I 次の英文を読んで，以下の設問に答えよ。(80点)

I saw my first cell when I was at school, not long after my encounter with the yellow butterfly. My class had germinated onion seedlings and squashed their roots under a microscope slide to see what they were made from. My inspirational biology teacher, Keith Neal, explained that we would see cells, the basic unit of life. And there they were: neat arrays of box-like cells, all stacked up in orderly columns. (1)<u>How impressive it seemed that the growth and division of those tiny cells were enough to push the roots of an onion down through the soil,</u> to provide the growing plant with water, nutrients and anchorage.

As I learned more about cells, my sense of wonder only grew. Cells come in an incredible variety of shapes and sizes. Most of them are too small to be seen with the naked eye — they are truly minute. Individual cells of a type of parasitic bacteria that can infect the bladder could line up 3,000-abreast across a one-millimetre gap. [ア] If you had an egg for breakfast, consider the fact that the whole of its yolk is just one single cell. Some cells in our bodies are also huge. There are, for example, individual nerve cells that reach from the base of your spine all the way to the tip of your big toe. That means those cells can each be about a metre long!

(2)<u>Startling as all this diversity is, what is most interesting for me is what all cells have in common.</u> Scientists are always interested in identifying fundamental units, the best example being the atom as the basic unit of matter. Biology's atom is the cell. Cells are not only the basic structural unit of all living organisms, they are also the basic functional unit of life. What I mean by this is that cells are the smallest entities that have the core characteristics of life. This is the basis of what biologists call *cell theory*: to the best of our knowledge, everything that is alive on the planet is either a cell or made from a collection of cells. The cell is the simplest thing that can be said, definitively, to be alive.

Cell theory is about a century and a half old, and it has become one of biology's crucial foundations. Given the importance of this idea for understanding biology, I find it surprising that it has not caught the public imagination more than it has. This might be because most people are taught in school biology classes to think of cells as mere building blocks for more complex beings, when the reality is much more interesting.

The story of the cell begins in 1665 with Robert Hooke, a member of the newly formed Royal Society of London, one of the first science academies in the world. (3)科学においてはよくあることだが，彼の発見の引き金になったのは新たなテクノロジーであった。 Since most cells are too small to see with the naked eye, their discovery had to wait for the invention of the microscope in the early seventeenth century. Scientists are often a combination of theorist and skilled artisan, and this was certainly true of Hooke, who was equally comfortable exploring the frontiers of physics, architecture or biology as he was inventing scientific instruments. He built his own microscopes, which he then used to explore the strange worlds hidden beyond the reach of the naked eye.

One of the things Hooke looked at was a thin slice of cork. He saw that the cork wood was made up of row after row of walled cavities, very similar to the cells in the onion root tips I saw as a schoolboy 300 years later. Hooke named these cells after the Latin word *cella*, meaning a small room or cubicle. At that time Hooke did not know that the cells he had drawn were in fact not only the basic component of all plants, but of all life.

Not long after Hooke, the Dutch researcher Anton van Leeuwenhoek made another crucial observation when he discovered single-celled life. He spotted these microscopic organisms swimming in samples of pond water and growing in the plaque he scraped from his teeth: an observation that disturbed him, since he was rather proud of his dental hygiene! He gave these tiny beings an endearing name, that we no longer use today, 'animalcules'. Those he found flourishing between his teeth were, in fact, the first bacteria ever described. Leeuwenhoek had stumbled across an entire new domain of minute single-celled life forms.

We now know that bacteria and other sorts of microbial cells ('microbe' is a general term for all microscopic organisms that can live as single cells) are by far the most numerous life forms on Earth. They inhabit every environment, from the high atmosphere to the depths of the Earth's crust. [イ] They break down waste, build soils, recycle nutrients and capture from the air the nitrogen that plants and animals need to grow. And when scientists look at our own bodies, they see that for each and every one of our 30 trillion or more human cells, we have at least one microbial cell. You — and every other human being — are not an isolated, individual entity, but a huge and constantly changing colony made up of human and non-human cells. These cells of microscopic bacteria and fungi live *on* us and *in* us, affecting how we digest food and fight illnesses.

But before the seventeenth century, nobody had any idea that these invisible cells even existed, let alone that they worked according to the same basic principles as all other more visible life forms.

During the eighteenth century and into the beginning of the nineteenth century, microscopes and microscopic techniques improved, and very soon scientists were identifying cells from all manner of different creatures. Some began to speculate that all plants and animals were built from collections of those animalcules that Leeuwenhoek had identified several generations before them. Then, after a long gestation, the cell theory was finally fully born. In 1839 the botanist Matthias Schleiden and zoologist Theodore Schwann, summarized work from themselves and many other researchers, and wrote 'we have seen that all organisms are composed of essentially like parts, namely of cells'. Science had reached the illuminating conclusion that the cell is the fundamental structural unit of life.

The implications of this insight deepened further when biologists realized that every cell is a life form in its own right. This idea was captured by the pioneering pathologist Rudolf Virchow, when he wrote in 1858 'that every animal appears as a sum of vital units, each of which bears in itself the complete characteristics of life'.

What this means is that all cells are themselves alive. Biologists demonstrate this most vividly when they take cells from the multicellular bodies of animals or plants and keep them alive in glass or plastic vessels, often flat-bottomed vessels called Petri dishes. [ウ] They let researchers study biological processes without needing to deal with the complexity of whole organisms. Cells are active; they can move and respond to the environment, and their contents are always in motion. Compared to a whole organism, like an animal or a plant, a cell may seem simple, but it is definitely alive.

There was, however, (4) <u>an important gap in cell theory</u>, as originally formulated by Schleiden and Schwann. It did not describe how new cells came into being. That gap closed when biologists recognized that cells reproduce by dividing themselves from one cell into two, and concluded that cells are only ever made by the division of a pre-existing cell in two. Virchow popularized this idea with a Latin epigram: '*Omnis cellula e cellula*', that is, all cells come from cells. This phrase also helped to counter the incorrect idea, still popular amongst some at the time, that life arises spontaneously from inert matter all the time — it does not.

Cell division is the basis of the growth and development of all living organisms. It is the first critical step in the transformation of a single, uniform fertilized egg of an animal into a ball of cells and then, eventually, into a highly complex and organized living being, an embryo. It all begins with a cell dividing and producing two cells which can take on different identities. The entire development of the embryo that then takes place is based on this same process — repeated rounds of cell division, followed by the creation of an ever more elaborately patterned embryo, as cells mature into increasingly specialized tissues and organs. [エ] I think we would all respect cells a little more if we remembered that every one of us was once a single cell, formed when a sperm and an egg fused at the moment of our conception.

Cell division also explains the apparently miraculous ways the body heals itself. If you were to cut yourself with the edge of this page, it would be localized cell division around the cut that would repair the wound, helping to maintain a healthy body. Cancers, however, are the unfortunate counterpoint to the body's ability to instigate new rounds of cell division. Cancer is caused by the uncontrolled growth and division of cells that can spread their malignancy, damaging or even killing the body.

Growth, repair, degeneration and malignancy are all linked to changes in the properties of our cells, in sickness and in health, in youth and in old age. In fact, most diseases can be traced back to the malfunction of cells, and understanding what goes wrong in cells underpins how we develop new ways to treat disease.

Cell theory continues to influence the trajectory of research in the life sciences and in medical practice. [オ] Ever since my thirteen-year-old self squinted down a microscope and saw the cells of that onion root tip, I have been curious about cells and how they work. When I started as a biology researcher, I decided to study cells, in particular how cells reproduce themselves and control their division.

The cells I started to work with in the 1970s were yeast cells, which most people think are only good for making wine, beer or bread, not for tackling fundamental biological problems. But they are, in fact, a great model for understanding how cells of more complex organisms work. Yeast is a fungus, but its cells are surprisingly similar to plant and animal cells. They are also small, relatively simple, and grow quickly and inexpensively when fed on simple nutrients. In the lab we grow them either floating freely in a liquid broth or on top of a layer of jelly in a plastic Petri dish, where they form cream-coloured colonies a few millimetres across, each containing many millions of cells. Despite, or more accurately, because of their simplicity, yeast cells have helped us to understand how cells divide in most living organisms, including human cells.

Quite a lot of what we know about the uncontrolled cell divisions of cancer cells came first from studying the humble yeasts.

[Adapted from Paul Nurse, *What is Life? Five Great Ideas in Biology.* New York: W. W. Norton & Company, 2020: 5-11.]

Ⅰ-1. 下線部(1)を日本語に訳せ。

Ⅰ-2. 下線部(2)を日本語に訳せ。

Ⅰ-3. 下線部(3)を英語に訳せ。

Ⅰ-4. 下線部(4)のシュライデンとシュワンが最初に唱えた細胞理論における重大な欠落とは何か，またそれはのちにどう埋められたか，本文の内容に沿って80字以内の日本語で説明せよ。(句読点も文字数に含める。)

Ⅰ-5. [ア] から [オ] のそれぞれに入れるのにもっとも適切な文を選び，1から5の番号で答えよ。ただし，同じ選択肢を2度使うことはない。

1. It drastically shaped the course of my life too.
2. Other cells are immense.
3. Some of these cell lines have been growing in laboratories around the world for decades on end.
4. This means that all living organisms, regardless of their size or complexity, emerge from a single cell.
5. Without them, life would come to a standstill.

I -6. 以下の(A)と(B)の答としてもっとも適切なものを選び，番号で答えよ。

(A) Select the most suitable title for this passage.

1. A Guide to Experiments in Elementary Cell Biology
2. A History and Explanation of Basic Cell Biology
3. Famous Mistakes in Cell Biology Research
4. My Contributions to the Discovery of Cells
5. Recent Developments in Cancer Cell Research

(B) Select the statement about cells NOT found in the text.

1. Cells actively adapt to their environment, both through movement and in their content.
2. Cells can be found living at different altitudes.
3. Cells can cause various illnesses when they do not function as they should.
4. Cells come programmed to self-destruct and die when they are no longer needed.
5. Cells in both onion seedling roots and cork wood are arranged in rows or columns.

Ⅰ-7. 以下の１から10の文の中から本文の内容に一致するものを３つ選び，番号で答えよ。

1. When Robert Hooke viewed cork cells under a microscope, he realized that all living things share the cell as a fundamental structure.
2. Anton van Leeuwenhoek felt upset that the single-celled life forms he had discovered in pond water and plaque were rare, making their existence difficult to prove to others.
3. Cell theory finally became established in 1839 thanks to the efforts of multiple scientists carrying out research on what Robert Hooke had identified in 1665.
4. The number of microbial cells inhabiting a human both inside and out is estimated to be more than twice the number of human cells.
5. Rudolf Virchow disputed Matthias Schleiden's and Theodore Schwann's cell theory regarding the ability of cells to survive separately from the animal or plant they came from.
6. The author speculates that one reason cells are insufficiently valued is because we forget that human life began from a single cell.
7. Our skin repairs paper cuts by quickly sending new cells from distant parts of our body to the point of injury.
8. It was examining his own diseased cells under a microscope as an adolescent that inspired the author to become a cell biologist.
9. The fact that yeast colonies can be grown slowly in a lab under controlled conditions is an advantage for cell researchers.
10. The study of yeast cells has played a role in the development of our understanding of the mechanisms of cancer cell multiplication.

Ⅱ　次の英文を読んで，以下の設問に答えよ。(70点)

Most people tend to think of interruptions as originating from another person or from our devices, such as through a notification. But in our studies of people in their natural work environments, we observed a strange and regular phenomenon which typically looked like this: a person would be working on a task on their computer. Then, for no apparent reason to the observer, this person suddenly stopped what they were doing and checked their email or picked up their phone. There was no discernible stimulus that caused the person to interrupt themselves — there was rather some internal trigger, perhaps a thought, a memory, or habit. These interruptions originate from within ourselves. One of the most surprising results in our research is that we find that (1) <u>people are nearly as likely to self-interrupt due to something internal in them as to be interrupted by something external to them.</u>

We may not even be aware of how often we self-interrupt. Recently, in the middle of reading an article on AI, a random thought suddenly entered my mind to find out how safe it is to eat nonorganic strawberries. I couldn't get this question out of my mind and switched to my browser and searched for *strawberries* and *pesticides*. I then spent a good chunk of time reading about the topic (there are conflicting views, so this remains an unfinished task). Many of our participants report that these inner urges are disconnected from their work. Even basic human drives can cause us to self-interrupt: a graduate student of mine said that when she gets hungry, she self-interrupts to look up recipes.

What leads people to self-interrupt? Jing Jin and Laura Dabbish from Carnegie Mellon University set out to answer this question, and shadowed people in a workplace for about one hour each, noting down their interruptions, and then interviewed them to ask why they self-interrupted. They found that people self-interrupted for a range of reasons that you might guess: to change their environment to be more productive (e.g.*1, [A]), to do something less boring, to seek information, to take care of something that they remembered needs to be done, or to fill time (e.g., while [B]). Their current task might also cue them to interrupt themselves, like to send an email. People may also self-interrupt just out of habit, such as following a routine that includes checking news when starting to work.

Self-interruptions can help people manage stress, like [C]. Lea was a participant in one of our studies, in her late twenties, completing her PhD*2 while at the same time [D] in a software company. She needed to be ultra-disciplined as she had to manage both work and school projects. However, Lea complained about her difficulty in focusing because she self-interrupted so often, mostly to check social media. Upon more reflection, she explained that she self-interrupts to help herself cognitively cope with such an overwhelming schedule. Lea self-interrupts to switch from focused to rote attention. She has a good understanding of her personal attention rhythm and her level of cognitive resources available, so she can sense when she needs to self-interrupt. However, as she admits, she's not good at getting back on task.

Not too long ago, I was searching for an apartment in New York City for my sabbatical from UC Irvine*3. I put in a number of inquiries. While there wasn't really much urgency, I kept checking my inbox and the real estate sites to see if a response had come in. My anticipatory stress mounted, and it was hard to concentrate on my work. My first choice did come through. But even after the apartment was booked, it was hard for my mind to settle down and for me to not keep self-interrupting to check my inbox. It can take anywhere from 18 to 254 days to form a habit, and my habit of checking for rentals was developed in closer to 18 days.

I had become conditioned to self-interrupt, which is consistent with evidence that my student Victor González and I found in an early study from 2005. We observed thirty-six people in three different companies for three days each as they went about their daily work, using the Frederick Taylor stopwatch technique*4 that I described earlier. The observers recorded every moment-by-moment activity that each participant engaged in. In addition to timing their activities to the second, we also observed and noted down when people were being interrupted by something external to them (a person, a phone call, an email notification) or by something internal (i.e., with no observable stimulus). We looked then at interruptions within the broader view of people's working spheres. We found that 40 percent of the switching among working spheres was due to interruptions. The other times people switched working spheres were due to completing a task. They experienced gradually fewer interruptions as the day wore on.

Of the interrupting events, 56 percent were due to external interruptions, and 44 percent were due to self-interruptions. We then counted the number of internal and external interruptions on an hourly basis. We wanted to see if there was any relationship between these two kinds of interruptions in people's daily lives. We indeed found a stable pattern where, when external interruptions waxed or waned in one hour, the internal interruptions followed a similar pattern in the next hour. Thus, if external interruptions increased, then self-interruptions in the next hour would also increase. But only external interruptions predicted self-interruptions. Conditioning seems to play a role here. If a person is not getting interrupted externally, then it seems that a person will self-interrupt to maintain a consistent pattern of interruptions (and short attention spans). (2)我々は中断されることにあまりに慣れてしまったので，自分たち自身に対してそれをするのだ。

When you start getting external interruptions, it's like driving on a country road and then turning onto a busy highway. You were coasting along, and then suddenly have to deal with tailgaters and motorcyclists. (3)In the same way that driving on a congested highway is different from that peaceful country road, when you face interruptions, the cognitive operations you use, and even your goals, change. Since the most active goal in our mind governs our attention, to stay on task we need to perform a cognitive dance of trying to maintain endogenous (internal) control of our goals to keep on track with our project, while dealing with exogenous goals, such as answering the Slack[*5] messages of your colleagues and getting them the information they need from you. But we know from Zeigarnik's work[*6] that we tend to remember those unfinished tasks, however minor. Thus, our primary goal can get buried under the mental clutter from all those unfinished tasks.

Recall from Chapter 1[*7] that to resume an interrupted task, people have to rewrite their internal whiteboard, reconstructing their task schema, goals and thought processes, tapping into that limited pool of cognitive resources, which are best saved for actually doing the task. It takes time and effort to reconstruct our mental model of the task. Interruptions can linger in your mind, and this can create static interference as you try to work on your current task. (4) It is no wonder, then, that at the end of a busy day, especially with external interruptions, you feel drained.

[Adapted from Gloria Mark, *Attention Span: Finding Focus for a Fulfilling Life.* London: William Collins, 2023: 114-119.]

*1 e.g. for example の意

*2 PhD 博士号

*3 UC Irvine カリフォルニア大学アーバイン校(University of California, Irvine)

*4 the Frederick Taylor stopwatch technique 能率を上げる方法を探るため，活動時間をストップウォッチで測る方法

*5 Slack スラック(グループチャット等を提供する Web サービス)

*6 Zeigarnik's work ブリューマ・ヴリホヴナ・ゼイガルニク(旧ソビエト連邦の心理学者，精神科医)の仕事

*7 Chapter 1 本書第1章のタイトルは "Your Limited Cognitive Resources" である。

Ⅱ-1. 下線部(1)を日本語に訳せ。

Ⅱ-2. 下線部(2)を英語に訳せ。

Ⅱ-3. 下線部(3)を日本語に訳せ。

Ⅱ-4. 下線部(4)に “at the end of a busy day, especially with external interruptions, you feel drained” とあるが，これが “no wonder” であると言えるのはなぜか。70字以内で説明せよ。(句読点も文字数に含める。)

Ⅱ-5. [A] から [D] のそれぞれに入れるのにもっとも適切な語句を選び，1から4の番号で答えよ。ただし，同じ選択肢を2度使うことはない。

1. closing distracting windows
2. holding a demanding job
3. opening a steam valve
4. waiting for an email

Ⅱ-6. 以下の1から8の文の中から本文の内容に一致するものを2つ選び，番号で答えよ。

1. Overall, the author encourages readers to self-interrupt during work because trying not to do so is stressful and unhealthy.
2. The author has found that we often self-interrupt, thinking about things unrelated to our work, such as what kinds of food are not harmful.
3. Jing Jin and Laura Dabbish became skeptical about some self-interruption patterns after having observed and interviewed people in the workplace.
4. The author continued to check her email even after securing an apartment because she was excited about her move to New York City.
5. Victor González and the author failed to measure how much time thirty-six people needed to start their work for the day.
6. González and the author aimed to determine what percentage of people managed to complete their tasks in different working spheres despite interruptions.
7. According to an experiment conducted by González and the author, when external interruptions increase, internal interruptions also rise correspondingly in the subsequent hour.
8. The author points out a tendency among people to remember finished tasks better than uncompleted ones.