

2024 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 2024

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.		(2024)	
	Name	(Please print your name, underlining your family name)			Marks	

Answer the subsequent questions (I–IV) using the answer sheet.

I. Read the following two passages, (A) and (B), and answer the subsequent questions (1-2).

(A) A deoxyribonucleic acid (DNA) molecule consists of two long polynucleotide chains composed of four types of nucleotide subunits. The two chains are held together by [1] between the base portions of the nucleotides. Nucleotides are composed of a(n) [2] to which one or more phosphate groups and a nitrogen-containing base are attached. In the case of DNA nucleotides, the sugar is [3] attached to a single phosphate group, and the base may be either adenine, [4], thymine, or [5]. Adenine and [4] are two-ring bases which are called [6], and thymine and [5] are single-ring bases which are called [7]. The nucleotides are linked together in a chain through the sugars and phosphates by [8], which thus form a(n) [9] of alternating sugar-phosphate-sugar-phosphate.

The three-dimensional structure of DNA — the DNA double helix — arises from two polynucleotide chains and all the bases are on the inside of the double helix. In each base pair, a two-ring base, a(n) [6] is paired with a single-ring base, a(n) [7]. The members of each base pair can fit together within the double helix only if the two strands of the helix are antiparallel — that is, only if the polarity of one strand is oriented opposite to that of the other strand. A consequence of DNA's structure and base-pairing requirements is that each strand of a DNA molecule contains a sequence of nucleotides that is exactly [10] to the nucleotide sequence of its partner strand.

1. Fill in the blank ([1] – [10]) in passage (A) using the most suitable term from the list given below (A-W) and write down the corresponding letters in the designated spaces (I-1 (1) to (10)) on the answer sheet.

A. hydrogen bonds	B. guanine	C. backbone
D. xanthine	E. six-carbon sugar	F. glucose
G. subunits	H. ribose	I. sucrose
J. ionic bonds	K. uracil	L. five-carbon sugar
M. cytosine	N. quinoline	O. pyrimidine
P. covalent bonds	Q. side chain	R. peptide bonds
S. purine	T. deoxyribose	U. opposite
V. naphthalene	W. complementary	

(B) DNA molecules are present in cells. 1)Most of them in eukaryotic cells are known to be localized in the cell nucleus. However, there are exceptions, and 2)some organelles other than the cell nucleus, such as mitochondria, chloroplasts, and even Golgi apparatus, have DNA. The DNA molecules in the organelles are thought to be remnants of those held by another organism that had a symbiotic relationship during evolutionary processes. The most important role of DNA is to carry the genetic information that specifies the structures of all RNA molecules and proteins that make up a living organism. 3)In eukaryotes, nuclear DNA is stored in multiple chromosomes that can be observed with a microscope during cell division. Each chromosome contains a long string of DNA. 4)Genes that code for proteins make up the majority of the genes. However, there are many “RNA genes” — segments of DNA that generate functionally-significant RNA molecules, instead of proteins, as their final products. In humans, there are 46 chromosomes in a cell. 5)If the double helices comprising all 46 chromosomes in a human cell could be laid end to end, they would reach approximately 2,000 micrometers, yet the nucleus, which contains the DNA, is only about 6 micrometers in diameter. The cause of this difference has not yet been fully addressed.

2. Judge the correctness of the underlined sentences from 1) to 5) in passage (B), and write down the letter “T” for the correct sentence and the letter “F” for the incorrect one in the designated spaces (I-2 (1) to (5)) on the answer sheet.

II. Read the following three passages, (A) to (C), and answer the subsequent questions (1 – 4).

(A) 1) All living things on earth, including prokaryotes and eukaryotes, are categorized into autotrophs and heterotrophs. Autotrophs are capable of synthesizing organic compounds utilized for building their cellular constituents from inorganic compounds such as H₂O, CO₂, NH₃, and H₂S. For the synthesis of organic compounds, they need an energy source provided by light reaction or by chemical reaction through oxidation of inorganic compounds. On the other hand, heterotrophs synthesize their cellular constituents with organic compounds ultimately derived from autotrophs and thus depend on autotrophs for their own lives.

1. The following table shows a classification of organisms according to underlined part 1) in passage (A). Fill in the blank ([1] – [8]) in the table using the list of 8 unicellular organisms given below and write down the corresponding letters (A-H) in the designated spaces (II-1 (1) to (8)) on the answer sheet.

	Autotroph	Heterotroph
prokaryote	[1], [2]	[3], [4]
eukaryote	[5], [6]	[7], [8]

A. amoeba

B. *Chlamydomonas*

C. cyanobacteria

D. *Euglena*

E. lactic acid bacteria

F. methane bacteria

G. *Paramecium*

H. sulfur bacteria

(B) Plants are a large group of autotrophic organisms and carry out a light-driven fixation of CO₂ into carbohydrates known as photosynthesis. Photosynthesis occurs in two distinct processes designated the light reactions and the carbon (formerly dark) reactions. The site of photosynthesis in plant cells is [1], which is a member of subcellular organelles composed of a multi-membranous system. The envelope of [1] has two membranes, the outer and the inner. The inner membrane encloses a large space called the [2] containing various kinds of soluble enzymes involved in the [3] reactions. In the [2], a third membranous compartment called the [4] exists. The [4] is a highly folded membrane system and integrates several large complexes of membrane proteins involved in the [5] reactions. The [5] reactions generate ATP and NADPH, while the [3] reactions drive the synthesis of carbohydrates from CO₂ and H₂O using ATP and NADPH provided by the [5] reactions. The overall pathways of the [5] reactions and the [3] reactions are known as the [6] chain and the [7] cycle, respectively.

2. Fill in the blank ([1] – [7]) in passage (B) using the most suitable term from the list given below (A-M) and write down the corresponding letters in the designated spaces (II-1 (1) to (7)) on the answer sheet.

- | | | | |
|-----------------------|-------------|-----------|----------------|
| A. Calvin | B. channel | C. carbon | D. chloroplast |
| E. electron-transport | F. Krebs | G. light | H. microsome |
| I. mitochondrion | J. polysome | K. stroma | L. thylakoid |
| M. vacuole | | | |

(C) In most higher plants, atmospheric CO₂ taken up through stomata is initially fixed to form 3PG (3-phosphoglycerate), a three-carbon acid (C₃), which is then converted to sugars through subsequent metabolic pathways. 2) Certain species of plants, comprising several % of terrestrial plants, synthesize four-carbon acids (C₄), such as malate and aspartic acid, as the early products of CO₂ fixation. We name the former group of plants as C₃ plants and the latter one as C₄ plants. The C₄ acids are decarboxylated to release CO₂ at the later stage and the intracellular concentration of CO₂ in C₄ plants becomes higher than that in C₃ plants. Since the limiting factor for efficient CO₂ fixation by terrestrial plants is the concentration of CO₂ under atmospheric conditions, C₄ plants show a high ability of photosynthesis and grow faster than C₃ plants during hot and sunny seasons.

3. From the list given below (A-G), choose two plants belonging to the group of underlined part 2) in passage (C) and write down the corresponding letters in the designated spaces (II-3(1) to (2)) on the answer sheet.

A. maize (corn)	B. oat	C. rice	D. rye
E. sugarcane	F. sunflower	G. wheat	

4. Judge the correctness of the following descriptions (1) – (3) concerning C₄ plants, and write down the letter “T” for the correct sentence and the letter “F” for the incorrect one in the designated spaces (II-4(1) to (3)) on the answer sheet.

- (1) C₄ plants are found in several taxonomic families of flowering plants, suggesting that they have appeared due to convergent evolution in multiple lineages.
- (2) As described in passage (C), higher ability of photosynthesis of C₄ plants over C₃ plants becomes prominent under high temperature and high light. However, such advantageous characteristics of C₄ plants is hardly observed under drought.
- (3) The final products of CO₂ fixation in C₄ plants are sugars and starch. However, their chemical structures are largely different from those in C₃ plants.

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

In the Devon Period of the Paleozoic Era, [1] entered shallow and oxygen-poor water. They had lungs to breathe air and some species probably used stout fins to help them move on muddy bottoms. These fishes evolved to [2] with four limbs with digits. They diverged in the [3] Period and primitive [4] appeared among them. They laid shelled eggs on land. Their embryos grew in a(n) [5] protected by an eggshell. In the [6] Period, all the Earth's major landmasses were incorporated into a single supercontinent known as [7], where the land in the supercontinent became drier. The [4] with shelled eggs adapted to life in dry areas, diversified and became abundant. 1) The [6] Period ended the most extensive extinction event. Most marine and terrestrial species became extinct. In the [8] Period, synapsids and diapsids appeared and diversified. Synapsids later produced [9]. In the [10] and Cretaceous Periods, diapsids diversified and produced four groups such as dinosaurs, pterosaurs, ichthyosaurs, and plesiosaurs. However, in 2) the last mass extinction at the end of the Cretaceous Period, most large terrestrial and marine animals became extinct. After that, two groups survived and diversified. One group is [9] and another group is [11], a descendant of dinosaurs.

1. Fill in the blank ([1]–[11]) in the above passage with the most suitable term from the list given below (A-R) and write down the corresponding letters in the designated spaces (III-1(1) to (11)) on the answer sheet.

A. allantois

B. amnion

C. amphibians

D. birds

E. Cambrian

F. Carboniferous

G. Gondwana

H. Jurassic

I. Laurasia

J. lobe-fins

K. lungfishes

L. mammals

M. Ordovician

N. Pangea

O. Permian

P. reptiles

Q. Silurian

R. Triassic

2. From the list given below (A-F), choose two marine animal fossils that belong to the groups mentioned in the underlined part 1) in the passage above, and write down the corresponding letters in the designated spaces (III-2(1) to (2)) on the answer sheet.

A. ammonites	B. corals	C. Fusulina
D. sharks	E. stromatolites	F. trilobites

3. From the list given below (A-D), choose the main cause of extinction mentioned in the underlined part 2) in the passage above, and write down the corresponding letters in the designated space (III-3) on the answer sheet.

A. asteroid impact	B. flood basalt	C. global cooling
D. global warming		

IV. Read the following passage and answer the subsequent questions (1–2).

According to the biological species concept, a species is a group of [1] whose members have the potential to interbreed in nature and produce viable [2] offspring. Even if two species resemble in morphology but are reproductively isolated, they are different biological species. Many cryptic species have been discovered among morphologically similar forms by showing reproductive isolation. However, this concept does not apply to organisms that reproduce asexually, such as [3]. There is no way to evaluate the reproductive isolation of [4].

In this species concept, different species are designated by [5] of gene flow. Even if hybrids grew up, they became [6], such as a [7], the hybrid of a donkey and a horse. However, there are several pairs of species that are morphologically and ecologically distinct yet experience gene flow between them. Their hybrids are [2], such as the hybrid of a grizzly bear and a polar bear.

Speciation usually takes place with geographic separation. A geographic [8] prevents gene flows between two separated areas and promotes speciation. Once geographic separation had occurred, the gene pools continued to diverge.

1. Fill in the blank ([1]–[8]) in the above passage using the most suitable term from the list given below (A-L) and write down the corresponding letters in the designated spaces (IV-1(1) to (8)) on the answer sheet.

A. absence	B. bacteria	C. barrier
D. fertile	E. fossils	F. genes
G. individuals	H. infertile	I. mole
J. mule	K. populations	L. presence

2. From the list given below (A-I), choose each three causes of diversification of geographically separated populations, which are mentioned in the underlined part 1) of the passage above, and write down the corresponding letters in the designated spaces (IV-2(1) to (3)) on the answer sheet.

A. competition	B. genetic drift	C. interbreeding
D. mutations	E. natural selection	F. polyploidy
G. sexual selection	H. symbiosis	I. territory