

**AY2026 Entrance Examination for the Master's Program,
Graduate School of Bioagricultural Sciences, Nagoya University**

Subject chosen	Soil Science	For this subject Total pages (4) Page number (1)
-------------------	--------------	---

Answer all questions 1 through 4. Write your answers on separate sheets of paper for each question.

Question 1

Answer the following questions.

Question 1-1) What factors are responsible for differences in the rate of weathering of primary minerals? Explain using examples of minerals.

Question 1-2) Natural soils were classified into residual soils, transported soils, and colluvial soils with regard to their parent materials. Answer what type of soil each refers to.

Question 1-3) Explain the characteristics of Podzol profiles and the role of organic acids in their formation.

Question 1-4) Explain the following terms in soil science:
(1) allophane, (2) soil texture, (3) peat soil

AY2026 Entrance Examination for the Master's Program,
Graduate School of Bioagricultural Sciences, Nagoya University

Subject chosen	Soil Science	For this subject Total pages (4) Page number (2)
-------------------	--------------	---

Question 2

Read the following sentences and answer the following questions.

The primary source of soil organic matter is plant components. While some components, such as (a), are decomposed quickly in soil, others, such as (b), are decomposed slowly. A portion of the components with a slow decomposition rate is transformed to humic substances and accumulates in soil. Humic substances are generally classified into three fractions: the fraction soluble in alkali and insoluble in acid is called (c), the fraction soluble in both alkali and acid is called (d), and the fraction insoluble in both alkali and acid is called (e).

Question 2-1) Give a proper term to each of (a) to (e). Although (a) and (b) have more than two possible answers, give one of them.

Question 2-2) Soil organic matter becomes resistant to microbial decomposition by associating with clay minerals. Arrange the following clay minerals in order of higher accumulating potential of organic matter and explain the reasons for the different potentials.

(1) kaolinite, (2) imogolite, (3) smectite

Question 2-3) Humic substances can adsorb anions. Explain the adsorption mechanism.

AY2026 Entrance Examination for the Master's Program,
Graduate School of Bioagricultural Sciences, Nagoya University

Subject chosen	Soil Science	For this subject Total pages (4) Page number (3)
-------------------	--------------	---

Question 3

Answer the following questions.

Question 3-1) In general, the activity of soil fauna is higher in the soil of forests dominated by deciduous broad-leaved trees than in the soil of arable fields. Explain reasons for the different activities from multiple viewpoints.

Question 3-2) The plowed soil layer of a paddy field is differentiated into two layers after the field is flooded: an oxic thin surface layer with a few mm thickness and a reduced layer beneath.

3-2-1) Explain the reason why the plowed soil layer is differentiated into two layers after flooding.

3-2-2) Give two examples of chemoautotrophic microorganisms that are active in the oxic thin surface layer of flooded soils.

Question 3-3) Explain the following terms:

(1) ammonification, (2) rhizobia (root-nodule bacteria), (3) siderophore

AY2026 Entrance Examination for the Master's Program,
Graduate School of Bioagricultural Sciences, Nagoya University

Subject chosen	Soil Science	For this subject Total pages (4) Page number (4)
-------------------	--------------	---

Question 4

Read the following sentences and answer the following questions.

Plants can absorb water only when the water potential of their roots is lower than that of the soil (a). Roots accomplish this by lowering the (b) within the cells. When the root water potential falls below the critical level, (c) is lost and root cells collapse. The soil moisture content at this point is called (d).

The rate of water movement in soil is expressed by the law of (e) as follows:

$$Q = K (\Delta \Psi / \Delta x)$$

where, K is the (f), and $\Delta \Psi / \Delta x$ is called the (g). K is influenced by the soil porosity.

Question 4-1) Give a proper term to each of (a) to (g).

Question 4-2) Explain the classification of soil water based on its states with indicating the order of susceptibility to loss during the drying process.

Question 4-3) Answer what components make up the three-phase distribution of soil. Also, state which component(s) the underlined part "A" consists of.

**AY2026 Entrance Examination for the Master's Program,
Graduate School of Bioagricultural Sciences, Nagoya University**

Subject chosen	Soil Science
----------------	--------------

Question 1-1) Example :

The weathering rate of primary minerals depends on the complexity of their silica structure and constituent elements. Quartz and feldspar with three-dimensional silica structures weather most slowly, followed by mica with a two-dimensional structure, and then hornblende and pyroxene with chain structures. The amount and type of metal ions also affect weathering rates. For example, feldspars containing K, Na, or Ca weather faster than quartz, which consists solely of silica. Among micas, biotite, which contains Mg and Fe, weathers faster than muscovite, which contains K and Al.

Question 1-2) Example :

Soils developed from bedrock located directly beneath them are called "residual soil", whereas soils formed from volcanic ash transported by wind or sediment transported by water are called "alluvial soil". Soils deposited by landslides or sheet erosion are called "colluvial soil".

Question 1-3) Example: The profile of Podzols is characterized by the presence of an E-horizon (eluvial horizon) beneath the A-horizon, followed by either a Bh-horizon (humus accumulation horizon) or a Bs-horizon (iron accumulation horizon). During its formation process, organic acids play a role in the formation of the E-horizon by forming complexes with iron and aluminum in the A-horizon and leach them out. Colored organic acids, such as fulvic acid, also contributes to the formation of the E-horizon by migrating downward themselves.

Question 1-4) Examples:

- (1) An amorphous aluminosilicate mineral that consists of the primary clay mineral in volcanic ash soil (Andosol). It is granular and possesses microporosity. It has a large surface area and exhibits high cation exchange capacity and organic matter adsorption capacity.
- (2) The composition of sand, silt, and clay when the total weight of the three particle size fractions is regarded as 100%.
- (3) Organic soil primarily consisting of peat-partially decomposed remains of wetland plants.

Question 2-1)

- a starch, hemicellulose, cellulose, protein, etc.
- b lignin, suberin, cutin, etc.

- c humic acid
- d fulvic acid
- e humin

Question 2-2)

imogolite > smectite > kaolinite

Reasons: The specific surface area increases in this order. Smectite has higher swelling ability than kaolinite and can facilitate interlayer adsorption of organic matter.

Question 2-3)

Ionic adsorption to basic functional groups at low pH

Question 3-1)

Since a litter layer accumulating fallen leaves and branches is formed on the soil surface of forests dominated by deciduous broad-leaved trees, the amount of foods for macrofauna and mesofauna is abundant in forests than in arable fields. In addition, physical disruption by plowing and pesticide use in arable fields negatively affect the activity of soil fauna. The soil surface is easily exposed to drying stress and light irradiation. For these reasons, macrofauna and mesofauna are more active in forest soils.

Question 3-2)

Since the diffusion rate of O₂ is very slow under flooded conditions, the majority of the plowed soil layer shifts to reduced conditions, where anaerobic microorganisms predominate, after flooding. However, trace amounts of O₂ are supplied from surface water to the soil surface. Phototrophic organisms produce O₂ in surface water. Therefore, a paddy soil is differentiated into oxic and reduced layers after flooding.

Question 3-3)

(1) Ammonification is the process by which organic nitrogen in proteins and others is mineralized by microorganisms, resulting in the production of ammonia.

(2) Rhizobia (root-nodule bacteria) are symbiotic bacteria that form nodules on leguminous plants. They supply ammonia to host plants by fixing molecular nitrogen using energy provided by the host plants.

(3) Siderophores are chemical compounds that dissolve ferric iron compounds by chelating. Certain bacteria and fungi produce siderophores to absorb iron in neutral and alkaline soils, where ferric iron compounds dominate.

Question 4-1)

- a matric potential
- b osmotic pressure

- c swelling pressure (turgor pressure)
- d permanent wilting point
- e Darcy
- f hydraulic conductivity
- g hydraulic gradient

Question 4-2) Water present in macro-pores is called *gravitational water*; water held in capillary pores by surface tension is called *capillary water*; and water adsorbed onto the surfaces of soil particles is called *hygroscopic water*. These forms of water are lost from the soil in this order.

Question 4-3) The three-phase distribution of soil consists of the ratios of the gaseous, liquid, and solid phases. Porosity is the combined ratio of the gaseous and liquid phases.

出題意図

Question 1: Evaluate knowledge regarding soil materials, generation, and characteristics

Question 2: The questions examine fundamental knowledge of soil chemical properties, with special emphasis on soil organic matter.

Question 3:

Question 4: This question examines fundamental knowledge of soil physical properties, with particular emphasis on the states and movement of water and on the soil characteristics that govern these processes.