

1 次の英文は確率について書かれた文章の一部である。これを読んで以下の設問に答えなさい。

In order to illustrate the randomness, I will show a simple experiment. It is ^(A) taken from the field of games of chance; this is only because experiments on subjects belonging to other fields in which the theory of probability finds its application require apparatus much too elaborate to be shown here.

I have a bag containing ninety round disks, bearing the numbers 1 to 90. I extract one disc from the bag at random, I note whether the number it bears is an or an one and replace the disc. I repeat the experiment 100 times and denote all the numbers by 1's, and all numbers by 0's. The following table shows the result:

1	1	0	0	0	1	1	1	0	1
0	0	1	1	0	0	1	1	1	1
0	1	0	1	0	0	1	0	0	0
0	1	0	0	1	0	0	1	1	1
0	0	1	1	0	0	0	0	1	1
0	1	1	1	1	0	1	0	1	0
1	0	1	1	1	1	0	0	1	1
0	0	1	1	0	1	1	1	0	1
0	0	1	1	0	0	1	1	0	1
0	1	1	0	0	0	1	0	0	0

Among 100 experimental results we find fifty-one 1's; in other words, the relative frequency of the result 1 is 51/100. If we consider only the first, third, fifth draw, and so forth, i.e., if we take only the figures in the columns of the table, we find that 1's appear in twenty-four cases out of fifty; the relative frequency is 24/50. Using only the numbers in the horizontal rows of the table, we obtain, for the relative frequency of the result 1, the value / . We may further consider only those results whose place in the sequence

corresponds to one of the prime numbers, i.e., 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89 and (F). These twenty-five draws have produced twelve 1's, the relative frequency is thus $12/25$. Finally, ^(G) we may consider the 48 draws following a result 0. We find in this selection of results twenty-six 1's, i.e., the relative frequency $26/48$. These calculations show that, in all the different selections which we have tried out, the 1's always appear with a relative frequency of about $1/2$. I trust that this conveys the feeling that more extensive experiments, which I am not able to carry out here because of the lack of time, would demonstrate the phenomenon of randomness still more strikingly.

It is of course possible, after knowing the results of the hundred draws, to ^(H) indicate a method of selection which would produce only 1's, or only 0's, or 1's and 0's in any desired proportion. It is also possible that in some other group of a hundred experiments, analogous to the one just performed, one kind of selection may give a result widely different from $1/2$. The principle of randomness requires only that the relative frequency should converge to $1/2$ when the number of results in an arbitrarily selected partial sequence becomes larger and larger.

(注)

analogous : 類似の

apparatus : 器材

arbitrarily : 任意に

column : 縦列

convey : 伝える

converge : 収束する

draw : 引くこと

設 問

- (1) 下線部(A)は具体的に何を指すか。90字以内の日本語で説明しなさい。
- (2) , に入れる適切な単語を次の中から選びなさい。ただし同じ記号で示した箇所には同一の単語が入るものとする。
natural, even, complex, real, perfect, odd
- (3) , , に適切な数値を入れなさい。
- (4) 下線部(G)において、文中の語句 result 0 を result 1 に変える。このとき、本文の内容と矛盾しないためには、下線部(G)全体をどのように書き換えればよいか。英文で記述しなさい。
- (5) 下線部(H)を和訳しなさい。

2 次の英文は金属の水溶液中での腐食速度について書かれたものの一部である。これを読んで以下の設問に答えなさい。

Passivation is a phenomenon that affects the corrosion rate very significantly and always in a favorable direction to a corrosion resistance. Most metals that have a high degree of passivity are also those that form tight adherent protective oxide layers on the surface of the metal, although it is believed that the passivity ^(A)mechanism is not simply that of an oxide barrier mechanically separating the metal from the electrolyte. Stainless steel is passive because of its chromium content. When this chromium content exceeds about 11%, a complete surface oxide (Cr_2O_3) is formed in a few seconds on exposure to air. Similar oxide films form on aluminum ($\rightarrow\text{Al}_2\text{O}_3$), titanium ($\rightarrow\text{TiO}_2$), and silicon ($\rightarrow\text{SiO}_2$). Nickel and iron show some degree of passivity but not to the same extent as the others mentioned above. There is some controversy as to the nature of this barrier, but it is believed by many to be some type of thin hydrated oxide layer, on the order of tens of angstroms in thickness.

Passivation is usually demonstrated by polarization curves, where the electrode potential is plotted versus the log of the current density. For a normal active metal the current and hence the electrode dissolution rate increase exponentially with increasing positive potential on the electrode. This is termed the active state of the metal and correspondingly, the active region of the polarization curve. But the metals that possess the ability to become passive show a marked decrease in the corrosion rate, by a factor of 10^3 to 10^6 when the potential exceeds some critical value denoted as E_p on the polarization curve. The corresponding critical current is known as I_c . As the electrode potential exceeds the E_p value, the current density suddenly decreases to a constant value that does not change with increasing electrode potential. This is the passive state of the metal and is noted on the polarization curves as the passive region. But when the electrode potential attains a sufficiently high value (E_t) the metal again becomes active. This part of the curve is termed the transpassive region.

(注)

angstrom : オングストローム (長さの単位 $1 \text{ angstrom} = 10^{-10} \text{ m}$)

attain : 到達する

corrosion : 腐食

denote : 示す

dissolution : 溶解

electrode : 電極

electrolyte : 電解液

exceed : 上回る

exponentially : 指数関数的に

hydrated : 水和した

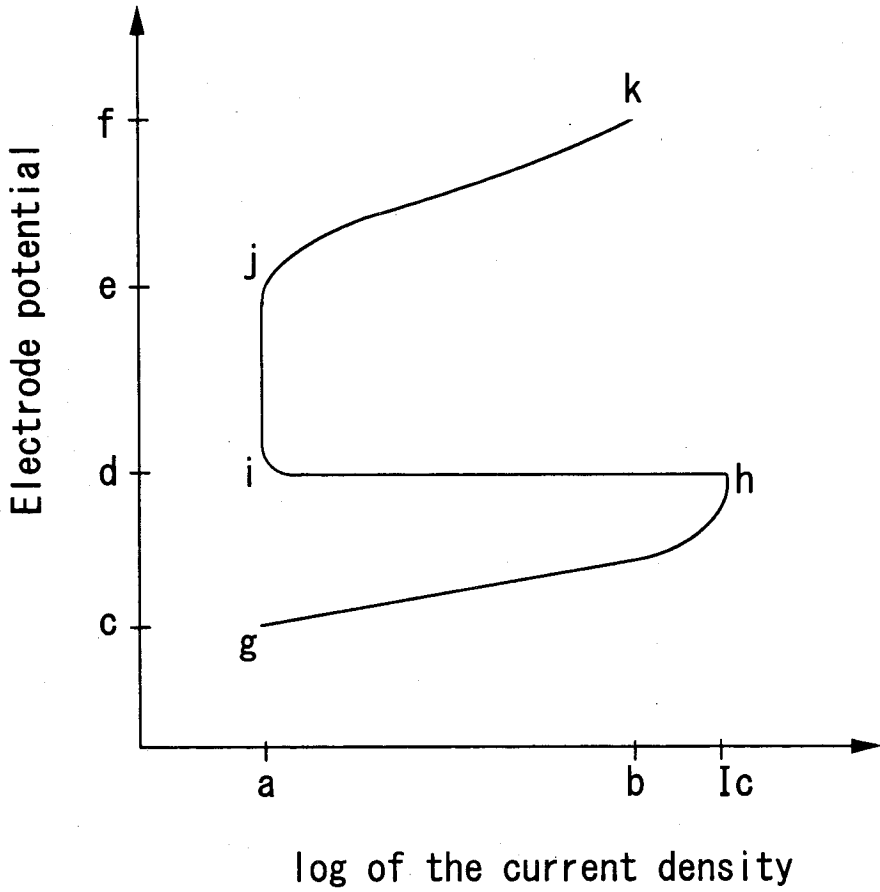
layer : 層

oxide : 酸化物

passivation : 不動態化

polarization : 分極

stainless steel : ステンレス



☒ Polarization curve for a metal

設 問

- (1) 下線部(A)を70字以内で和訳しなさい。
- (2) 鉄はアルミニウムとは異なる不動態層を形成すると考えられているが、それぞれの特徴を日本語で述べなさい。
- (3) 第2段落は図の分極曲線の説明である。 E_p と E_t に対応するものを図中のaからfの中から選びなさい。
- (4) 文中で説明されている(ア)transpassive region, (イ)passive region, (ウ)active regionに対応する範囲を図中の記号gからkを用いて示しなさい。なお、解答はg—kのように書きなさい。

3 真核生物の細胞中にはDNAが核以外にミトコンドリアにも存在する。ミトコンドリアDNAは特殊な遺伝様式をするので、非常に近縁な生物間の系統関係を推測するためのマーカー(目印)として近年の進化生物学では用いられてきた。ところが、1999年に出版された2個の論文は、その遺伝様式に関する従来の仮説が正しくない可能性を示唆した。以下はこれに関する“Fathers can be influential too”というタイトルの論評の一部である。これを読んで以下の設問に答えなさい。

- ① The assumption that mitochondrial DNA is inherited purely through the maternal line is a lynchpin of studies tracking human evolutionary history and the movements of human populations in the prehistoric past. This is why we talk of an African Eve as the common ancestor of all living humans, rather than an African Adam.
- ② But two reports published in March 1999 now show that this assumption is unwarranted. DNA from paternal mitochondria can indeed sneak into the maternal line from time to time and could seriously upset estimates of evolutionary relationships. The possibility of paternal DNA in the mitochondrial line may mean the reassessment of many evolutionary and molecular anthropological studies that have used human mitochondrial DNA as a “molecular clock” to time prehistoric events.
- ③ Mitochondrial DNA has been commandeered by molecular evolutionists as the ideal material to track the history of recent human evolution and human migration. Compared with the DNA in the chromosomes, it is small and has a fairly high mutation rate, which means that sufficient differences will accumulate over the relatively short period of time (tens to hundreds of thousands of years) that is of immediate interest. Its greatest advantage for this type of analysis, however, was the assumption that it is passed on directly from mother to child, without the intervention of complicating factors.
- ④ The mitochondria in a fertilized egg all come from the egg cytoplasm, which is provided by the mother. No paternal mitochondria, donated by sperm, seem to

persist. On this assumption, your mitochondrial DNA is a clone of your mother's, your grandmother's, and your great-grandmother's, and so on, back through the female line as far as you care to go.

- ⑤ This simplifies the task of evolutionary analysis considerably. Family trees of human populations are constructed by counting the number of differences that have accumulated in the DNA sequences of different human lineages. Those lineages with the fewest differences have diverged most recently and are most closely related. If one can assume that any difference between two mitochondrial DNAs is due to mutation only,^(B) one can count each difference as a purely independent event and do the statistical calculations accordingly.
- ⑥ If however, there is occasional mixing of maternal and paternal mitochondrial DNA by genetic recombination, one can never be sure whether the same difference occurring in two different human lineages is due to two independent mutation events or to the transfer of a mutation from one lineage to another by recombination.
- ⑦ Biologists have warned for some years that paternal mitochondria do penetrate the human egg and survive for several hours. And there is evidence of recombination between paternal and maternal mitochondrial DNA in mice and other organisms. But unambiguous evidence of recombination between maternal and paternal mitochondrial DNA in human populations has been hard to find.

(注)

African Eve: ミトコンドリアDNAをマーカーとして使用した研究の結果、人類の起源がアフリカであるという論文が1987年に発表されて以来この俗称が一般化している

anthropological studies: 人類学的研究

biologist: 生物学者

chromosome: 染色体

clone: クローン(遺伝的に同一の集団)
commandeer: 徴用する
cytoplasm: 細胞質
evolutionary analysis: 進化的解析(DNA等を使用してどのように進化がおきたのかを推測する研究)
fertilized egg: 受精卵
human evolution: 人類進化
human population: 人類集団
lineage: 系統群
lynchpin: 物事の要をなすもの
molecular clock: 分子時計(進化してきた時間の推測に利用されるDNA等の分子)
molecular evolutionist: 分子進化学者
mutation: 突然変異, 変異
recombination: 組み換え
sperm: 精子

設問

- (1) 下線部(A)を和訳しなさい。
- (2) 下線部(B)の If ではじまる文章でない場合はどのような場合でどのようなこととなるかが①～⑦の段落のうちの一つで説明されている。その段落は何番か。また、その段落を和訳しなさい。
- (3) 1999年以前にも真核細胞の核以外の部分に存在するDNAの特殊な遺伝様式に関する仮説と矛盾する研究結果があったことが①～⑦の段落のうちの一つで説明されている。その段落は何番か答えなさい。
- (4) 従来 of 仮説で特殊な遺伝様式をすること以外にミトコンドリアのDNAが非常に近縁な生物間の系統解析のマーカーとして近年の進化生物学で用いられてきた理由がある。80字以内の日本語で説明しなさい。

4 以下の英文を読んで設問に答えなさい。

To an observer on the ground, an airplane appears to fly (A) a beeline toward its destination. But things look very different (C) inside the cockpit. Buffeted by winds or shifts in air pressure, the plane regularly drifts off course. When this happens, the pilot makes a correction by steering the plane (D) the opposite direction. If the pilot overcorrects, then he or she must correct the correction, and so on. The plane actually flies (E) a zigzag.

Feedback is a central feature of life: All organisms share this ability to sense how they're doing and to make changes in "mid-flight" when necessary. The process of feedback governs how we grow, respond to stress and challenge, and regulate factors such as body temperature, blood pressure, and cholesterol level. This apparent purposefulness, largely unconscious, operates at every level — (F) the interaction of proteins in cells (G) the interaction of organisms in complex ecologies.

How does feedback work? The process requires two elements: First, some kind of device to measure the difference between the current state of affairs and some preset "desired" state; and second, some kind of responsive machinery that can reduce that difference. The bigger the difference, the harder that machinery must work. This is negative feedback. But sometimes feedback operates as an amplifier, increasing the difference between the status quo and the objective. This is called positive feedback — and can lead to runaway and breakdown. It can also lead to creation and change.

(注)

status quo : そのままの状態

設 問

(1) (A), (C), (D), (E), (F), (G)に, それぞれ適当な英単語(前置詞) 1語を入れなさい。

- (2) 下線(B)と反対の意味を持つ英単語(名詞) 1語を文中から見つけて書きなさい。
- (3) この文章では、負のフィードバックを可能にするためには、どういう装置が必要であると主張しているか、日本語 50 字以内で簡潔に説明しなさい。
- (4) 本文に述べられているような正のフィードバックと負のフィードバックのシステムを説明している文章を、以下の①～⑤の中から一つずつ選び、その番号をそれぞれ書きなさい。

① Although the system for copying DNA is extremely accurate, mistakes do happen; sometimes these mistakes can be devastating. Other threats to the integrity of DNA, which regularly damage nucleotides, include chemical events inside cells and ultraviolet light. The cell recruits an army of repair enzymes to handle these problems. In this system, three kinds of repair enzymes regularly patrol DNA and repair any errors they find.

② Life is more than the sum of its parts. If you throw a number of highly predictable individuals together, they will almost certainly interact and organize in completely unforeseeable and complex ways. Take the information molecule, DNA. We've seen how DNA is a long chain molecule composed of four kinds of nucleotides. There's nothing in the basic makeup or chemistry of those nucleotides that gives a hint of DNA's remarkable role in life. Only when they get strung together in the specific sequences of DNA do we perceive a wholly new quality — information.

- ③ The regulation occurs in a loop when a signal stimulates the production of more, not less, of a product. The more there is of the product, the more of it that is produced. In biology, this process is called cascading. Events trigger other events in ever-growing amplification. This can lead to a dangerous situation, as in the case of addiction or the unrestrained cell growth of cancer.
- ④ Energy flows through the biomass of plants, animals, and microorganisms in complex food chains. At the levels where energy is actually captured, transferred, and put to work, a simpler pattern prevails. Incredibly, the entire plant and animal world runs on the work of just two kinds of bacteria-sized organelles within cells. Chloroplasts in plant cells make sugar using the energy of sunlight. Mitochondria, in both plant and animal cells, break down the sugar and make ATP.
- ⑤ What exactly is the on/off signal in an enzyme assembly line? It is the final product molecule itself. This molecule is the equivalent of a message sent by the supervisor back to the first worker in the assembly line. When it fits into place on the enzyme, it says, "Enough already. Stop making us." In addition, site-filling by signal molecules is statistical. If lots of product molecules are around, a given set of identical sites are more likely to be filled. As the concentration of product molecules decreases, they start falling out of the sites, leaving them empty.