

2020 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 2020

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**.

(2020)

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

Marks	
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I. Read the following passage about environmental responses of plants and plant hormones and answer the subsequent questions 1 – 5 using the answer sheet.

Plants exhibit various responses toward environmental changes. Plant hormones are often involved in these plant responses. For example, when we put plants horizontally in the dark, plant stems bend upward whereas roots bend downward. This response is mediated by auxin. Also, the phenomenon called apical dominance is regulated via the interaction between auxin and cytokinin. On the other hand, it is known that gibberellin promotes seed germination. In addition to these plant hormones, there are distinct plant hormones, i.e., ethylene that promotes defoliation, and abscisic acid that controls stomatal movement.

1. The following experiment 1 related to the roles of auxin and gibberellin was conducted. What kind of interpretation is correct to explain the obtained experimental data shown in Table 1? Record the letters (A – H) indicating the two correct interpretations in the designated space (I-1) on the answer sheet.

Experiment 1

As shown in Figure 1, stems (10 mm length) were cut from seedlings of the adzuki bean. Then twelve stem segments were floated on a culture solution without plant hormones, a culture solution with auxin, a culture solution with gibberellin, or a culture solution with both auxin and gibberellin. After 8-hour incubation, the length and weight of each segment were measured. The average data in each culture solution were shown in Table 1. In the experiment, the cell number of the stem segment did not change. Also, the increase of the weight in the stem segments was mainly due to the increase of water in the segments, which also accompanied the increase of the volume of the segments.

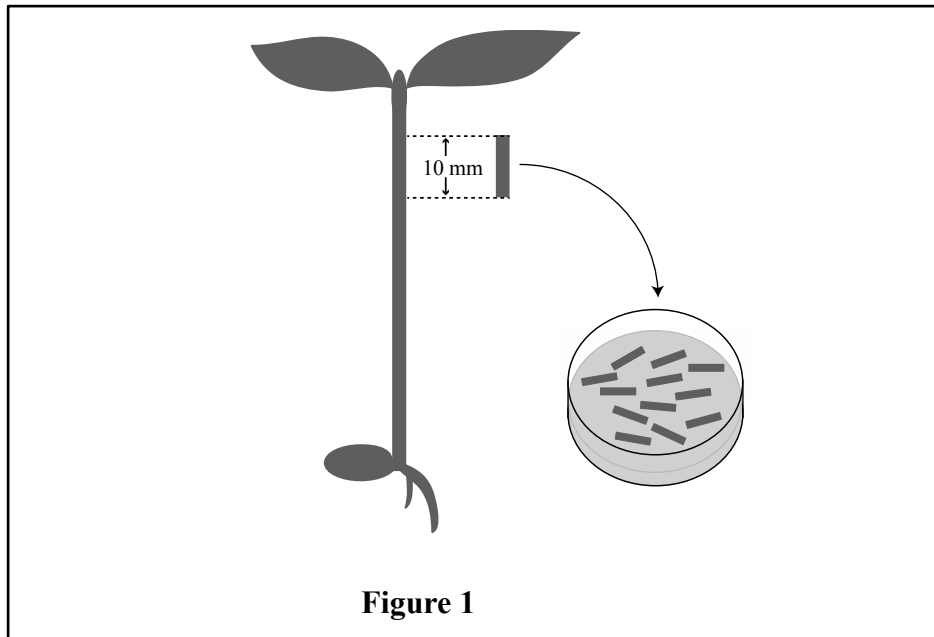


Table 1

Solution	Length (mm)	Weight (mg)
No plant hormone	11.4	30.5
Auxin	15.6	48.6
Gibberellin	11.3	30.3
Auxin + gibberellin	18.7	49.8

- A Gibberellin alone is able to promote stem elongation.
- B Auxin alone is able to increase the water absorbing power of the stems.
- C Auxin alone is not able to promote stem elongation, but only auxin plus gibberellin is able to promote the elongation.
- D The auxin-dependent elongation is not affected by gibberellin.
- E The stem segments incubated in the presence of auxin plus gibberellin are thinner than those incubated in the presence of auxin alone.
- F Weight per unit length in the stem segments is larger in the segments incubated in the presence of auxin plus gibberellin compared with that in the segments incubated in the presence of auxin alone.
- G Gibberellin alone is able to promote the water absorbing power of the stems.
- H There is no difference in weight per unit length in the stems between the presence of auxin alone and the presence of auxin plus gibberellin in their incubation.

2. In the experiment 1, the weight increase of stem segments under plant hormone treatments is mainly due to the increase of water. What is an intracellular structure that exhibits big changes in shape and size in this phenomenon? Record the letter (A – F) indicating the most appropriate intracellular structure in the designated space (I-2) on the answer sheet.

- | | | |
|---------------|--------------|-----------------|
| A chloroplast | B Golgi body | C mitochondrion |
| D nucleus | E peroxisome | F vacuole |

3. Related to the underlined part 1, which of the following sentences is correct for the explanation of the apical dominance mechanism? Record the letter (A – D) for the correct sentence in the designated space (I-3) on the answer sheet.

- A Auxin produced in the apical bud promotes production of cytokinin that represses the growth of lateral buds.
- B Auxin produced in the apical bud represses production of cytokinin that promotes the growth of lateral buds.
- C Cytokinin produced in the apical bud promotes production of auxin that represses the growth of lateral buds.
- D Cytokinin produced in the apical bud represses production of auxin that promotes the growth of lateral buds.

4. Related to the underlined part 2, the experiment 2 shown below was conducted. Record the letter (A – E) indicating the most appropriate description for the experiment 2 in the designated space (I-4) on the answer sheet.

Experiment 2

Twigs with leaves cut from a deciduous tree (wild type) were placed together with a ripe apple in a sealed container and then incubated for 6 days. As a result, defoliation was observed. On the other hand, when twigs with leaves from the wild-type tree alone were incubated in a sealed container for 6 days, defoliation was not observed. There is also a mutant strain of this deciduous tree that does not show defoliation in the defoliation season for the wild type. Twigs with leaves from the mutant tree were placed together with a ripe apple in a sealed container and incubated for 6 days. As a result, defoliation was observed.

- A Ripe apples are not able to produce ethylene.
- B Ripe apples are able to produce ethylene but ethylene has no effects on the mutant.
- C The mutant is not able either to produce ethylene or to respond to ethylene.
- D The mutant is able to produce ethylene but is not able to respond to ethylene.
- E The mutant is not able to produce ethylene but is able to respond to ethylene.

5. Which of the following sentences are incorrect for the explanation of abscisic acid in the underlined part 3? Record the letters (A – E) for the two incorrect sentences in the designated space (I-5) on the answer sheet.

- A Absciscic acid was discovered as a substance that represses defoliation.
- B When a plant is subjected to water deficiency, abscisic acid is produced, resulting in stomatal closure.
- C The content of abscisic acid is reduced in the plant subjected to cold stress.
- D Absciscic acid is involved in the maintenance of seed dormancy.
- E Absciscic acid promotes the synthesis of ethylene.

II. Read the following passage and answer the subsequent questions 1 – 9 using the answer sheet.

Plants and some other organisms are called [1] because they biosynthesize all their own organic compounds, including 1carbohydrates, lipids, proteins, and nucleic acids, from inorganic ones. Most [1] use a process called photosynthesis to make their own nutrients. Photosynthesis is a process whereby light energy is transformed into [2] energy, which is stored in the [3] of sugars made from 2carbon dioxide (a 1-carbon molecule) and water. For this reason, biologists refer to [1] as the [4] of the biosphere. In contrast, animals and fungi are [5], organisms that cannot make organic molecules from inorganic ones. Among [5], which are unable to make their own nutrients, animals feed on organic compounds produced by other organisms, so that they are called biosphere's [6]. Fungi feed on organic matter such as dead organisms, feces, and fallen leaves, leading to break-down of dead or decaying organisms; these types of [5] are known as decomposers.

Photosynthesis consists of both 3light-dependent reactions and light-independent reactions (Calvin-Benson cycle). In plants, the light-dependent reactions occur within the chloroplast [7], where the 4chlorophyll pigments reside. In the reactions, water is oxidized, and [8] is released. The electrons freed from water are used to make ATP and [9]. The light-independent reactions take place in the chloroplast [10]. In the reactions, the enzyme, ribulose biphosphate carboxylase (RUBISCO), which is said to be the most abundant protein on the planet, adds carbon dioxide to ribulose biphosphate (RuBP), a [α]-carbon molecule. The resulting molecule immediately breaks down into 3-phosphoglycerate. With the energy of ATP and the electrons from [9], 3-phosphoglycerate is converted into glyceraldehyde 3-phosphate (G3P), an energy-rich sugar molecule that can be used to make glucose and other organic molecules.

1. Fill in the blanks ([1]–[10]) in the above passage using the most suitable term from the list given below and record the appropriate letters (A – T) in the designated spaces (II-1 (1)~(10)) on the answer sheet.

A atomic nucleus	B chemical elements	C autotrophs
D bonds	E chemical	F consumers
G electrical	H FADH ₂	I heterotrophs
J hydrogen	K intermembrane space	L mixotrophs
M NADH	N NADPH	O nitrogen
P oxygen	Q physical	R producers
S stroma	T thylakoids	

2. Related to the term shown in the underlined part 1 above, which of the following carbohydrate is correct as basic materials forming the exoskeleton of arthropods? Record the letter (A – E) indicating the correct answer in the designated space (II-2) on the answer sheet.

A agarose B cellulose C chitin D glycogen E starch

3. Related to the term shown in the underlined part 2 above, which of the following numerical values is correct as the concentration of carbon dioxide in Earth's atmosphere? Record the letter (A – E) for the correct answer in the designated space (II-3) on the answer sheet.

A 0.04 ppm B 0.4 ppm C 4 ppm D 40 ppm E 400 ppm

4. Which of the following color of light is correct as the least effective in driving the reactions of photosynthesis, shown in the underlined part 3 above? Record the letter (A – F) indicating the correct answer in the designated space (II-4) on the answer sheet.

A blue B green C orange D red E violet
F yellow

5. From the list given below, choose the correct element contained in chlorophyll, which is shown in the underlined part 4 above. Record the letter (A – E) indicating the correct answer in the designated space (II-5) on the answer sheet.

A Fe B Mg C Mo D Ni E Zn

6. Choose the correct numerical value to fill in the blank [α] in the above passage from the list given below. Record the letter (A – E) indicating the correct answer in the designated space (II-6) on the answer sheet.

A 1 B 2 C 3 D 4 E 5

7. If 3 moles of carbon dioxide are used in the photosynthesis reaction, what mass (g) of glucose will be produced (atomic weights: H=1, C=12, O=16)? Record the letter (A–E) indicating the correct answer in the designated space (II-7) on the answer sheet.

A 3 B 9 C 30 D 90 E 180

8. If 3 moles of carbon dioxide enter the light-independent reactions, how many mole(s) of G3P will be counted as net gain? Record the letter (A – E) indicating the correct answer in the designated space (II-8) on the answer sheet.

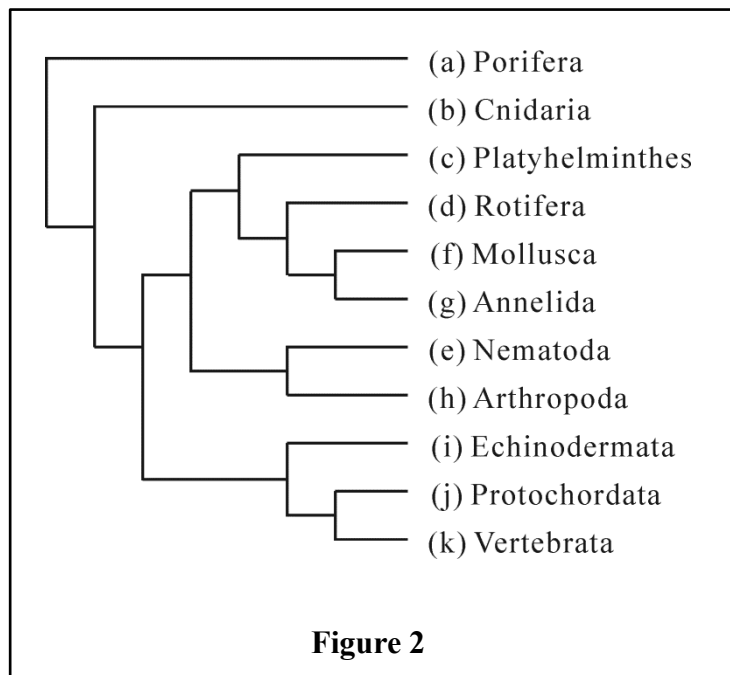
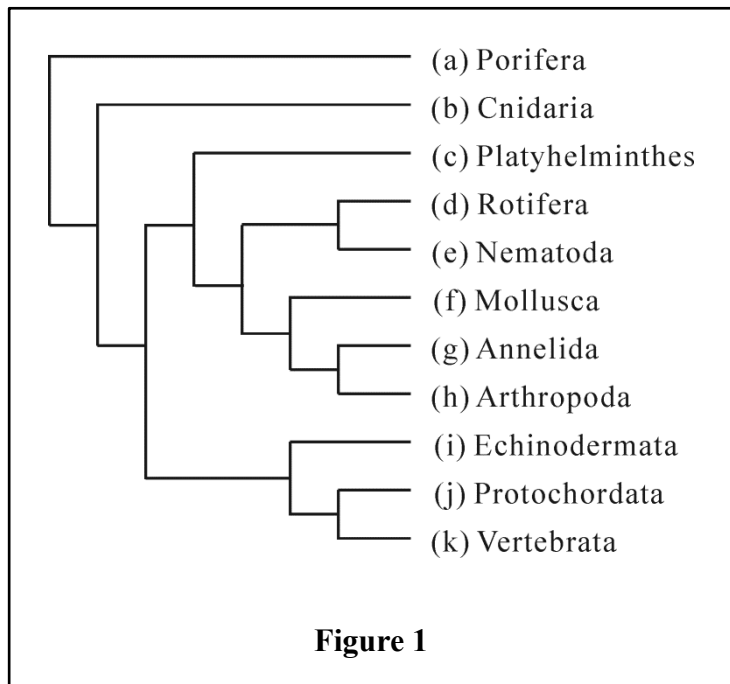
A 0.03 B 0.1 C 0.3 D 1 E 3

9. Of the following metabolic processes, which is common to photosynthesis and cellular respiration? Record the letter (A – D) indicating the correct answer in the designated space (II-9) on the answer sheet.

- A Reactions that split H₂O molecules
- B Reactions that absorb light of different wavelength
- C Reactions that convert carbon dioxide to sugar
- D Reactions that store energy by pumping H⁺ across the membranes

III. Read the following passage and answer the subsequent questions 1 – 6 using the answer sheet.

The phylogeny of major animal groups has been estimated as shown in Figure 1 by comparing the 1body plan, and 2mode of development. According to the results of recent 3molecular phylogenetics, however, the phylogeny of animal groups is reconstructed as shown in Figure 2.



1. From the list given below, choose the animal belonging to each of the groups (a) – (j), and record the appropriate letters (A – O) in the designated spaces (III-1 (a)~(j)) on the answer sheet.

- | | | | | | |
|---|-----------|---|------------|---|----------|
| A | amoeba | B | arrow worm | C | ascidian |
| D | barnacle | E | coelacanth | F | coral |
| G | earthworm | H | eel | I | frog |
| J | octopus | K | planarian | L | rotifer |
| M | roundworm | N | sea urchin | O | sponge |

2. Related to the underlined part 1 above, we can divide these animal groups into three larger groups based on the number of germ layers. Choose the most appropriate classification from A – F in Table 1, and record the letter (A – F) in the designated space (III-2) on the answer sheet.

Table 1

	Group1	Group 2	Group 3
A	(a)	(b)	(c)(d)(e)(f)(g)(h)(i)(j)(k)
B	(a)(b)	(c)(d)(e)	(f)(g)(h)(i)(j)(k)
C	(a)(b)	(c)(d)(e)(f)(g)(h)	(i)(j)(k)
D	(a)(b)	(c)(d)(e)(f)(g)(h)(i)(j)	(k)
E	(a)(b)	(c)(d)(f)(g)	(e)(h)(i)(j)(k)
F	(a)(b)(c)	(d)(e)	(f)(g)(h)(i)(j)(k)

3. Related to the underlined part 1 above, we can classify these animal groups into three large groups based on the presence/absence and morphology of the body cavity. Choose the most appropriate classification from A – F in Table 1, and record the letter (A – F) in the designated space (III-3) on the answer sheet.

4. Fill in the blanks ([1] – [4]) in the following passage related to the underlined part 2 above, using the most suitable term from the list given below. Record the appropriate letters (A – O) in the designated spaces (III-4 (1)~(4)) on the answer sheet.

Because the [1] formed in the early embryo becomes the mouth in animal groups (c) – (h), these animal groups are called [2]. On the contrary, the [1] formed in the early embryo becomes the anus, and the mouth is formed secondarily at the end of [3] in animal groups (i) – (k), and therefore these animal groups are called [4].

- | | | | | | |
|---|-------------|---|-------------|---|---------------|
| A | animal pole | B | archenteron | C | Bilateria |
| D | blastocoel | E | blastopore | F | Deuterostomia |
| G | mesenchyme | H | Metazoa | I | neural tube |
| J | notochord | K | Protostomia | L | Protozoa |
| M | Radiata | N | somite | O | vegetal pole |

5. Which of the following sentences are incorrect as explanations of molecular phylogenetics in the underlined part 3 above? Record the letters (A – E) indicating the two incorrect sentences in the designated space (III-5) on the answer sheet.

- A Molecular phylogenetics is a branch of biology that clarifies evolutionary relationships among organisms by analyzing and comparing their proteins or nucleic acids.
- B After the invention of the PCR (polymerase chain reaction) technique and the development of the automated sequencer of nucleic acids, RNA sequence analysis is predominantly used.
- C Molecular phylogenetics has demonstrated evolutionary relationships that were not shown only by morphological comparison.
- D Molecular phylogenetics needs living biological specimens and therefore is not applicable to past biological specimens such as fossils.
- E By the difference of amino acid sequence in proteins or nucleic acid sequence, we can estimate the approximate time when organisms diverged.

6 According to the results of molecular phylogenetics, the classification of animal groups (c) – (h) was greatly revised. Which of the following sentences are incorrect as explanations of this change? Record the letters (A – E) indicating the two incorrect sentences in the designated space (III-6) on the answer sheet.

- A The animal groups (c) – (h) are classified into two major groups.
- B Animal groups that grow by ecdysis share a common ancestor.
- C Animal groups that have segmentation in their body plan share a common ancestor.
- D Animal groups that undergo holoblastic cleavage in their early development share a common ancestor.
- E The similarity between the trochophore larva and adult Rotifera is confirmed again.

IV. Choose the most suitable answer from A – E that matches the following phrases 1 – 8, and record the corresponding letters in the designated spaces (IV-1~8) of the answer sheet.

1. A scientist who discovered the codon (UUU) for phenylalanine

- A Avery B Franklin C Hershey
D Morgan E Nirenberg

2. A chromosomal structure where spindle fibers attach during mitosis

- A centrosome B chiasma C kinetochore
D promoter E telomere

3. A phenomenon that locusts change their morphology and behavior based on the difference of population density

- A Allee effect B caste system C cyclical fluctuation
D niche E phase polyphenism

4. A kingdom absent in the five-kingdom system?

- A Animalia B Fungi C Monera
D Plantae E Bacteria

5. A hormone found primarily in males

- A estrogen B FSH C melatonin
D prolactin E testosterone

6. A pheromone that acts by affecting the physiology of the recipients with a change of developmental events of organs

- A aggregation pheromone B alarm pheromone
C queen substance D sex pheromone
E trail pheromone

7. A mammalian brain region that controls the endocrine system.

- A cerebellum B cerebrum C hypothalamus
D midbrain E thalamus

8. An organ that does not play an important role in excretion of NaCl of marine animals.

A gill of teleosts

B kidney of teleosts

C kidney of mammals

D salt gland of birds

E salt gland of reptiles