問題①　Question①

Read the article and answer the following questions in English.

The text of the question has been omitted for copyright protection. Please refer to the following sources.

(From Luo Y and Stent S, et al, News and Views *Nature* 626, 724-725 (2024))

Question①

1. Answer the following question within 40 words each.

(1) What three main environmental factors did Saint-André and colleagues' study identify as having significant effects on cytokine variability, comparable to genetics and age?

(2) How does smoking exert long-term effects on the adaptive immune system, according to the study?

2. According to the article, are the following statements True or False? Circle "True" or "False" on the answer sheet.

(1) Cytokines are released by pathogens to help the body fight infections.

(2)　Smoking affects both the innate and adaptive branches of the immune system.

(3) DNA methylation increases as a result of smoking, leading to higher cytokine production.

(4) The cytokine CXCL5 and the protein CEACAM6 are both found at elevated levels in the blood of smokers.

問題②　Question②

Read the article and answer the following questions in English.

The text of the question has been omitted for copyright protection. Please refer to the following sources.

(Modified from Brestoff, J.R. *et al.* Recommendations for mitochondria transfer and transplantation nomenclature and characterization. *Nat Metab* 2025, **7**, 53–67.)

Question②

1. Answer the following questions within 40 words each.

   (1) Briefly explain functional benefits of mitochondrial transfer for recipient cells.
   (2) What are the major challenges that need to be addressed before mitochondrial transfer can be safely used in clinical applications?
   (3) Why is mitochondrial transfer considered potentially useful in regenerative medicine?

2. Are the following statements True or False? Circle “True” or “False” in the parentheses on the answer sheet.

   (1) Mitochondria transfer only occurs during cell division.
   (2) Connexin-43 may help form gap junctions involved in mitochondrial transfer.
   (3) Transferred mitochondria always integrate seamlessly with the host cell’s genome.
   (4) Stem cells can donate mitochondria to damaged heart tissue in experimental models.

問題③　Question③

Read the article and answer the following questions in English.

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(From Helena Kudiabor, Virtual lab powered by ‘AI scientists’ super-charges biomedical research, *Nature* 636, 532-533 (2024))

Question③

1. Answer the following questions within 40 words each.

(1) What goal did the authors give to the LLMs in the virtual laboratory?

(2) According to James Zou, what is the focus of human researchers in the virtual lab?

2. According to this article, which of the following statements are True or False? Circle "True" or "False" on the answer sheet.

(1) The virtual laboratory system was able to design over 100 nanobody structures that can bind to the COVID-19 virus.

(2) Yanjun Gao believes that AI can be fully trusted to make scientific decisions without human oversight at the current stage.

(3) The virtual lab created by Zou and his colleagues focused on applying LLMs to experiments with a very narrow scope.

(4) The AI agents in the virtual lab could utilize other existing AI research tools like AlphaFold.

(5) The study found that none of the nanobodies designed by the AI system were effective against newer variants of the SARS-CoV-2 virus.

Answers to Question①

1. （各 30 点）

（1）Smoking, cytomegalovirus infection, and body mass index (BMI) were identified as the main environmental contributors to cytokine variability.

（2）Smoking causes DNA methylation changes that alter gene expression related to immune signalling and metabolism, leading to lasting effects on adaptive cytokine responses.

2.（各 10 点）

(1) False

(2) True

(3) False

(4) True

Answers to Question ②

1. （各 20 点：計 60 点）

(1) Mitochondrial transfer provides energy to stressed or damaged cells, helping them avoid apoptosis and regain function. This benefit is especially important in tissues such as the heart or brain after injury.

(2) Major challenges include preserving mitochondrial integrity, achieving targeted delivery to specific tissues, and preventing immune responses that could reject or damage the transplanted mitochondria.

(3) Mitochondrial transfer is useful in regenerative medicine because it restores bioenergetics, supports damaged cells, reduces oxidative stress, and promotes tissue repair. It helps reverse cellular dysfunction, especially in heart and nerve tissues, enabling recovery after injury or disease.

2. （各 10 点：計 40 点）

(1) False

(2) True

(3) False

(4) True

Answers to Question ③

1. 各 25 点

(1) The authors' goal for the LLMs was to design new nanobodies to target the SARS-CoV-2 virus and instruct them to develop other LLMs to achieve it.

(2) James Zou says the human researchers focus on providing more high-level feedback to guide the direction of the virtual lab.

2. 各 10 点

(1) False

(2) False

(3) False

(4) True

(5) False