

2010 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 2010

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

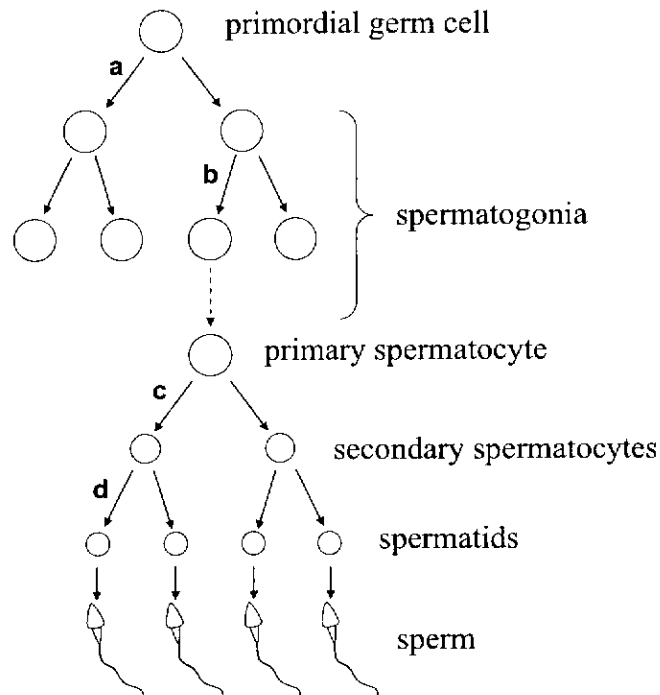
# Biology

**Q1** From ①–⑤ below choose the statement that correctly describes somatic cell division.

**1**

- ① The part of a germinating seed where root elongation is rapid is good for observing somatic cell division.
- ② A cell in prophase has twice as much DNA as one of its daughter cells at the completion of somatic cell division.
- ③ In animal cells, the cytoplasm is divided by the formation of a cell plate at the equatorial plane.
- ④ In telophase, the chromosomes have started to be pulled toward the poles by spindle fibers.
- ⑤ During prophase, the nuclear membrane and the nucleolus disappear. During metaphase, homologous chromosomes line up at the equatorial plane as they undergo synapsis.

**Q2** The figure below schematically represents the process of spermatogenesis in animals. Answer questions (1) and (2) concerning this.



(1) Which of **a–d** in the figure corresponds to meiosis? From ①–⑤ below choose the correct combination. **2**

- ① **a, b**      ② **b, c**      ③ **a, c**      ④ **a, d**      ⑤ **c, d**

(2) If the primordial germ cell's nuclear phase is  $2n$  and its number of chromosomes is 8 ( $2n=8$ ), what are the nuclear phase and number of chromosomes in a spermatogonium, primary spermatocyte, and spermatid? From ①–⑥ below choose the correct combination. **3**

	spermatogonium	primary spermatocyte	spermatid
①	$2n=8$	$2n=8$	$2n=4$
②	$2n=8$	$2n=8$	$n=4$
③	$2n=8$	$n=4$	$n=4$
④	$2n=8$	$n=4$	$n=2$
⑤	$n=8$	$n=8$	$n=4$
⑥	$n=8$	$n=4$	$n=2$

**Q3** Experiments 1–3 below concern development of newts. Referring to these experiments, from

①–④ below choose the statement that is correct.

4

Experiment 1: Tissue from the presumptive neural region of an early gastrula was transplanted to the presumptive epidermal region of another embryo at the same stage. Afterwards, the transplant differentiated into epidermis.

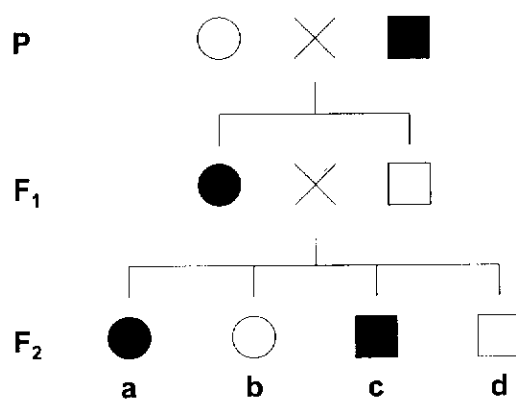
Experiment 2: Tissue from the presumptive neural region of an early neurula was transplanted to the presumptive epidermal region of another embryo at the same stage. Afterwards, the transplant differentiated into nerves.

Experiment 3: Tissue from the dorsal lip of an early gastrula was transplanted to the blastocoel of another embryo at the same stage. This resulted in the formation of a secondary embryo. In the secondary embryo, notochord and other mesodermal organs differentiated from the transplanted tissue, and a neural tube and epidermis were formed from the embryo to which the tissue was transplanted.

- ① The presumptive fate of the presumptive epidermal region is decided by the time of the early gastrula stage.
- ② The presumptive fate of the presumptive neural region is decided by the time of the early gastrula stage.
- ③ The presumptive fate of the presumptive neural region is decided by the time of the early neural stage.
- ④ The transplant tissues used in experiments 1-3 differentiate into the same organ as the region where they are transplanted, regardless of the embryo's stage of development.

**Q4** Read the following paragraph and answer questions (1) and (2) below.

Wild-type *Drosophila melanogaster* normally have red eyes, but in rare cases some individuals have white eyes. The gene responsible for eye color is located on the X-chromosome. White eyes are recessive to red eyes. The figure below shows the result of a crossing experiment that used a white-eyed female and a red-eyed male as the parents. The symbols are: ○ white-eyed female, □ white-eyed male, ● red-eyed female, and ■ red-eyed male.



(1) If a red-eyed male is crossed with a female from the F<sub>1</sub> generation, what is the phenotype segregation ratio of the resulting male and female offspring? From ①–⑤ below choose the best answer. 5

- ① red-eyed female : white-eyed female : red-eyed male : white-eyed male = 1 : 1 : 1 : 1
- ② red-eyed female : white-eyed female : red-eyed male : white-eyed male = 1 : 0 : 1 : 0
- ③ red-eyed female : white-eyed female : red-eyed male : white-eyed male = 1 : 1 : 2 : 0
- ④ red-eyed female : white-eyed female : red-eyed male : white-eyed male = 2 : 0 : 1 : 1
- ⑤ red-eyed female : white-eyed female : red-eyed male : white-eyed male = 1 : 1 : 0 : 2

(2) Which F<sub>2</sub> individuals in the figure would produce only red-eyed females and white-eyed males when crossed? From ①–④ below choose the best answer. 6

- ① a and c
- ② a and d
- ③ b and c
- ④ b and d

**Q5** Secretion of thyroxine, a type of thyroid hormone, is regulated by feedback. How would artificial suppression of thyroid gland functioning in a mammal affect the amount of hormones secreted? From ①–⑥ below choose the correct combination. **7**

	Thyroxine	Thyroid-stimulating hormone	Thyrotropin-releasing hormone
①	decreases	decreases	increases
②	decreases	increases	decreases
③	decreases	increases	increases
④	increases	decreases	decreases
⑤	increases	decreases	increases
⑥	increases	increases	decreases

**Q6** The paragraph below describes regulation of blood glucose level in humans. From ①–⑥ below choose the combination of terms that correctly fills blanks **a** – **c** in the paragraph. **8**

Several endocrine glands are involved in the regulation of blood glucose level. The secretion of **a** by the adrenal medulla **b** the breakdown of glycogen, causing the blood glucose level to increase. Secretion of **c** by the pancreas decreases the blood glucose level.

	<b>a</b>	<b>b</b>	<b>c</b>
①	adrenaline	stimulates	insulin
②	adrenaline	suppresses	insulin
③	adrenaline	stimulates	glucagon
④	glucocorticoid	suppresses	glucagon
⑤	glucocorticoid	stimulates	insulin
⑥	glucocorticoid	suppresses	glucagon

**Q7** The human auditory sense results from the changing of sound into vibrations of gas, liquid, and solid in the ear. Answer questions (1) and (2) below concerning this.

(1) In what structure of the ear do vibrations of a gas change into vibrations of a solid? From ①–⑤ below choose the correct answer. 9

- ① tympanic membrane
- ② auditory ossicle
- ③ semicircular canal
- ④ acoustic nerve
- ⑤ cochlea

(2) What is the function of liquid in the process of hearing? From ①–④ below choose the best answer. 10

- ① Collecting air vibrations.
- ② Sensing the body's inclination.
- ③ Causing the basilar membrane to vibrate.
- ④ Amplifying membrane vibrations.



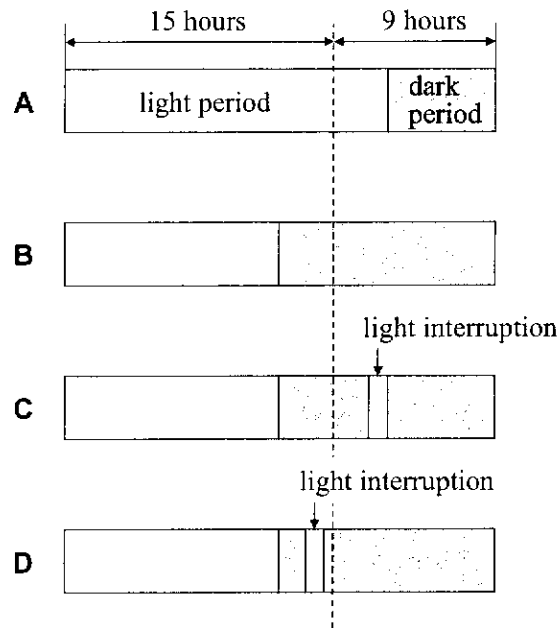
**Q8** The paragraph below describes leaf stomata. From ①–⑧ below choose the combination of terms that correctly fills blanks **a** – **c** in the paragraph. **11**

The cell wall of guard cells in leaf epidermis is **a** on the stoma side than it is on the opposite side. When the guard cells have absorbed a sufficient amount of water, they bend apart, thereby opening the stoma. When the guard cells lack sufficient water, the amount of **b** in them rapidly increases. As a result, the osmotic pressure and turgor pressure inside them **c**, so the stoma closes.

	<b>a</b>	<b>b</b>	<b>c</b>
①	thinner	cytokinin	decrease
②	thinner	cytokinin	increase
③	thinner	abscisic acid	decrease
④	thinner	abscisic acid	increase
⑤	thicker	cytokinin	decrease
⑥	thicker	cytokinin	increase
⑦	thicker	abscisic acid	decrease
⑧	thicker	abscisic acid	increase

**Q9** A certain species of long-day plant was used to perform experiments **A–D** below in order to examine flower bud formation. As shown below, the experiments involved different combinations of light periods, dark periods, and light interruption. If the plant’s critical dark period is 9 hours, in which two experiments did flower buds form? From ①–⑥ below choose the correct combination.

**12**



- ① A, B      ② A, C      ③ A, D      ④ B, C      ⑤ B, D      ⑥ C, D

**Q10** Answer questions (1) and (2) below concerning metabolism.

- (1) From ①–④ below choose the combination of terms that correctly fills blanks **a** – **d** in the following paragraph. **13**

The various chemical changes that occur in the body are collectively referred to as metabolism. One type of metabolic reaction is **a**, in which complex substances are synthesized from simple substances. Another type is **b**, in which complex substances are broken down into simple substances. **a** is an energy-**c** reaction, while **b** is an energy-**d** reaction.

	<b>a</b>	<b>b</b>	<b>c</b>	<b>d</b>
①	anabolism	catabolism	absorbing	releasing
②	catabolism	anabolism	absorbing	releasing
③	anabolism	catabolism	releasing	absorbing
④	catabolism	anabolism	releasing	absorbing

- (2) Which two reaction systems in A–D are a catabolic reaction system or are part of a catabolic reaction system? From ①–⑥ below choose the correct combination. **14**

- A alcohol fermentation
- B chemosynthesis
- C nitrogen fixation
- D citric acid cycle

- ① A, B      ② B, C      ③ A, C      ④ A, D      ⑤ B, D      ⑥ C, D

**Q11** Statements (a)–(f) below concern plant photosynthesis. Which two statements are correct?

From ①–⑧ below choose the correct combination.

**15**

- (a) The first reaction of photosynthesis is a reaction in which light energy activates chlorophyll in the stroma.
- (b) In photosynthesis, ATP (adenosine triphosphate) is synthesized using energy released by the electron transport system.
- (c) The oxygen released by photosynthesis derives from carbon dioxide.
- (d) The first substance made after the intake of carbon dioxide is a 5-carbon compound.
- (e) The process whereby organic compounds are formed using the carbon dioxide taken in is called the Calvin-Benson cycle.
- (f) Many plants appear green because the light used in photosynthesis is mainly green light.

- ① a, b      ② a, f      ③ b, c      ④ b, e
- ⑤ c, d      ⑥ c, f      ⑦ d, e      ⑧ d, f

**Q12** Statements (a)–(f) below concern immunity. Which two statements are correct? From ①–⑧ below choose the correct combination. **16**

- (a) B cells are a type of lymphocyte and are produced in bone marrow.
- (b) T cells mature and differentiate in the thyroid gland.
- (c) B cells attack pathogens by producing antigens.
- (d) Pollinosis (hay fever) is an allergic reaction and is an example of cell-mediated immunity.
- (e) Rejection of transplanted organs is an example of humoral immunity.
- (f) Tuberculin reactions are an example of cell-mediated immunity.

- |        |        |        |        |
|--------|--------|--------|--------|
| ① a, b | ② a, f | ③ b, c | ④ b, e |
| ⑤ c, d | ⑥ c, f | ⑦ d, e | ⑧ d, f |

**Q13** From ①–⑥ below choose the statement that does **not** correctly describe the process of gene expression in eukaryotic cells.

**17**

- ① The genetic information of DNA is transcribed to RNA.
- ② The RNA becomes messenger RNA via the process of splicing.
- ③ The messenger RNA binds with ribosomes.
- ④ Each transfer RNA transports an amino acid.
- ⑤ Transfer RNA codons bind complementarily with messenger RNA anticodons, forming a strand of amino acids.
- ⑥ The amino acids bind together through peptide bonds, thereby forming protein.

**Q14** From ①–⑥ below choose the combination of terms that correctly fills blanks **a** – **c** in the following paragraph. **18**

If tissue from a carrot root is cultured with the necessary nutrients and plant hormone, the cells will **a** and form a cluster of cells called a **b**. If the cluster continues to be cultured with sufficient nutrients and plant hormone, it will sprout and eventually develop into a complete plant. The same result can be obtained from leaf and stalk cells, showing that the somatic cells of plants possess **c**.

	<b>a</b>	<b>b</b>	<b>c</b>
①	differentiate	regeneration blastema	homeostasis
②	dedifferentiate	regeneration blastema	totipotency
③	differentiate	callus	homeostasis
④	dedifferentiate	callus	totipotency
⑤	differentiate	regeneration blastema	totipotency
⑥	dedifferentiate	callus	homeostasis