前期日程

科目　外国語（英語）

医　学　部　医　学　科

注　　意

1. 開始の合図があるまで，この問題冊子を開いてはいけません。
2. 問題は１ページから９ページにわたっています。
3. 解答用紙は３枚，下書用紙は１枚で，問題冊子とは別になっています。
4. 問題冊子，解答用紙，下書用紙に不備がある場合は，直ちにその旨を監督者に申し出てください。
5. すべての解答用紙の所定の欄に，志望学部・学科（１か所）と受験番号（２か所）を記入してください。
6. 解答は，すべて解答用紙の所定の欄に記入してください。解答用紙の所定の欄以外に記入された解答は，評価（採点）の対象としません。
7. 試験終了後，問題冊子と下書用紙は持ち帰ってください。

1 **Read the following passage and answer the questions that follow. All questions must be answered in English. Words marked with an asterisk (*) are defined at the end of this passage in the Notes section.**

Twice, quarterback Patrick Mahomes has led the Kansas City Chiefs to victory in the Super Bowl, the championship of U.S. football. Although most fans have their eyes on the ball as Mahomes prepares to throw, his tongue does something just as interesting. Just as basketball star Michael Jordan did as he went up for a dunk, and dart players often do as they take aim for a bull's-eye, Mahomes prepares to pass by sticking out his tongue. That may be more than a silly habit, some scientists say. Those tongue actions may improve the accuracy of his hand movements.

A small but growing group of researchers is fascinated by an organ we often take for [(A)]. We rarely think about how fast and flexible our own tongue needs to be to form words or avoid being bitten while helping us taste and swallow food. But that's just the start of (B) the tongue's versatility across the animal kingdom. Without tongues, few if any of earth's **vertebrates*** could exist. The first of their ancestors to crawl out of the water some 400 million years ago found a buffet stocked with new types of foods, but (C) [a / took / tongue / sample them / to / it]. The range of foods available to these pioneers broadened as tongues diversified into new, specialized forms—and ultimately took on functions beyond eating.

"The incredible variation in vertebrate tongue form is filled with astonishing examples of almost unbelievable adaptation," says Kurt Schwenk from the University of Connecticut. **Salamanders*** whipping out sticky tongues longer than their bodies to catch insects; snakes "smelling" their environment with their forked tongue tips; hummingbirds drinking nectar from deep inside flowers; bats clicking their tongues to **echolocate***—all show how tongues have enabled vertebrates to exploit every part of land and sea. In humans, still more functions crowded aboard the tongue. "I am amazed by everything we do with our tongue: eat, talk, kiss. It's (D) [central / a human / to / what / a / part of / it is / be]," says Jessica Mark Welch from the Forsyth Institute.

(E) Managing these functions triggered the expansion of brain capacity, paving the way not just for throwing touchdown passes, but perhaps also for thinking on our [(F)]. "The idea is that if you can reach with your tongue, you can reach with your hands, and you can reach with your thoughts," says Ian Whishaw from the University of Lethbridge. "Intuitively, perhaps we know this," he adds when we use phrases like "[(G)] of the tongue," "slip of the tongue," and "biting my tongue."

Yet how tongues came about "is one of the biggest mysteries in our evolutionary history," says Sam Van Wassenbergh from the University of Antwerp. Like other soft tissues, tongues are rarely preserved in fossils. Hidden inside the mouth, they resist easy observation. In the past decade, however, new technologies have begun to reveal tongues in action in different groups of animals. That work is beginning to yield new insights about the tongue's evolutionary path, and how its specializations fueled further diversification. Kory Evans from Rice University says the more biologists learn, the more convinced they are that "tongues are really fantastic."

A (H) [to / slippery thing / a / turns / tongue / to be / define / out]. Although tongue-like structures exist in virtually all vertebrates, from **lampreys*** to mammals, "There is no clear definition to what makes a 'true tongue,'" says Daniel Schwarz from the State Museum of Natural History Stuttgart. We think tongues are soft, muscular, and flexible—like our own. The human tongue is a muscular **hydrostat***, which, like a water balloon, must maintain the same overall volume when its shape changes. So, when Mahomes sticks out his tongue, it gets thinner overall than when it's just bunched up in his mouth; the same is true for a giraffe's purple tongue when it stretches 46 centimeters to catch leaves from a spiny tree branch.

But stranger cases exist elsewhere in the animal kingdom. The organ on the roof of the mouth of fish such as carp and catfish can also be a bundle of muscle, but biologists are doubtful whether it should be considered a tongue. "Instead of being at the bottom of the mouth, it's at the top," says Patricia Hernandez from George Washington University. And despite many ideas, no one really knows this organ's function, Hernandez adds.

That's because fish don't need tongues like ours to swallow their food. They can rely on suction. They open their jaws wide, expand their throats, and pump water through their gill slits to create currents that sweep in food.

But, "The (I) [the water / animals / of / their head / moment / out / stick], suction becomes useless," says Schwenk, who has devoted his career to the study of animal tongues. Once those creatures made landfall, "they needed something to take the place of water" to draw prey into their digestive system—and air is not dense enough. For millions of years, early land creatures likely crawled back to the ocean to swallow prey caught on land. A few may have held their heads up high and let gravity do the work, like many birds today.

But the makings of a new way of feeding were already present in fish anatomy: a series of curved bones and the supporting muscles. In fish these curved bones form the jaws, the hyoid bone that supports the back of the jaw, and the skeleton that forms the throat and gill slits. When fish feed, muscles supporting these structures generate suction by depressing and retracting the hyoid and expanding the gill slits to draw water in. To tongue specialists, those motions (J) look familiar. "The hyoid's movement to generate suction is very similar to the movement of the tongue back and forth to manipulate prey," Schwenk explains.

Schwenk and Van Wassenbergh think that in early land vertebrates, the curved bones and related muscles began to change to form a "prototongue," perhaps a muscular pad attached to the hyoid that flapped when the hyoid moved. Over time, the pad became longer and more controllable, and more skilled at grabbing and maneuvering prey.

Based on experiments with **newts***, Schwarz thinks a prototongue became functional even before the transition to land. Like other salamanders, newts are aquatic when young but mostly live on land as adults. Their **metamorphosis***, and the change in feeding strategies that accompanies it, might be akin to water-to-land changes that occurred hundreds of millions of years ago. And it holds a clue to how those changes might have unfolded.

Schwarz and his team found that before newts transform into full-fledged adults, they develop a tongue-like **appendage*** that presses food against sharp, needle-like "teeth" on the roof of their mouth. The finding, which he and his colleagues reported in 2020, suggests a tongue-like structure may have helped early four-footed animals feed, even before they climbed onto solid ground.

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It is in mammals that the tongue displays its fullest versatility. The mammalian tongue has evolved into a complex network of muscle fibers capable of moving in complex ways even without any bones, tendons, or joints. It contributes to suckling in most species, helps with thermoregulation in some, and takes on even more specialized tasks in a few, such as producing the sounds used for echolocation in bats and speech in humans. And it hosts the taste buds that help guide feeding in all these species. "The tongues of most mammals perform great feats," says David Hu from the Georgia Institute of Technology. "It's truly a multifunctional tool, and has only received less attention because it is less accessible than an animal's external appendages."

The tongue's most essential job in mammals (K) is to position food to be chewed and swallowed. Depending on the species, that could mean shifting the food from one side to another with each bite or confining it to just one side, while the tongue itself stays safely away from chomping teeth. Then, with the addition of saliva it helps produce, the tongue shapes mashed food into a rounded "**bolus***" that can fit easily down the throat. Finally, it pushes that bolus back to be swallowed, making sure no food enters the airways. In a sense, the tongue has become a "hand of the mouth," (L) says J.D. Laurence-Chasen from the National Renewable Energy Laboratory.

All this processing enables mammals to digest food more rapidly and efficiently, so they get more from their diet than most other animals. That bounty has fueled other evolutionary advances, such as high metabolic rate and activity, prolonged pregnancies, and large brains. Indeed, Callum Ross from the University of Chicago counts (M) the origin of chewing as one of the three course-changing evolutionary transitions enabled by the tongue, along with the shift from water to land and the origin of human speech.

(N) Until recently, researchers couldn't get a detailed view of how the tongue maneuvers food because lips, cheeks, and teeth got in the [(O)]. But lately Ross's group has been using a technique called x-ray reconstruction of moving morphology (XROMM) that involves recording the movements of surgically implanted beads with x-rays and turning the results into 3D animations.

In their experiments with monkeys, cameras simultaneously capture images from different angles as an animal eats or drinks, and the reconstructed animation allows the researchers to see how the tongue moves in relation to the jaws and teeth. "We are able to see features of movement that were utterly hidden," explains Elizabeth Brainerd from Brown University and an XROMM pioneer who has advised Ross on how to adapt this technology for his studies. By comparing tongue movements in different species, researchers hope to learn how tongue specializations may have contributed to the evolution of each animal's lifestyle and food preferences.

(Elizabeth Pennisi, 2023, *Science*, extracted and modified.)

*Notes:

vertebrate: an animal having a backbone

salamander: a tailed animal that lives in water and on land

echolocate: to find the way using soundwave

lamprey: any eel-like fish, having a round mouth with horny teeth

hydrostat: an electrical device for detecting the presence of water, as from overflow or leakage.

newt: a small, slender-bodied animal that lives in water and on land

metamorphosis: a process in which something changes completely into something very different

appendage: a part or organ such as an arm, leg, tail or fin

bolus: a soft roundish mass of chewed food

(1) Choose the letter for the most suitable word from the list below, (a) through (i), to fill in the blanks [(A)], [(F)], [(G)], and [(O)] respectively.

(a) arms	(b) guaranteed	(c) teeth
(d) road	(e) tip	(f) way
(g) granted	(h) feet	(i) touches

(2) From the options below, select as many appropriate choices (letters) as possible that correspond to the passage's context of (B) the tongue's versatility.

(a) Snakes use their forked tongues to sense the smells in their surroundings.

(b) The bone and muscle structures of early fish formed the prototypes for teeth and tongues.

(c) Salamanders utilize their sticky tongues to hook insects.

(d) Humans use their tongues only to send signals to their beloved ones.

(e) Birds lift their heads up high always using their tongues to swallow their prey whenever they catch them.

(f) Long before early four-legged creatures first ventured onto land, they already possessed tongue-like structures similar to teeth.

(g) Mammalian tongues are multifunctional; they enable us to eat, speak, kiss, and taste.

(3) Put the words in the square brackets of (C), (D), (H), and (I) in the correct order.

(4) Which theory or idea is suggested by the fact that (E) Managing these functions triggered the expansion of brain capacity? Identify the sentence that answers this question in the passage and provide the first and last five words of the sentence in English. Do not count punctuation marks (" ") or periods (.) in your count.

(5) What do (J) those motions refer to? Write your answer following "Those motions refer to" on your answer sheet.

(6) Which of the following descriptions (a) through (f) are included in (K)The tongue's most essential job in mammals? Choose the correct sentences and write the corresponding letters of the chosen sentences in the order as appearing in the passage.

(a) The tongue serves to position food by moving it from one side of the mouth to the other with each bite, while the tongue skillfully avoids getting bitten by the teeth.
(b) The tongue helps the food not to get into the airways.
(c) The tongue, housing taste buds, plays a crucial role in guiding eating behavior across mammals.
(d) The tongue moves a "bolus" towards the back for swallowing.
(e) The tongue hasn't been studied as much because it's harder to reach than an animal's outer body parts.
(f) Adding saliva, the tongue assists in forming a "bolus."

(7) As for (L), how has the tongue developed its movement like a hand of the mouth? Identify one sentence that answers this question the best, and provide the first and last five words of the sentence in English. Do not include quotation marks (" ") or periods (.) in your answer.

(8) Why does Callum Ross count (M)the origin of chewing as one of the course-changing evolutionary transitions? Describe it within 50 English words.

(9) Why couldn't researchers obtain a detailed view of how the tongue maneuvers food, as mentioned in the underlined section (N)"Until recently, researchers couldn't get a detailed view of how the tongue maneuvers food"? Find and copy the sentences from the passage that describe the reasons most appropriately.

2 **Read the passage below and answer the questions. All questions must be answered in English. Words marked with an asterisk (*) are defined at the end of this passage in the Notes section.**

On a chilly holiday Monday in January 2020, a medical milestone passed largely unnoticed. In a New York City operating room, surgeons gently removed the heart from a 43-year-old man who had died and shuttled it steps away to a patient in desperate need of a new one.

More than 3,500 people in the United States (U.S.) receive a new heart each year. But (A) this case was different—the first of its kind in the country. "It took us 6 months to prepare," says Nader Moazami, surgical head of heart transplantation at New York University (NYU) Langone Health, where the operation took place. The run-up included oversight from an ethics board, education sessions with nurses and anesthesiologists, and lengthy conversations with the local organization that represents organ donor families. Physicians spent hours practicing in the hospital's **cadaver*** lab, prepping for organ recovery from the donor. "We wanted to make sure that we controlled every aspect," Moazami says.

That's because this donor, unlike most, was not declared dead because of loss of brain function. He had been suffering from end-stage liver disease and was in a coma and on a ventilator, with no hope of regaining consciousness—but his brain still showed activity. His family made the painful choice to remove life support. Following that decision, they expressed a wish to donate his organs, even agreeing to transfer him to NYU Langone Health before he died so his heart could be recovered afterward.

In individuals declared brain dead, organs can be recovered before life support is disconnected, as these people have already died; such machinery keeps organs oxygenated and healthy prior to transplant. But for this man the donation process would be altered: Life support had to be withdrawn for death to occur. His heart stopped, and his circulation with it.

As is customary regardless of whether organs will be donated, physicians waited 5 minutes to ensure that the heart didn't start beating again on its own. It did not, and the man was declared dead. The baton then passed to the organ recovery and transplant team. They clamped blood vessels running from the **torso*** to the brain and reconnected his body to machines that circulated oxygenated blood, causing the heart to begin pumping again.

These two interventions—initiating a heartbeat after death is declared and taking steps to prevent blood flow to the brain—are at the core of a raging debate about the ethics of such donations. To some people, the approach risks disrupting the dying process; to others, it allows that process to continue as the family desires, while also honoring individual or family wishes for organ donation.

The debate touches on the definition of death, Moazami says. "When the heart stops, we say, 'time of death, 5:20 a.m.'" But, "The fact of the matter is, death is a process. Death is not a time point." Cells can take hours to die. Sophisticated machinery can induce a heartbeat hours after death, but does that make a person "alive"?

An expanding number of hospitals and organ procurement organizations (OPOs), which work with donor families, support this novel category of donations, and the number performed in the U.S. is growing. "I had about 3 months, tops," left to live, says Tony Donatelli, 41, who lives near San Diego with his wife and two young children, and who developed a rare disease that causes a dangerous buildup of protein in the body. On Valentine's Day 2022, he became the first person in the world known to receive a heart, liver, and kidney from a donor whose organs were **perfused*** after circulatory death. Donatelli is back to surfing, woodworking, and wrestling on the floor with his sons. "I cannot tell you how lucky I am," he says.

Yet professional groups have expressed dueling views about (B) <u>the new organ donation strategy</u>, and a paper in press urges more research. Some countries are holding off on these organ donations, whereas others embrace them. One OPO says families who welcome donation do so without regard for the organ recovery technique, as such gifts can bring comfort after a terrible loss; another worries that without more research and greater attention to legal and ethical questions, there's a risk fewer people may volunteer to be organ donors. Meanwhile, surgeons say this category of donors could increase heart transplants by up to 30%, saving lives with organs that would otherwise go unused.

"There is definitely that initial reaction that there's something different" about this, says Anji Wall, an abdominal transplant surgeon and bioethicist at Baylor University Medical Center. Although Wall acknowledges the complexities, she supports such transplants and has performed them herself. "At the end of the day, the donor is dead," she says. "What you do does not make them alive again."

(Jennifer Couzin-Frankel, 2023, *Science*, extracted and slightly modified)

*Notes:**

cadaver: a dead human body

torso: the main part of the body, not including the head, arms or legs

perfused: recirculated

(1) As for the underlined statement (A), how was this case different? Make a list of the differences. Each difference must be written in a full sentence in English. You can use some of the expressions in the passage if it is necessary.

(2) What do you think about the new donation strategy (B)? Write your thoughts about it in about 300 words in English.