※ 注意：請於試卷內之「非選擇題作答區」依序作答，並應註明作答之大題及小題題號。

1. Please translate the following paragraph into Chinese (15%)

The aromatic amino acids (aroAAs) L-phenylalanine (Phe), L-tyrosine (Tyr) and L-tryptophan (Trp) serve as fundamental building blocks of proteins and diverse secondary metabolites across all life. These molecules are produced by organisms on a massive global scale—lignin synthesis, for example, drives 20–30% of all photosynthetically fixed carbon through the pathways of aroAA biosynthesis. Despite some differences in the arrangement of the biosynthetic pathways and their modes of regulation across organisms, all de novo biosynthesis of these aroAAs relies on a universally conserved set of chemical transformations to convert chorismate—the common aromatic precursor—into Phe, Tyr and Trp. These chemistries are ancient and likely existed in some of the earliest ancestors in the tree of life. (Adapted from Nature Chemical Biology, 2024, 20: 1086-1093)

2. Please translate the following paragraph into Chinese (15%)

ADP-ribosylation is a ubiquitous modification of biomolecules, including proteins and nucleic acids, that regulates various cellular functions in all kingdoms of life. The recent emergence of new technologies to study ADP-ribosylation has reshaped our understanding of the molecular mechanisms that govern the establishment, removal, and recognition of this modification, as well as its impact on cellular and organismal function. These advances have also revealed the intricate involvement of ADP-ribosylation in human physiology and pathology and the enormous potential that their manipulation holds for therapy. In this review, we present the state-of-the-art findings covering the work in structural biology, biochemistry, cell biology, and clinical aspects of ADP-ribosylation. (Adapted from Cell, 2023, 21: 4475-4495)

3. Please translate the following paragraph into Chinese (20%)

Iron is an essential nutrient for the growth, survival and virulence of almost all bacteria. To access iron, many bacteria produce siderophores, molecules with a high affinity for iron. Research has highlighted substantial diversity in the chemical structure of siderophores produced by bacteria, as well as remarkable variety in the molecular mechanisms involved in strategies for acquiring iron through these molecules. The metal-chelating properties of siderophores, characterized by their high affinity for iron and ability to chelate numerous other metals (albeit with lower affinity compared with iron), have also generated interest in diverse fields. Siderophores find applications in the environment, such as in bioremediation and agriculture, in which emerging and innovative strategies are being developed to address pollution and enhance nutrient availability for plants. Moreover, in medicine, siderophores could be used as a tool for novel antimicrobial therapies and medical imaging, as well as in haemochromatosis, thalassemia or cancer treatments. This Review offers insights into the diversity of siderophores, highlighting their potential applications in environmental and medical contexts. (Adapted from Nature reviews microbiology, 2025, 23: 24-40)

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4. **Please translate the following paragraph into Chinese (10%)**

Plant–microbe interactions (PMIs) are regulated through a wide range of mechanisms in which sterols from plants and microbes are involved in numerous ways, including recognition, transduction, communication, and/or exchanges between partners. Phytosterol equilibrium is regulated by PMIs through expression of genes involved in phytosterol biosynthesis, together with their accumulation. As such, PMI outcomes also include plasma membrane (PM) functionalization events, in which phytosterols have a central role, and activation of sterol-interacting proteins involved in cell signaling. In spite (or perhaps because) of such multifaceted abilities, an overall mechanism of sterol contribution is difficult to determine. However, promising approaches exploring sterol diversity, their contribution to PMI outcomes, and their localization would help us to decipher their crucial role in PMIs.
(Adapted from Trends in Plant Science, 2024, 29: 524-534)

5. **Please translate the following paragraph into Chinese (20%)**

Understanding of how soil organic matter (SOM) chemistry is altered in a changing climate has advanced considerably; however, most SOM components remain unidentified, impeding the ability to characterize a major fraction of organic matter and predict what types of molecules, and from which sources, will persist in soil. We present a novel approach to better characterize SOM extracts by integrating information from three types of analyses, and we deploy this method to characterize decaying root-detritus soil microcosms subjected to either drought or normal conditions. To observe broad differences in composition, we employed direct infusion Fourier-transform ion cyclotron resonance mass spectrometry (DI-FT-ICR MS). We complemented this with liquid chromatography tandem mass spectrometry (LC-MS/MS) to identify components by library matching. Since libraries contain only a small fraction of SOM components, we also used fragment spectral cosine similarity scores to relate unknowns and library matches through molecular networks. This integrated approach allowed us to corroborate DI-FT-ICR MS molecular formulas using library matches, which included fungal metabolites and related polyphenolic compounds. We also inferred structures of unknowns from molecular networks and improved LC-MS/MS annotation rates from ~5 to 35% by considering DI-FT-ICR MS molecular formula assignments. Under drought conditions, we found greater relative amounts of lignin-like vs condensed aromatic polyphenol formulas and lower average nominal oxidation state of carbon, suggesting reduced decomposition of SOM and/or microbes under stress. Our integrated approach provides a framework for enhanced annotation of SOM components that is more comprehensive than performing individual data analyses in parallel. (Adapted from Analytical Chemistry, 2024, 96: 11699-11706)

6. **Choose the correct answer for each question after reading the paragraphs below (20%)**

Soil minerals and metals

Bacteria and archaea have evolved enzymatic pathways that enable them to use various metal ions to harvest reducing equivalents and generate energy. Iron, as the fourth most abundant element in the earth crust, has a prominent role in this regard. Although oxidized iron, that is, Fe(III), can be used as an alternative electron acceptor to O_2 for respiration under anoxic conditions, the reduced Fe species, that is, Fe(II), can be used as an electron donor coupled to the enzymatic reduction of O_2, nitrate or even CO_2 in anoxygenic photosynthesis. For example, anaerobic methane oxidation by archaea with Fe(III) acting as an electron acceptor and subsequent Fe(II) accumulation has been reported in paddy soils and flooded forests. As the solubility of iron at circumneutral pH conditions varies with the redox state, Fe(II) generally being more soluble than Fe(III), the redox transformation of iron is often associated with mineral precipitation or mineral dissolution with consequences for soil redox and sorption properties. Likewise, manganese, and even toxic metals such as uranium and chromate, can be oxidized and reduced. As their solubility varies depending on their redox state (dissolved Mn(II), Cr(VI), U(VI) versus precipitated MnO_2, Cr_2O_3, UO_2), microbial redox transformations of these metals also determine their solubility and bioavailability.

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As a consequence, their toxicity or their availability as electron acceptors or donors thus influences the ecological responses of soil microorganisms. Fe(II)-oxidizing and Fe(III)-reducing bacteria are also known to produce mixed-valent redox-active minerals such as magnetite (Fe_3O_4 with an ideal stoichiometry of Fe(II):Fe(III) of 1:2) or green rust phases; that is, sulfate-bearing, chloride-bearing or carbonate-bearing layered Fe(II)–Fe(III)-containing minerals. These minerals are reactive and further transform into other phases such as goethite over time. Because they can contain varying ranges of Fe(II)/Fe(III) ratios, they also possess a broad range of redox potentials (from reducing to oxidizing), which enables a diverse community of soil microorganisms to use these minerals either as electron donors or as acceptors. Consequently, the microbial formation of such reactive, meta-stable minerals can affect soil redox and sorption processes. (Adapted from Nature Review Microbiology, 2024, 22: 226-239)

(1) According to the passage, why is iron (Fe) considered significant for bacteria and archaea in soil environments?

(A) Because Fe(III) completely replaces the need for O_2 under all conditions.
(B) Because Fe is the most abundant element in Earth's crust.
(C) Because Fe can serve as either an electron acceptor (Fe(III)) or donor (Fe(II)) in microbial respiration.
(D) Because Fe is the only metal that can undergo redox reactions in soil.

(2) "Fe(II)-oxidizing and Fe(III)-reducing bacteria are also known to produce mixed-valent redox-active minerals." In this context, what does "mixed-valent" most closely mean?

(A) Containing a mixture of different metal elements.
(B) Having more than one oxidation state of the same metal present.
(C) Possessing no fixed molecular structure.
(D) Forming completely stable mineral phases under all conditions.

(3) What happens to metals such as manganese (Mn), uranium (U), or chromate (Cr) when their redox states change?

(A) They lose their toxicity entirely.
(B) They remain chemically unchanged but gain color.
(C) Their solubility and bioavailability can be altered significantly.
(D) Their role in microbial energy generation is not affected.

(4) Based on the passage, which of the following descriptions about microbial redox transformations is accurate?

(A) Fe(II) is always more insoluble than Fe(III), and thus cannot participate in soil redox processes.
(B) Microbial formation of reactive, meta-stable minerals may influence soil redox and sorption properties.
(C) Toxic metals like uranium or chromate cannot be reduced by bacteria or archaea.
(D) Iron's redox transformation is unrelated to mineral precipitation or dissolution in soils.

(5) According to the passage, which statement about anoxygenic photosynthesis is correct?

(A) It only occurs in the presence of abundant O_2.
(B) It can utilize Fe(II) as an electron donor to reduce CO_2.
(C) It cannot happen in flooded soils.
(D) It requires high concentrations of nitrate to proceed.

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