2021 年度
大学院理工学研究科【生命理学専攻】博士前期課程
一般選抜試験(第Ⅰ期) 問題

英　　語

開始時刻　午前 10 時 30 分
終了時刻　午前 11 時 30 分

【注意事項】

１．答案用紙には受験番号、氏名を必ず記入してください。
２．問題番号を明記された答案用紙を使用して解答してください。
３．配布された答案用紙は試験が終了したら、必ず提出してください。
（問題用紙は提出する必要はありません）

問１：次の文章を読んで、下の問い（１）～（５）に答えなさい。

Global Carbon Dioxide (CO_2) emissions are expected to decline eight per cent to 30.6 gigatonnes (Gt) in 2020, reaching levels last seen in 2010, International Energy Agency said as part of its Global Energy Review 2020. The report highlighted that not only are annual CO_2 emissions in 2020 set to decline at an unprecedented rate, the decline is also expected to be almost twice as large as all previous declines since the end of World War II. a)"Such a reduction would be the largest ever, six times larger than the previous record reduction of 0.4 Gt in 2009 due to the financial crisis and twice as large as the combined total of all previous reductions since the end of World War II," the report noted.

The report has attributed the decline in emissions to the steep decline in energy demand during the first quarter of 2020. b)CO_2 emissions fell more than energy demand, as the most carbon-intensive fuels experienced the largest declines in demand during Q1 2020. Global CO_2 emissions were over 5 per cent lower in the first quarter of 2020 as compared to the corresponding quarter in 2019, mainly due to an eight per cent decline in emissions from coal, 4.5 per cent from oil and 2.3 per cent from natural gas.

c)According to the report, CO_2 emissions declined the most in the regions that suffered the earliest and largest impacts of Covid-19. Of the almost 2.6 Gt reduction in CO_2 emissions expected in 2020, reduced coal use would contribute over 1.1 Gt, followed by 1 Gt from oil and 0.4 Gt from gas. The United States is expected to undergo the largest absolute declines at around 600 Mt, with China and the European Union not far behind. d)The report cautioned that the rebound in emissions subsequently may be larger than the decline, unless the wave of investment to restart the economy is dedicated to cleaner and more resilient energy infrastructure.

(Source: Cited from "Global CO_2 emissions to decline 8 per cent in 2020, surpassing any previous declines: IEA", Energyworld.com, May 4, 2020.)

（１）下線部 (a) を日本語に訳しなさい

（２）下線部 (b) の理由は何だと書かれているか。またそのような事態を引き起こした、2020 年特有の背景について因果関係が分かる様に説明しなさい。

（３）下線部 (c) を日本語に訳しなさい

（４）下線部 (d) を日本語に訳しなさい

（５）下線部 (d) の cleaner and more resilient energy infrastructure とは具体的にどの様なものを指すか、例を挙げて説明しなさい

問 2：次の文章を読んで、下の問い（1）～（5）に答えなさい。

The DNA in a cellular organelle called the mitochondrion encodes just 13 proteins, all of which are involved in generating the cell's energy supply. Mutations in mitochondrial DNA (mtDNA) can cause a range of incurable, life-limiting metabolic diseases in humans. (a)The development of tools for editing mtDNA has therefore been a long-sought goal in mitochondrial genetics. Writing in Nature, Mok *et al.* report a molecular tool that for the first time enables precise editing of mtDNA. Key to this achievement was the discovery of a toxin secreted by bacteria to kill neighbouring bacteria.

The bacterial toxin discovered by Mok *et al.* is a cytidine deaminase enzyme called (b)DddA, which catalyses the conversion of the nucleotide base cytosine (C) to another base, uracil (U). A remarkable feature of DddA is that it targets double-stranded DNA, [c] all previously identified cytidine deaminases target single-stranded DNA. Crucially, although conventional genome-editing approaches involve nuclease enzymes that act as molecular scissors to cut DNA on both strands, DddA converts C to U without inducing double-strand DNA breaks. This makes it particularly well suited to editing the mitochondrial genome, which lacks efficient mechanisms for repairing double-strand DNA breaks.

(d)The researchers had to overcome several challenges to repurpose DddA for mitochondrial genome editing. Chief among these is the fact that cytidine deaminase is toxic to mammalian cells. Mok *et al.* split the toxin domain of DddA into two inactive parts called split-$DddA_{tox}$ halves. They fused these halves to mitochondrial targeting signal, TALE, containing proteins, which can be engineered to bind to specified DNA sequences. Binding of the two TALEs to mtDNA brings together, and so activates, the split-$DddA_{tox}$ halves.

(Source: Modified from Nature, "Mitochondrial genome editing gets precise", July 8, 2020.)

（1）下線部 (a) を和訳しなさい。

（2）下線部 (a) 文中に"a long-sought goal"と書かれている理由を日本語で説明しなさい。

（3）下線 (b) の酵素 DddA の働きについて、その酵素の触媒反応、同種の他の酵素との機能的違い、そしてゲノム編集の酵素としてユニークな点について日本語で説明しなさい。

（4）文章中の[c]に入る最も適切な語句を、次の i.～iv.のうちから一つ選びなさい。

i. although　　ii. therefore　　iii. whereas　　iv. or

（5）下線部 (d) について、DddA がもつ問題のうち主となる問題とは何か、またそれを研究者がどのように克服したかを日本語で説明しなさい。

問 3：次の語群から1つだけを選び、その概要を英語で説明しなさい。少なくとも 50 語以上書くこと。

(a) 大気汚染（Air pollution）

(b) 生態系（Ecosystem）

(c) 突然変異 (mutation)

(d) 減数分裂 (meiosis)

(e) 細胞呼吸　(cellular respiration)