※ 注意：請於試卷內之「非選擇題作答區」作答，並應註明作答之題號。

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

Five different resistant starch types have been frequently referred in the literature, depending on their interaction pattern with the starch digestive enzymes in the human upper gastrointestinal tract. Resistant starch type 1 (RS1) is commonly referred to as the physically inaccessible starch, such as those entrapped in the cell wall capsule and storage protein matrix of whole legumes and grains. The encapsulation materials act as the physical barriers, inhibiting the free access of starch toward the digestive enzymes in human upper gastrointestinal tract. Resistant starch type 2 (RS2) is defined as the native starch granules, typically with B- or C-type crystallinity polymorph. This is due to the dense compaction of semi-crystalline double helices in these granules, which has a low binding affinity toward the starch digestive enzymes. Resistant starch type 3 (RS3) is called the retrograded starch, which is formed after a certain cooling period by gelatinized starch. RS3 is formed due to the low catalytic activity of starch digestive enzymes toward starch double helices, as well as the physical barriers of retrograded gel matrix against the diffusion of starch digestive enzymes. Resistant starch type 4 (RS4) is the chemically modified starch, because the functional groups can block the starch access to the digestive enzymes. Finally, resistant starch type 5 (RS5) is the amylose-lipid complex, which has a similar resistant mechanism toward starch digestive enzymes as RS3. (Adapted from Critical Reviews in Food Science and Nutrition, 2023, 63, 6412-6422)

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

Microbes can contribute to slowing down the depletion of non-atmospheric carbon reservoirs, in particular, the use of fossil fuels. Microbes can be harnessed to produce fuel compounds (e.g., hydrocarbons and H_2), precursors of fuel (e.g., fats and fatty acids), or other diverse chemicals conventionally produced from petroleum (e.g., plastics and other building block chemicals of petrochemical industries) consuming renewable carbon sources derived from biomass or waste materials or even from CO_2 and CH_4. Such microbial cell factories facilitate the sustainable flow of carbon within the terrestrial reservoir or between the terrestrial and atmospheric reservoirs, providing an alternative route for manufacturing products instead of pumping out carbon from the Earth's crust (i.e., petroleum) to the atmosphere. (Adapted from Environmental Microbiology, 2023, 25, 17-25)

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

Flavonoids have many health benefits but have limited bioavailability due to low permeability across the apical surface of intestinal epithelial cells. We adopted a lipid-based delivery system (LNPs) to overcome this problem. As mentioned previously, the LNP system is degraded in the intestine by bile salts and digestive enzymes, which results in the formation of mixed micelles. Flavonoids incorporated into LNPs would solubilize well in these micelles, whereas a native flavonoid would not be easily taken up by intestinal epithelial cells. The micelles amassed at the epithelial surface are absorbed by enterocytes, which would increase the quantity of bioaccessible and bioavailable flavonoids. The flavonoid bioaccessibilities (%) of the fabricated LNP samples were greater than that of the native flavonoid, regardless of the type (quercetin, ~12-fold; naringenin, ~5-fold; hesperetin, ~5-fold). The high bioaccessibility of the quercetin-loaded LNPs may be due to the considerable hydrophobicity ($\log P = 2.74$). These results were in agreement with previously reported research in cases of curcumin and genistein.

The antioxidant activity of flavonoids is sensitive to pH and salt, which could decrease the therapeutic benefit due to the dramatic changes in pH and ion concentrations encountered during oral digestion. The LNPs were incubated with in vitro media without enzymes during digestion tests (mouth, stomach, and small intestine) to evaluate the protectibility of flavonoid-loaded LNPs. During the serial digestion test, the protectability values of quercetin-, naringenin-, and hesperetin-loaded LNPs decreased to 97, 96, and 95%, respectively, which meant

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successful protection of the flavonoids by the LNP system against harsh conditions such as low pH and high concentration of salts. In vitro degradation of other bioactive materials (curcumin and genistein) has also been reported at similar levels. Therefore, our LNP system protected the flavonoids from pH and salt changes during digestion, and the protected flavonoids could maintain their antioxidant activity. (Adapted from Journal of Agricultural and Food Chemistry, 2015, 63, 5266–5272)

(1) What was the problem the authors dealt with in this study?
  (A) The antioxidant activity of flavonoids is low.
  (B) The antioxidant activity of flavonoids is sensitive to pH and salt.
  (C) Flavonoids have limited bioavailability.
  (D) Flavonoids cannot be delivered by a lipid-based delivery system.

(2) "The micelles amassed at the epithelial surface are absorbed by enterocytes ". What does "amassed" mean?
  (A) located
  (B) accumulated
  (C) attracted
  (D) merged

(3) What happened when flavonoids were incorporated into LNPs?
  (A) Only quercetin, naringenin, and hesperetin, but not curcumin and genistein, can be protected from degradation in the intestine by bile salts and digestive enzymes.
  (B) The therapeutic benefit of flavonoids decreased.
  (C) The antioxidant activity of the fabricated LNP samples was lower than that of the native flavonoid.
  (D) The flavonoid bioaccessibilities of the fabricated LNP samples were greater than that of the native flavonoid.

(4) According to the paragraph, which description is accurate?
  (A) Flavonoids were successfully protected by the LNP system against harsh conditions such as low pH and high concentrations of salts.
  (B) During digestion tests, flavonoid-loaded LNPs were provided in the animal diets.
  (C) The high bioaccessibility of the quercetin-loaded LNPs may be due to the low hydrophobicity.
  (D) Unlike flavonoids incorporated into LNPs, native flavonoids can not be taken up by intestinal epithelial cells.

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

Losses of soil organic carbon (SOC) could accelerate global warming, whereas the sequestration of carbon dioxide (CO_2) into soils in the form of SOC holds promise for mitigating climate change. The processes involved in the formation and preservation of organic carbon in soil have been subjects of debate for over a century. A classical paradigm emphasizes the roles of plant carbon inputs and soil organic matter decomposition in driving SOC storage and persistence. The rates of plant primary production govern the quantity of organic carbon introduced to soils through processes such as litterfall, root turnover, and exudation. Simultaneously, the decomposition of organic matter, primarily controlled by microorganisms, plays a crucial role in determining the rate of SOC loss. These microorganisms break down organic matter, releasing carbon into the atmosphere as CO_2. Tremendous efforts have been made to track the quantity and decomposability of external carbon sources to soils and their rate of decomposition, variations in space and time, and the interactions with complex local environments (for example, temperature, moisture, and the soil mineral matrix). Despite these efforts, a comprehensive understanding of these controls has not yielded substantially improved quantification of SOC

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storage. The mechanisms underlying the magnitude of global SOC storage and its spatial distributions remain largely unknown, hindering reliable projections of terrestrial biosphere feedback to a changing climate. (Adapted from Nature 2023, 618, 981–985)

5. Please translate the following paragraph into Chinese (30%)

The continuous rice–wheat (R–W) system is the predominant cropping practice in South Asia, currently facing sustainability challenges. These challenges encompass nutrient mining, degradation of soil quality, and depletion of groundwater resources. The continuous cereal-cereal rotations without species diversification and prudent fertilizer application have raised serious concerns regarding nutrient use efficiency. Nitrogen (N) and phosphorus (P) are crucial nutrients for crop cultivation. In Indian agriculture, P is often regarded as the "king-pin" and an indispensable component of the "energy currency" within plants. Despite its significance, P deficiency substantially constrains crop yields, particularly in tropical agro-regions, with N as another limiting factor. In particular, P deficiency is widespread in R–W systems and P recovery efficiency is often documented to be below 30%. Soil samples collected from 257 districts out of 500 districts (51%) across India showed low available P. Furthermore, the critical limit of P in rice and wheat ranges between 10.6–11.8 mg kg^{-1} and 3.3–7.9 mg kg^{-1} in the alluvial soil, respectively, and the soil's inability to supply the required P level leads to lower crop yield. The availability of P in the soil and its dynamic composition have been linked to several soil chemical properties, including pH, as well as the relative abundance of calcium (Ca), iron (Fe), and aluminum (Al) compounds. Additionally, microbial activity and moisture conditions play important roles in determining soil P bioavailability. In alkaline soils, the primary determinant of soil P availability is often the presence of various Ca compounds, such as calcium carbonate. The speciation of P in the soil solid phase is a vital method for assessing the relative abundance of inorganic P (Pi) and organic P (Po), particularly in calcareous soils where Po constitutes the dominant pool, accounting for approximately 80% of the total P content. In lowland rice systems, where flooding-induced P dissolution is a common phenomenon, soil-P fractionation would be an excellent approach for examining the inter-conversion among different Pi and Po fractions and their relationships with P availability. Given the compelling evidence from previous studies, an insight into soil processes related to long-term soil/crop management practices in rice production systems is vital for developing crop/nutrient management options to sustain soil fertility. (Adapted from Scientific Reports 2024, 14, 65)

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