※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

A. Reading Comprehension: There will be 5 short articles and 5 questions after each article. Please identify the choice that best answers the question. (25 questions, 3 points each, total 75 points for Part A)

Q 1-5 are based on "How Are Memories Stored and Retrieved" in Science on Jul. 1, 2005.

The birth of the modern era of memory research is often pegged to the publication, in 1957, of an account of the neurological patient H.M. At age 27, H.M. had large chunks of the temporal lobes of his brain surgically removed in a last-ditch effort to relieve chronic epilepsy. The surgery worked, but it left H.M. unable to remember anything that happened—or anyone he met—after his surgery. The case showed that the medial temporal lobes (MTL), which include the hippocampus, are crucial for making new memories. H.M.'s case also revealed, on closer examination, that memory is not a monolith: Given a tricky mirror drawing task, H.M.'s performance improved steadily over 3 days even though he had no memory of his previous practice. Remembering how is not the same as remembering what, as far as the brain is concerned.

Thanks to experiments on animals and the advent of human brain imaging, scientists now have a working knowledge of the various kinds of memory as well as which parts of the brain are involved in each. But persistent gaps remain. Although the MTL has indeed proved critical for declarative memory—the recollection of facts and events—the region remains something of a black box. How its various components interact during memory encoding and retrieval is unresolved. Moreover, the MTL is not the final repository of declarative memories. Such memories are apparently filed to the cerebral cortex for long-term storage, but how this happens, and how memories are represented in the cortex, remains unclear.

More than a century ago, the great Spanish neuroanatomist Santiago Ramón y Cajal proposed that making memories must require neurons to strengthen their connections with one another. Dogma at the time held that no new neurons are born in the adult brain, so Ramón y Cajal made the reasonable assumption that the key changes must occur between existing neurons. Until recently, scientists had few clues about how this might happen.

Since the 1970s, however, work on isolated chunks of nervous-system tissue has identified a host of molecular players in memory formation. Many of the same molecules have been implicated in both declarative and nondeclarative memory and in species as varied as sea slugs, fruit flies, and rodents, suggesting that the molecular machinery for memory has been widely conserved. A key insight from this work has been that short-term memory (lasting minutes) involves chemical modifications that strengthen existing connections, called synapses, between neurons, whereas long-term memory (lasting days or weeks) requires protein synthesis and probably the construction of new synapses.

Tying this work to the whole-brain research is a major challenge. A potential bridge is a process called long-term potentiation (LTP), a type of synaptic strengthening that has been scrutinized in slices of rodent hippocampus and is widely considered a likely physiological basis for memory. A conclusive demonstration that LTP really does underlie memory formation in vivo would be a big breakthrough.

Meanwhile, more questions keep popping up. Recent studies have found that patterns of neural activity seen when an animal is learning a new task are replayed later during sleep. Could this play a role in solidifying memories? Other work shows that our memories are not as trustworthy as we generally assume. Why is memory so labile? A hint may come from recent studies that revive the controversial notion that memories are briefly vulnerable to manipulation each time they're recalled. Finally, the no-new-neurons dogma went down in flames in the 1990s, with the demonstration that the hippocampus, of all places, is a virtual neuron nursery throughout life. The extent to which these newborn cells support learning and memory remains to be seen.

1. The reason why H.M. had most medial temporal lobes surgically removed was because he suffered from (A) brain tumor. (B) epilepsy. (C) cancer. (D) migraine. (E) insomnia.
2. According to H.M.'s symptoms after his brain surgery, which of the following statement is correct? (A) H.M. had retrograde amnesia that he lost memories prior to his surgery. (B) H.M. had anterograde amnesia that he was unable to form new memories after his surgery. (C) H.M. improved considerably on a mirror-tracing task. (D) There are various kinds of memory. (E) B, C, & D.
3. According to the text, where is the final storage site for declarative memories? (A) The medial temporal lobes. (B) Hippocampus. (C) Cerebellum. (D) Cerebral cortex. (E) A black box.
4. Which statement about the difference between declarative and nondeclarative memory is false? (A) Declarative memory is facts and information acquired through learning, whereas nondeclarative memory is memory about perceptual or motor procedures. (B) Only declarative memory requires protein synthesis to construct new synapses. (C) The key molecules involved in both memories are almost the same. (D) Declarative memory is the type of memory so profoundly impaired by H.M.'s surgery. (E) Declarative memory deals with 'what', and nondeclarative memory deals with 'how'.
5. According to the text, which of the following statement is correct? (A) The dogma that no new neurons are born in the adult brain holds true. (B) After memory is consolidated into long-term memory, it is very solid and cannot be modified at all. (C) Ramón y Cajal proposed that memory formation occurs in synapse. (D) From *in vivo* studies, scientists are very certain that long-term potentiation is the cellular mechanism responsible for memory. (E) Our memories are always trustworthy.

Q 6-10 are based on "What Is the Biological Basis of Consciousness" in Science on Jul. 1, 2005.

The discourse on consciousness has been hugely influenced by René Descartes, the French philosopher who in the mid–17th century declared that body and mind are made of different stuff entirely. It must be so, Descartes concluded, because the body exists in both time and space, whereas the mind has no spatial dimension.

Recent scientifically oriented accounts of consciousness generally reject Descartes's solution; most prefer to treat body and mind as different aspects of the same thing. In this view, consciousness emerges from the properties and organization of neurons in the brain. But how? And how can scientists, with their devotion to

objective observation and measurement, gain access to the inherently private and subjective realm of consciousness?

Some insights have come from examining neurological patients whose injuries have altered their consciousness. Damage to certain evolutionarily ancient structures in the brainstem robs people of consciousness entirely, leaving them in a coma or a persistent vegetative state. Although these regions may be a master switch for consciousness, they are unlikely to be its sole source. Different aspects of consciousness are probably generated in different brain regions. Damage to visual areas of the cerebral cortex, for example, can produce strange deficits limited to visual awareness. One extensively studied patient, known as D.F., is unable to identify shapes or determine the orientation of a thin slot in a vertical disk. Yet when asked to pick up a card and slide it through the slot, she does so easily. At some level, D.F. must know the orientation of the slot to be able to do this, but she seems not to know she knows.

Cleverly designed experiments can produce similar dissociations of unconscious and conscious knowledge in people without neurological damage. And researchers hope that scanning the brains of subjects engaged in such tasks will reveal clues about the neural activity required for conscious awareness. Work with monkeys also may elucidate some aspects of consciousness, particularly visual awareness. One experimental approach is to present a monkey with an optical illusion that creates a "bistable percept," looking like one thing one moment and another the next. (The orientation-flipping Necker cube is a well-known example.) Monkeys can be trained to indicate which version they perceive. At the same time, researchers hunt for neurons that track the monkey's perception, in hopes that these neurons will lead them to the neural systems involved in conscious visual awareness and ultimately to an explanation of how a particular pattern of photons hitting the retina produces the experience of seeing, say, a rose.

Experiments under way at present generally address only pieces of the consciousness puzzle, and very few directly address the most enigmatic aspect of the conscious human mind: the sense of self. Yet the experimental work has begun, and if the results don't provide a blinding insight into how consciousness arises from tangles of neurons, they should at least refine the next round of questions.

Ultimately, scientists would like to understand not just the biological basis of consciousness but also why it exists. What selection pressure led to its development, and how many of our fellow creatures share it? Some researchers suspect that consciousness is not unique to humans, but of course much depends on how the term is defined. Biological markers for consciousness might help settle the matter and shed light on how consciousness develops early in life. Such markers could also inform medical decisions about loved ones who are in an unresponsive state.

Until fairly recently, tackling the subject of consciousness was a dubious career move for any scientist without tenure (and perhaps a Nobel Prize already in the bag). Fortunately, more young researchers are now joining the fray. The unanswered questions should keep them—and the printing presses—busy for many years to come.

6. What's René Descartes perspective on consciousness? (A) The mind and body are distinct and separable. (B) Consciousness emerges from the activities of neurons in our brains. (C) It is possible for the mind to exist without the body, and vice versa. (D) A & C. (E) None of above.

7. According to the text, which of the following statement is correct? (A) The brainstem robs are a master switch for consciousness. (B) Different aspects of consciousness are likely generated in different brain regions. (C) The patient D.F. can pick up a card and slide it through the slot easily without identifying the orientation of a thin slot. (D) D.F. had damage to her visual areas of the cerebral cortex. (E) All of above.

8. The purpose to present a monkey with an optical illusion that creates a "bistable percept" is to: (A) check monkey's eyesight. (B) examine monkey's brain damage. (C) understand the neuronal basis for monkey's conscious visual awareness. (D) show monkey the kaleidoscope. (E) play with monkey.

9. Which statement about 'the sense of self' is false? (A) It is about how one views oneself, both the 'inner' and 'outer' self. (B) It is the most enigmatic aspect of the conscious human mind. (C) Animals can have consciousness, depending on how we define it. (D) A minimal kind of sense of self is necessary for consciousness. (E) None of above.

10. According to the text, which of the following statement is correct? (A) A Nobel Prize Laureate is the only person suitable for studying consciousness. (B) Young scientists should not study consciousness. (C) Searching for the biological markers for consciousness is a dubious career move. (D) We know so little about the biological basis of consciousness. (E) C & D.

Q 11-15 are based on a research article in Science Robotics on Dec. 20, 2017.

For at least the last two millennia, human beings have endeavored to understand the systems and mechanisms that make up the human body, such as the principles of muscle control, the sensory nervous system that connects the brain and the body, the mechanisms of learning in the brain, and the accomplishment of the simple act of walking. In recent years, technology has developed to the point where humanoid robots that mimic human body structures are now being constructed, and these enable us to study the systems in the human body by making humanoids or through experimental trials in the real world. However, a limitation of conventional humanoids is that they have been designed on the basis of the theories of conventional engineering, mechanics, electronics, and informatics. They are also primarily intended for engineering-oriented applications, such as task achievement in daily life, personal assistance, or disaster response. By contrast, our intent is to design a humanoid based on human systems—including the musculoskeletal structure, sensory nervous system, and methods of information processing in the brain—to support science-oriented goals, such as gaining a deeper understanding of the internal mechanisms of humans.

Our research team has successfully developed musculoskeletal robots, and it seems possible to use these to our stated purpose because they imitate the human musculoskeletal structure, support the flexible body and behaviors of humans, and support human-style muscle actuation using tendon-driven actuators. However, those musculoskeletal robots are not accurate enough for our purpose from an anatomical point of view, such as body

proportions, muscle arrangements, and joint structures, although their actuation does mimic human muscle contraction. Other research teams have also successfully developed musculoskeletal robots from an anthropomimetic point of view. The body structures and shapes of their robots were inspired from humans, and they provided effective schemes for controlling and modeling those kinds of robots. However, their robots were not capable of performing whole-body motions because they did not have tendon-driven legs for supporting their weight.

Therefore, we propose a human mimetic humanoid that provides a high degree of anatomical fidelity to the human structure and is capable of whole-body motions. We believe that such a human mimetic humanoid can provide new opportunities to advance science, such as in the field of musculoskeletal physical simulation, to capture and quantitatively analyze the internal data of a moving human body using the sensors of a human mimetic humanoid. Here, we detail the design principles of an anatomically correct human mimetic humanoid in the following areas: (i) body proportions, (ii) skeletal structures, (iii) muscle arrangement, and (iv) joint performance.

We also describe the development of the Kenshiro and Kengoro humanoids as examples. The human mimetic design concept is the common concept for each humanoid. Kenshiro is the first humanoid developed based on the concept, and then Kengoro was developed with a lot of improvements for a higher degree of fidelity to humans. These humanoids have anatomically correct musculoskeletal structures in their bodies, so that we can evaluate the fidelity of the musculoskeletal structures relative to that of a human.

11. For more than 2000 years, human beings have tried to get hold of: (A) the function of our sensory nervous system. (B) the execution of simple act of walking. (C) the principles of muscle control. (D) the mechanisms of learning in the brain. (E) All of above.

12. For the limitation of conventional humanoid robots, which of the following statement is false? (A) They cannot perform whole-body motions. (B) They are designed based the theories of conventional engineering. (C) They are primarily designed for disaster response. (D) They are designed based the theories of electronics and informatics. (E) They are primarily designed for personal assistance.

13. What is the limitation of the original developed musculoskeletal robots by the authors? (A) They did not support the flexible body and behaviors of humans. (B) They did not have anatomical accuracy. (C) They did not have tendon-driven legs for supporting their weight. (D) They did not speak fluently. (E) All of above.

14. Which of the following area(s) an anatomically correct human mimetic humanoid? (A) Joint performance. (B) Skeletal structures. (C) Body proportions. (D) Muscle arrangement. (E) All of above.

15. According to the text, which of the following statement is correct? (A) Kenshiro is the first anatomically correct musculoskeletal humanoid. (B) Kenshiro performs better than Kengoro. (C) Both Kenshiro and Kengoro have tendon-driven actuators. (D) A & C. (E) B & C.

Q 16-20 are based on a "Working Life" article in Science on Apr. 7, 2017.

After finishing my undergrad studies, I did what many newly minted electrical engineers do and moved to Silicon Valley. Working at Apple, I was living my dream of contributing to the very products I had always admired. Yet, after a couple of years, I began to feel as though something was missing. I longed to better understand the world beyond the realm of computers and find a new frontier for exploration. I had some misgivings about venturing into an unfamiliar domain, but at the same time, I was excited by the prospect of diving into a discipline that I didn't know anything about. After much deliberation, I decided to take a risk by looking for something completely outside my expertise, where an interdisciplinary perspective might be an asset.

This search ultimately led me to graduate school to study biology. At first, it was as if I was starting over, taking classes I had by-passed as an undergraduate, such as Introductory Organic Chemistry. But my motivation to master a new field made the experience enjoyable rather than frustrating. Moreover, I was captivated by the science. In my biology classes, I felt I was being offered gold nuggets of information that earlier generations of researchers had painstakingly acquired. This sense of wonder made it easier to return to homework and tests after a 4-year hiatus from school.

On my journey to laboratory research in biology, bioinformatics served as something of a bridge between the mountains of computational and experimental research. Starting from familiar terrain helped smooth my transition, but climbing the peak of experimentation was still a steep learning curve, fraught with weeks of optimizing protocols and uncovering sources of error. It turns out that pipetting correctly for hours on end is far more difficult than it looks.

But the time I dedicated to developing these skills was well spent. My background in both computation and experimentation gives me the perspective to understand the challenges that each side faces, and it allows me to choose the approach that is best suited for the problem at hand. Luckily, I have always had advisers who encouraged me to cross between fields and supported me along the way.

Yet, as I have progressed in my academic career, I have noticed that the culture of science often emphasizes the differences between approaches, rather than building bridges that integrate them. A researcher could be either a biologist *or* a computer scientist, a theoretician *or* an empiricist, a field researcher *or* a lab rat. Nowhere was this tendency more apparent than in the dichotomy between wet lab and dry lab research. New graduate students often have to choose one or the other—even though many scientific advances rely on a combination of approaches.

In my view, we do our students a disservice when we prepare them for only one domain of expertise. Graduate students in bioinformatics should know not only how to program, but also how to pipette. Similarly, students in the biological sciences should augment their expertise with programming, chemistry, statistics, or other complementary fields. They may not need to master every topic, but solid experience in different areas can serve them well as they develop their careers.

Now, as I begin running my own lab, I aspire to teach students a variety of approaches from different fields. I do not wish to create a wet lab or a dry lab, but a "soggy" lab, where scientists can comfortably bridge domains.

This may require spending extra time to find and train students who are willing to embrace this approach, but I think that it will pay off in the long run—much like my decision to leave Apple almost 10 years ago. In the end, the empowerment that comes from learning a new discipline makes the added effort worthwhile. Now that I have been down that road, I hope to guide others who are willing to cross bridges in the pursuit of science.

16. Which professional field(s) the author is good at? (A) Bioinformatics. (B) Electrical engineering. (C) History. (D) A & B. (E) All of above.
17. Why did the author leave Apple 10 years ago? (A) He got fired. (B) He job-hopped to Google. (C) He decided to peruse a PhD. degree in Bioinformatics. (D) He got married. (E) He was sick.
18. What does the author do now? (A) A professor. (B) A web designer. (C) A real estate salesman. (D) A statistician. (E) A chemist.
19. According to the text, which of the following statement is false? (A) The culture of science often emphasizes the differences between approaches. (B) We should train students for only one domain of expertise. (C) Many scientific advances rely on the multidisciplinary approach. (D) The author realizes that pipetting correctly for hours on end is difficult. (E) The author enjoyed his time at graduate school.
20. Why does the author want to create a soggy lab? (A) To teach students a variety of approaches from different fields. (B) To train students master every discipline. (C) To break the dichotomy between wet lab and dry lab research. (D) A & C. (E) All of above.

Q 21-25 are based on a review article in Annual Reviews of Psychology in 2018.

"Women are from Venus, men are from Mars" is a phrase that is often used to explain observed differences in the way women and men think, feel, and act. It conveys the inevitability of such differences by suggesting that men and women originate from planets that are light-years apart, implying that they are as inherently different as they would be if they were separate species.

There is no denying that there are differences between men and women in many life domains. The question, however, is to what extent these differences reflect the way men and women essentially *are*, and to what extent they result from how we *think* men and women differ from each other because of gender stereotypes. Identifying the nature and content of gender stereotypes clarifies the fact that they not only describe typical differences between men and women, but also prescribe what men and women should be and how they should behave in different life domains.

In light of the visible evidence that men as well as women can and do care for family members and friends and that women as well as men can display high levels of performance and ambition, it would seem silly to maintain that warmth typifies (all) women and competence characterizes (all) men.

Indeed, at present, many people would be reluctant to explicitly make such claims. Nevertheless, their private convictions and implicit beliefs still often rely on these stereotypical associations—without them realizing that this is the case. For instance, in computerized reaction time tasks, people more quickly and

effortlessly connect names and faces of women to various aspects of family life, whereas names and faces of men come more easily to mind when thinking about professional careers. Indeed, across different cultures and contexts, even those who are reluctant to claim that women are less competent (i.e., do not endorse hostile sexist views) may still believe that women are particularly sensitive and need to be protected by men (so-called benevolent sexism).

People find it difficult to recognize that these more subtle and implicit beliefs may also reflect stereotypical views of women and men. Yet the gender stereotypes implicitly endorsed in this way can overrule more explicitly stated intentions to treat men and women equally. For instance, the admiration for stereotypical qualities of women that characterizes endorsement of benevolent sexist views is associated with acceptance of domestic violence against women and a desire to restrict their rights to regulate pregnancy and reproduction. In couples that implicitly endorse gender stereotypes in this way, the needs of the male partner for intimacy are prioritized over the achievement ambitions of the female partner. In task contexts, benevolent and implicit—rather than more hostile and explicit—references to gender stereotypes cause women to downplay their achievements and ambitions and to emphasize their interpersonal skills.

The power of implicit beliefs is also visible among parents, even those who claim that they show no difference in how they raise boys and girls. Those who implicitly make gender stereotypical associations are more likely to behave differently toward their sons than their daughters, for instance, when disciplining them. Thus, from a very early age, children are implicitly taught about gender stereotypes and reproduce them in their own beliefs and behaviors. For instance, the implicit assumption that math is not for girls is already observed among girls at age nine. This assumption becomes stronger in adolescence and better predicts academic achievement and enrollment preferences than girls' explicit views about gender and math. Thus, even though explicit attitudes toward men and women have become more egalitarian over the years—and, in many countries, legislation is in place to enforce equal treatment—at the implicit level, gender stereotypes continue to shape our judgments and behaviors.

21. What does the phrase "Women are from Venus, men are from Mars" mean? (A) In ancient times, women lived in Venus, man lived in Mars. (B) The differences between women and men are huge. (C) Both women and men love on Earth. (D) Both women and men are human beings. (E) All of above.

22. Why do we need to identify the nature and content of gender stereotypes? (A) Because women and men are separate species. (B) Because gender stereotypes prescribe what men and women should be. (C) Because gender stereotypes prescribe how mean and women should behave in different life domains. (D) B & C. (E) A & C.

23. According to the text, which of the following statement is correct? (A) All women are warm, whereas all men are competent. (B) All women want to marry and have children, whereas all men love sports. (C) The implicit gender stereotypes continue to shape our judgments and behaviors in daily life. (D) Gender stereotypes are good attitudes and should be explicitly claimed. (E) None of above.

24. According to the text, what are the drawback(s) of "benevolent sexism"? (A) Acceptance of domestic violence against women. (B) Cause women to downplay their achievements and ambitions and to emphasize their interpersonal skills. (C) The needs of the male partner for intimacy are prioritized over the achievement ambitions of the female partner. (D) A desire to restrict their rights to regulate pregnancy and reproduction. (E) All of above.

25. By what age the implicit assumption that math is not for girls is first observed? (A) 3. (B) 5. (C) 7. (D) 9. (E) 15.

B. Translation: Please read the following five passages and translate them into Chinese. (5 passages, 5 points each, total 25 points for Part B)

Passage #1 is adopted from a research article in Molecular Psychiatry on Sep. 15, 2017.

A new hypothesis, named the 'undirected susceptibility to change hypothesis', posits that selective serotonin reuptake inhibitor (SSRI) treatment does not drive changes in mood *per se* but, by increasing brain plasticity, creates a window of opportunity for a change that is driven by the quality of the environment. In particular, the increase in serotonin levels, induced by SSRIs, enhances neural plasticity and thus renders the individual more susceptible to the environment. The main consequence of such hypothesis is the lack of univocal outcome of SSRI administration: in a favorable environment, treatment leads to a reduction of symptoms; by contrast, in a stressful environment, it leads to a worse prognosis.

Passage #2 is adopted from a "Correspondence" article in Nature on Dec. 21, 2017.

In my experience, by far the most distracting external noise is a conversation about an interesting topic of research, particularly if it is sufficiently close to my own work that I have to listen. Even if it does not directly affect my research, it still commands my intense concentration and attention to details of data, mathematics, computer coding and logical development. An occasional disturbance of this nature is acceptable, given that it can lead to cross-fertilization of knowledge and ideas. As head of a research group for almost 40 years, I have surreptitiously fostered just such a scheme by using a comfortable coffee area as a discussion platform with a blackboard to hand — and discreetly siting two more in the abutting corridors.

Passage #3 is adopted from a "News" article in Science on Dec. 22, 2017.

On 17 August, scientists around the world witnessed something never seen before: One hundred and thirty million light-years away, two neutron stars spiraled into each other in a spectacular explosion that was studied by observatories ranging from gamma ray detectors to radio telescopes. The blast confirmed several key astrophysical models, revealed a birthplace of many heavy elements, and tested general relativity as never before. Especially remarkable was the way the event was spotted: by detecting the infinitesimal ripples in space itself, called gravitational waves, that the spiraling neutron stars radiated before they merged. The merger poses puzzles that whet astrophysicists' appetites for more such collisions. Through gravitational-wave astronomy, scientists also hope to see new types of events, such as mergers of a neutron star and a black hole, which theory suggests are rare, or supernova explosions of individual stars in our Milky Way galaxy.

Passage #4 is adopted from a review article in Biological Psychiatry on Feb. 1, 2018.

There has been an explosion of interest in the study of microorganisms inhabiting the gastrointestinal tract (gut microbiota) and their impact on host health and physiology. Accumulating data suggest that altered communication between gut microbiota and host systems could participate in disorders such as obesity, diabetes mellitus, and autoimmune disorders as well as neuropsychiatric disorders, including autism, anxiety, and major depressive disorders. The conceptual development of the microbiome-gut-brain axis has facilitated understanding of the complex and bidirectional networks between gastrointestinal microbiota and their host, highlighting potential mechanisms through which this environment influences central nervous system physiology. However, uncertainty remains regarding the generalizability of controlled animal studies to the more multifaceted pattern of human pathophysiology, especially with regard to the therapeutic potential for neuropsychiatric health.

Passage #5 is adopted from a "Editors' Choice" article in Science on Aug. 25, 2017.

The beautiful songs of male humpback whales are composed of a sequence of sounds that is repeated to form a theme, and themes are sung in a particular order to form the song. Whale songs sometimes change rapidly, with males in one population quickly adopting the song type of another. To understand how learning of a new song takes place, Garland *et al.* studied two rapid changes during which four clear recordings of the rare transitional stage between old and new songs were made. The males learned the new songs by joining new and old themes, sometimes creating a hybrid theme. This learning had aspects in common with that observed in certain songbirds and even humans.