat |

3. Choose a halophyte as defined in the underlined part 3 among A–F and put its letter in the designated space (II–3) of the answer sheet.

- | | | |
|---------|---------------|------------|
| A cedar | B cherry tree | C chestnut |
| D fir | E mangrove | F rose |

4. Which are the organelles whose function is to isolate and store unnecessary materials like those shown in the underlined part 4? Choose the proper one among A–F and put its letter in the designated space (II–4) of the answer sheet.

- | | | |
|----------------|----------------|----------------|
| A chloroplasts | B Golgi bodies | C mitochondria |
| D nuclei | E ribosomes | F vacuoles |

5. What is the phenomenon that is most deeply related to the blockage of water absorption by salt accumulation in the soil as described in the underlined part 5? Choose the proper one among A–D and put its letter in the designated space (II–5) of the answer sheet.

- A evaporation of water from the surface of pure water in a beaker.
- B transpiration of leaves of a cactus whose leaves are covered with thick cuticle.
- C water movement between solutions with different concentrations partitioned with a semipermeable membrane.
- D water movement inside a hose under pressure.

III The following passage describes the fights of hermit crabs for snail shells. Answer the subsequent questions 1–7.

Coastal hermit crabs live in snail shells. As snail shells are not part of the hermit crab's body, they do not grow following the growth of the hermit crab inside. Hermit crabs should obtain appropriate-sized shells as they grow. Figure 2 shows the relationship between crab size and shell size. In this figure, the optimal shell size is shown by a line. For example, the optimal-sized shell for a crab of 5 mm in carapace length (Crab D) is 14 mm in shell width. Shells deviating from this size are unsuitable for this crab. Larger shells are heavy and difficult to carry, and in smaller shells crabs cannot completely conceal the body.

A hermit crab sometimes attacks another crab to obtain a new shell. In this at-

tempt, an attacker crab that succeeds in evicting the other should discard its original shell and move into the newly obtained shell. As a result, the attacked crab moves into the shell discarded by the attacker crab. Thus, fights by hermit crabs for shells assume a form of exchange.

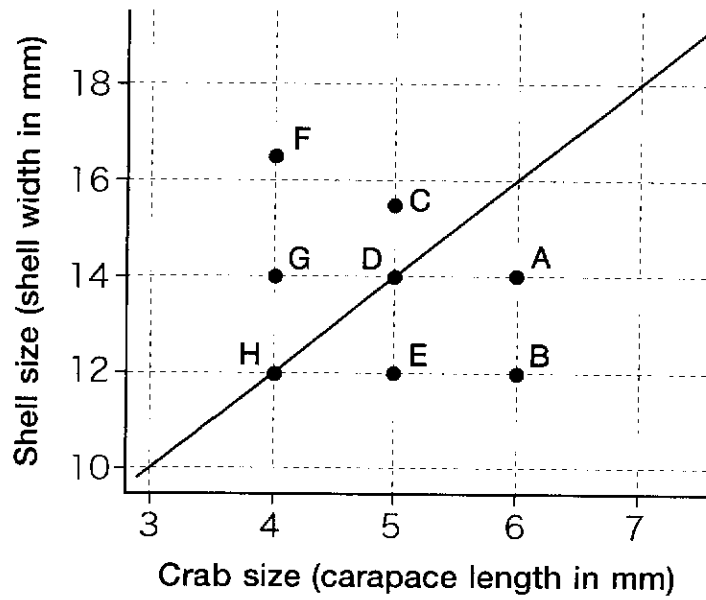


Figure 2

1. Hermit crabs are relatives of brachyuran crabs and prawns. What group do these animals including hermit crabs belong to? Choose a suitable taxon from the choices listed below, and put the letter in the designated space (III-1) of the answer sheet.
2. What taxon do snails belong to? Choose a suitable one from the choices listed below, and put the letter in the designated space (III-2) of the answer sheet.
3. The line in Figure 2 represents a linear increase. What does this mean? Choose a suitable sentence from the following five A-E, and put the letter in the designated space (III-3) of the answer sheet.
 - A The growth of a hermit crab is affected by the size of the shell it occupies.
 - B Because the growth rate decreases as a hermit crab grows, a large hermit crab requires a relatively small shell.
 - C The optimal shell size decreases as the size of the hermit crab decreases.
 - D There is an inversely proportional relationship between the optimal shell size and the crab size.
 - E A hermit crab utilizes the inner space of a shell, so the optimal shell size increases in cubic proportion to the crab size.
4. A hermit crab can not attack equal-sized crabs or ones larger than itself. Which crabs can Crab D in Figure 2 attack? Choose all the possible crabs from those shown in the figure, and put their letters in the designated space (III-4) of the answer sheet.
5. What is the optimal size for Crab B in Figure 2. Put the value in mm in the designated space (III-5) of the answer sheet.

6. When a crab obtains a new shell whose size is nearer to the optimal value than the original, the crab can be regarded as gaining, but when the new one further deviates from the optimal than the original, it can be regarded as losing. Which is the crab that Crab E in Figure 2 can attack, so that the shell exchange yields gains for both crabs? Choose such a crab from those shown in the figure, and put the letter in the designated space (III-6) of the answer sheet.

7. Which is the crab that Crab C in Figure 2 can attack, so that the shell exchange yields a gain for the attacker and a loss for the attacked? Choose such a crab from those shown in the figure, and put the letter in the designated space (III-7) of the answer sheet.

Choices :

- | | | |
|------------|-------------------|-----------------|
| A Annelida | B Arthropoda | C Echinodermata |
| D Mollusca | E Platyhelminthes | F Rotifera |

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

It is said that plants appeared on the earth during the time between the Ordovician period and the [1] period of the Paleozoic era, some four hundred million years ago. The first plants that appeared on land may have been [2] or Bryophytes, and it is [2] that had become large-sized on land and markedly expanded their habitat by the Carboniferous period of the Paleozoic era. Although unlike plants living in water, [2] cannot absorb water and nutrients from the whole plant body, they developed the tube system called [3], which enabled the plants to absorb water and nutrients at one part of the plant body and transport them to the other parts. In addition, after developing [4] on the surface of leaves, they are able to prevent water loss and lower the leaf temperature by opening and closing [4]. Thanks to these

changes [2] adapted themselves to [5] land conditions to some extent. [2], however, need external water at the time of [6] and their habitats were limited to areas not too [5], such as river coasts.

It is [7] that have evolved from [2]. [7] can tolerate [5] conditions more pronouncedly. Because [7] do not need external water at the time of [6], they were suitable to life under [5] inland conditions. [7] developed cuticle layers on the surface of the whole plant body, which effectively prevent water loss from the surface of the plant body. [7] include [8] and [9], and in the flower of the former [10] are exposed, whereas in the flower of the latter [10] are covered by ovaries. [8] appeared in the late Devonian period of the Paleozoic era and prospered during the time from the Carboniferous period to the Permian period. [9] appeared during the time from the Jurassic period to the Cretaceous period of the Mesozoic era, and diversified during the period from then to the Cenozoic era. [9] further differentiated into [11] and [12].

At the end of the process of plant evolution, crops appeared after the appearance of human beings, very recently in the history of the earth. Crops may have evolved from ancestral wild plant species by [13]. They can be distinguished from wild plants by many characteristics. One of them is the non-dormant characteristics of the seeds, by which crops germinate uniformly when planted. Crops do not contain toxic substances in store organs like fruits. The seeds or fruits of wild plants generally are detached from the plant body when mature, whereas the seeds or fruits of crops are not and efficient harvest is possible. In crops, harvested organs, such as the grains of cereal crops, the fruits of fruit vegetables and the corms or tuberous roots in root crops, are enlarged abnormally.

1. Fill the blanks (1-13) in the above passage by choosing proper one from a group of terms presented below. Put their letters in the designated spaces (IV-1-1~13) of the answer sheet.

- | | | |
|--------------------|------------------------|--------------------|
| A angiosperms | B artificial selection | C blue-green algae |
| D Cambrian | E dicotyledons | F dry |
| G eggs | H epidermis | I gymnosperms |
| J humid | K isolation | L lichens |
| M monocotyledons | N natural selection | O ovules |
| P phloem | Q placenta | R pteridophytes |
| S reproduction | T Silurian | U spermatophytes |
| V sperms | W spores | X stomata |
| Y vascular bundles | Z xylem | |

2. As mentioned in the underlined part 1, plants that appeared on land had to lower the leaf temperature. As the reason for this, choose the most proper one from A-D and put its letter in the designated space (IV-2) of the answer sheet.

- A to absorb a sufficient amount of solar radiation.
- B to adapt to high air temperature, caused by high CO₂ concentration in the atmosphere.
- C because of low plant height.
- D because of thin leaf mesophyll.

3. As described in the underlined part 2, crops have various characteristics clearly different from wild plants. On the other hand, wild plants 1) have dormancy, 2) contain toxic substances in store organs, 3) detach seeds and fruits and 4) do not enlarge grains, fruits or storing roots remarkably. Among the above 4 points, as the reasons for 1) and 2), choose the most proper ones from A-F and put their letters in the designated spaces (IV-3-1 and IV-3-2) of the answer sheet.

- A to economize production.
- B to ensure the distribution of seeds.
- C to escape from being eaten by animals.
- D to restrict the habitat.
- E to increase the germination rates of seeds.
- F to increase survival due to adaptation to environmental changes.

V Choose the most suitable item that matches the following phrases 1–6 from the subsequent lists, and put their letters in the designated spaces (V–1~6) of the answer sheet.

1. A base pairing with adenine in DNA molecule

- | | | |
|-------------|------------|-----------|
| A adenosine | B cytosine | C glycine |
| D guanine | E thymine | F uracil |

2. A process that copies necessary genetic information to RNA from DNA

- | | | |
|-------------------|-----------------|---------------|
| A differentiation | B transcription | C translation |
| D transportation | E synthesis | |

3. Reactions that occur in stroma among reactions included in photosynthesis

- A decomposition of water
- B photochemical reaction
- C photophosphorylation
- D production of hydrogen with a high-energy electron
- E reactions in Calvin cycle

4. A plant that needs long days for flowering in general

- | | | |
|---------|-----------------|-------------|
| A maize | B morning glory | C rape seed |
| D rice | E xanthium | |

5. An animal belonging to the acoelomates

- | | | |
|-------------|--------------|-------------|
| A earthworm | B euglena | C jellyfish |
| D planarian | E sea-urchin | F lancelet |

6. The approximate amount of carbon dioxide contained in the air

- | | | |
|-------------------------|-------------------------|-------------------------|
| A $4 \times 10^{-6} \%$ | B $4 \times 10^{-5} \%$ | C $4 \times 10^{-4} \%$ |
| D $4 \times 10^{-3} \%$ | E $4 \times 10^{-2} \%$ | F $4 \times 10^{-1} \%$ |