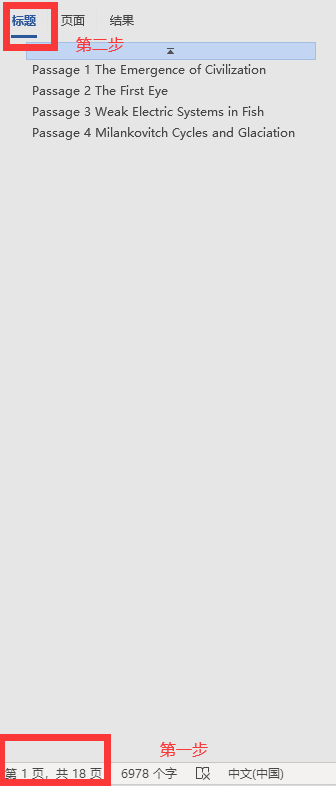
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# Passage 1 The Emergence of Civilization

**(2015.3.14)**Paragraph1

Starting around 8000 B.C.E., the most extensive exploitation of agriculture occurred in river valleys, where there were both good soil and a dependable water supply regardless of the amount of rainfall. In the Near East, this happened in the Fertile Crescent, the region extending up the Nile Valley in Egypt, north through the Levant (Palestine, Lebanon, and Syria), and southeast into the Tigris and Euphrates river valleys of Mesopotamia. The richest soil was located in the deltas at the mouths of the rivers, but the deltas were swampy and subject to flooding. Before they could be farmed, they needed to be drained and irrigated, and flood-control systems had to be constructed. These activities required administrative organization and the ability to mobilize large pools of labor. In Mesopotamia, perhaps as a consequence of a period of drought, massive land-use projects were undertaken after 4000 B.C.E. to cultivate the rich delta soils of the Tigris and Euphrates Rivers. The land was so productive that many more people could be fed, and a great population explosion resulted. Villages grew into cities of tens of thousands of persons.

**1. Which of the following helps explain why the most extensive exploitation of agriculture occurred in river valleys?**

1. In river valleys farmers did not have to depend on rain for water.
2. The soil in river valleys did not require irrigation.
3. Swampy areas in river valleys were easy to drain.
4. The expanding populations in river valleys provided large pools of labor.

**2. Why does the author mention a period of drought?**

1. To help explain why the richest soils in the Near East were located in the deltas at the mouths of the Tigris and Euphrates Rivers
2. To suggest a reason for undertaking the massive effort to make the deltas of the Tigris and Euphrates Rivers farmable
3. To identify a condition that often affected agricultural production in Mesopotamia
4. To support the idea that mobilizing large pools of labor after 4000 B.C.E. required significant administrative organization

**3. According to paragraph 1, what was one result of the farming systems developed in river deltas in the Near East?**

1. There was a large increase in the overall amount of food produced
2. Large pools of labor became available to perform administrative tasks.
3. The soil in these deltas grew much richer.
4. The number of farming villages surrounding cities increased.

Paragraph 2:

These large cities needed some form of centralized administration. Archaeological evidence indicates that the organization initially was provided by religion, for the largest building in each city was a massive temple honoring one of the Mesopotamian gods. In Uruk, for example, a 60-foot- long temple known as the White House was built before 3000 B.C.E. There were no other large public buildings, suggesting that the priests who were in charge of the temples also were responsible for governing the city and organizing people to work in the fields and on irrigation projects building and maintaining systems of ditches and dams.

**4. According to paragraph 2, the fact that temples appear to have been the only large public buildings in Mesopotamian cities has been interpreted as evidence that these cities**

1. needed some form of central administration
2. were initially administered by priests
3. were all governed from Uruk
4. had difficulty organizing workers for building projects

Paragraph 3:

The great concentration of wealth and resources in the river valleys brought with it further technological advances, such as wheeled vehicles, multicolored pottery and the pottery wheel, and the weaving of wool garments. Advances in metal technology just before 2000 B.C.E. resulted in the creation of bronze, a durable alloy (or mixture) of about 90 percent copper and 10 percent tin that provided a sharp cutting edge for weapons.

**5. The word “durable” in the passage is closest in meaning to**

1. existing for a long time without significant damage
2. difficult to produce
3. recently discovered
4. extremely useful

**6. Paragraph 3 indicates that technological advances affected all of the following EXCEPT**

1. transportation
2. clothing manufacture
3. warfare and hunting
4. the distribution of wealth and resources

Paragraph 4:

By 3000 B.C.E., the economies and administrations of Mesopotamia and Egypt had become so complex that some form of record keeping was needed. As a result, writing was invented. Once a society became literate, it passed from the period known as prehistory into the historic period. In fact, the word “history” comes from a Greek word meaning narrative people could not provide a detailed permanent account of their past until they were able to write.

**7. According to paragraph 4, why was writing invented**

1. To reduce unnecessary social complexity
2. To keep economic and administrative records
3. To record oral historical narratives
4. To help people better understand their own past

Paragraph 5:

The totality of these developments resulted in the appearance, around 3000 B.C.E., of a new form of culture called civilization. The first civilizations had several defining characteristics. They had economies based on agriculture. They had cities that functioned as administrative centers and usually had large populations. They had different social classes, such as free persons and slaves. They had specialization of labor, that is, different people serving, for example, as rulers, priests, craft workers, merchants, soldiers, and farmers. And they had metal technology and a system of writing. As of 3000 B.C.E., civilization in these terms existed in Mesopotamia, Egypt, India, and China.

**8. The word defining in the passage is closest in meaning to**

1. important
2. obvious
3. identifying
4. interesting

**9. According to paragraph 5, all of the following are true of the first civilizations EXCEPT:**

1. Their soldiers and priests also worked as farmers.
2. Their populations were divided into different social classes.
3. They had developed technologies for working with metals.
4. They were typically administered from large cities.

Paragraph 6:

This first phase of civilization is called the Bronze Age because of the importance of metal technology. The most characteristic Near Eastern Bronze Age civilizations, those of Mesopotamia and Egypt, were located in river valleys, were based on the extensive exploitation of agriculture, and supported large populations. Bronze was a valuable commodity in these civilizations; the copper and tin needed for its manufacture did not exist in river valleys and had to be imported. ■Bronze was therefore used mainly for luxury items, such as jewelry or weapons, not for everyday domestic items, which were made from pottery, animal products, wood, and stone. ■In particular, bronze was not used for farming tools. ■Thus, early civilizations based on large-scale agriculture, such as those of Mesopotamia and Egypt, were feasible only in soils that could be worked by wooden plows pulled by people or draft animals such as oxen. ■Other Bronze Age civilizations, however, such as those that arose in the Levant and eastern Mediterranean, took advantage of their location on communication routes to pursue economies based on trade.

**10. The word domestic in the passage is closet in meaning to**

1. Practical
2. Household
3. Standard
4. Necessary

**11. According to paragraph 6, why was bronze not used for farming tools in Bronze age civilizations of the Near East**

1. Wooden farming tools were more effective in the soils of the region.
2. Bronze farming tools would have deteriorated quickly in the climate.
3. Bronze was too expensive to use for farming tools.
4. People had not yet discovered how to make farming tools out of bronze.

**12. According to paragraph 6, which of the following was true of at least some civilizations of the Bronze Age?**

1. They did not develop urban centers with large populations.
2. They did not use metals to make bronze.
3. They had an economy that was not based on agriculture.
4. They did not use bronze for luxury items such as jewelry.

**13. Look at the four squares [■] that indicate where the following sentence could be added to the passage.**

*This significantly limited the availability of bronze.*

**14. Directions: An introductory sentence for a brief summary of the passage is provided below. Complete the summary by selecting the THREE answer choices that express the most important ideas in the passage. Some sentences do not belong in the summary because they express ideas that are not presented in the passage or are minor ideas in the passage. This question is worth 2 points.**

Drag your choices to the spaces where they belong. To review the passage, click on View Text.

**Answer Choices**

1. Before the rise of large cities with complex economies, there had been no need for any kind of administrative structure to organize workers, and thus religion tended to be the only source of authority.
2. Large cities functioned as administrative centers, creating a concentration of wealth and resources that stimulated technological advances, such as the invention of writing and the creation of bronze.
3. By 3000 B.C.E., a number of agricultural societies had emerged as civilizations characterized by large cities, centralized administrations,、、、、、、、、、、、、、、、、、、、、、、、、、、、、、、、、、、、、、、、、、、 specialization of labor, class divisions, metal technology, and writing.
4. For a culture to be considered a civilization, it must have independently invented its own form of writing and become generally literate, thereby moving from prehistory into the historic period.
5. Although river-valley societies had to import the metals for making bronze, the first phase of civilization is known as the Bronze Age because of the importance of metal technology in these societies.
6. The creation of bronze made it possible for civilizations based on large-scale agriculture to be located far away from the river valleys and deltas in areas where the soil was less rich and less easy to work.

# Passage 2 The First Eye(2015.3.14)

Paragraph 1:

Putting a date on the first appearance of eyes depends on what one means by eye. If the term refers to a multicellular organ, even if it has just a few cells, then by definition, eyes could not form before there were multicellular animals. But many protists (animal-like, plantlike, or fungus-like unicellular organisms that require a water-based environment) can detect light by using aggregations of pigment molecules, and they use this information to modify their metabolic activity or motility (the ability to move spontaneously and independently). One of the familiar living examples, probably known to anyone who has taken a biology class, is the aquatic protozoan Euglena, which has an eyespot near its motile fIagellum (hairlike structure). Some living protists are very like their ancestral forms embedded in ancient sedimentary rocks, and this similarity suggests that the ability to detect light and modify behavior in response to light has been around for a very long time. Animals arose from one of such unicellular creatures, perhaps from one already specialized for a primitive kind of vision.

**1. The word “aggregations” in the passage is closest in meaning to**

1. Parts.
2. Reactions.
3. Groups.
4. Types.

**2. Paragraph 1 supports all of the following statements about protists EXCEPT:**

1. Some are multicellular.
2. Some are able to move.
3. Some have pigment molecules.
4. They live in environments that contain moisture.

**3. According to paragraph 1, what have scientists concluded from the fact that some living protists are very like their ancestral forms**

1. The eye did not evolve until multicellular organisms arose.
2. The ability to detect light and change behavior in response to light has existed for a long time.
3. The ancestral forms of these living protists likely had an eyespot near the motile flagellum.
4. The ancestral forms of these living protists depended primarily on light as the mechanism for modifying their metabolic activity or motility.

Paragraph 2:

An eye is a collection of cells that are specialized for light detection through the presence of photosensitive pigment as well as a means of restricting the direction of incoming light that will strike the photosensitive cells. This definition says nothing about image formation, lenses, eye movements, or any of the other features we associate with our own eyes, but it does recognize the simplest form of functional and anatomical specialisation namely, detection of light. Everything else can be built up from this simple beginning, and some animals appear to have had eyes almost from the beginning of the animal kingdom.

**4. Paragraph 2 implies which of the following about the early eyes**

1. They were able to detect simple movements almost from the beginning of their evolution.
2. They were not as sensitive to light as once thought.
3. They could not form images.
4. Their cells had more photosensitive pigment than do human eyes

Paragraph 3:

Animals were scarce 600 million years ago in the geological era called the Precambrian. There are very few fossil remains from that time (though more keep turning up), and most evidence of the presence of animals is indirect, such as small tunnels in rock that could be ancient worm burrowings. But just 50 million years or so later, fossilized bits and pieces of animals abound, suggesting that a great burst of evolutionary creativity occurred in the 50-million-year interval. This surge of new life, marked by an abundance of animals, is called the Cambrian explosion.

**5. Which of the sentences below best expresses the essential information in the highlighted sentence in the passage. Incorrect choices change the meaning in important ways or leave out essential information.**

1. There are few fossils from the Precambrian, though more keep turning up.
2. Most evidence of animals in the fossil record is indirect and little of it is from the Precambrian.
3. Tunnels in Precambrian rocks that may have been made by worms provide indirect evidence of these animals existing at that time.
4. There are very few fossils of animals from the Precambrian and most evidence of animal life from that period is indirect.

**6. According to paragraph 3, the Cambrian period was characterized by**

1. A great abundance of animals
2. A slow rate of animal extinction
3. The rapid fossilization of animals
4. An increase in the life span of some animals

Paragraph 4:

The first direct evidence for the early origin of eyes comes from fossils that are about 530 million years old, a time shortly after the Cambrian explosion; they were found on a mountainside in British Columbia in a deposit known as the Burgess Shale. The Burgess Shale fossils are extraordinarily important because among them are remains of soft-bodied creatures, many of them lacking shells and other hard parts that fossilize easily. Consequently, their preservation is little short of miraculous (as are the delicate methods used to reconstruct three-dimensional structure from these flattened fossils), and they are one of the few known repositories of early soft-bodied animals.

**7. The phrase little short of miraculous is closest in meaning**

1. To very highly valued
2. Amazing because almost impossible
3. Causing controversy
4. Almost but not quite complete

**8. According to paragraph 4, all of the following are true of the Burgess Shale EXCEPT:**

1. Its fossils were in a flattened condition when discovered.
2. Its fossils provide direct evidence about the origin of eyes.
3. It contains fossils of both Precambrian and Cambrian animals.
4. It contains fossilized remains of soft-bodied organisms.

Paragraph 5:

Not all of the Burgess animals had eyes. However, some did. (Gross features location, size, and hemispheric shape are responsible for the designation of some structures as eyes). The reconstructed eyes of these Burgess animals look superficially like eyes of some living crustaceans, particularly those of shrimp and crabs whose eyes are mounted on stalks that improve the range of vision by raising the eyes above the surface of the head. The eyes of some Burgess organisms sat on stalks; those of others were on or a part of the body surface. One animal, Opabinia, had five eyes: two lateral pairs and a single medial eye; at least one of the lateral pairs had stalks that could have been movable. And some trilobite-like animals in the Burgess Shale had faceted eyes much like those of later fossil trilobites.

**9. The word designation in the passage is closest in meaning to**

1. Evolution
2. Identification
3. Reconstruction
4. Confusion

**10. The word lateral in the passage indicates a location at the**

1. Front
2. Back
3. Top
4. Side

**11. Why does the author point out that The eyes of some Burgess organisms sat on stalks?**

1. To suggest that some Burgess organisms had a greater range of vision than do living shrimp and crabs
2. To explain why it is thought that one of the lateral pairs of eyes in Opabinia may have been movable
3. To explain why the eyes of some Burgess animals were not recognizable as such before they were reconstructed
4. To support the statement that the reconstructed eyes of Burgess animals look superficially like the eyes of some living crustaceans

Paragraph 6:

Although the presence of eyes on some of the Burgess animals indicates that eyes have been around for a very long time, it is unlikely that these were the first eyes; they seem much too large and (potentially) well developed to be brand new inventions. The best we can do is put the origin of eyes somewhere between the beginning of the Cambrian explosion, about 600 million years ago, and the death of the Burgess animals, some 530 million years ago.

**12. Paragraph 6 suggests that the first eyes probably**

1. Came into existence long before 600 million years ago
2. Came into existence at a late point in the Cambrian period
3. Existed before the animals of the Burgess Shale existed
4. Were larger than those of animals found in the Burgess Shale

Paragraph 1:

Putting a date on the first appearance of eyes depends on what one means by eye. If the term refers to a multicellular organ, even if it has just a few cells, then by definition, eyes could not form before there were multicellular animals. ■But many protists (animal-like, plantlike, or fungus-like unicellular organisms that require a water-based environment) can detect light by using aggregations of pigment molecules, and they use this information to modify their metabolic activity or motility (the ability to move spontaneously and independently). ■One of the familiar living examples, probably known to anyone who has taken a biology class, is the aquatic protozoan Euglena, which has an eyespot near its motile fIagellum (hairlike structure). ■Some living protists are very like their ancestral forms embedded in ancient sedimentary rocks, and this similarity suggests that the ability to detect light and modify behavior in response to light has been around for a very long time. ■Animals arose from one of such unicellular creatures, perhaps from one already specialized for a primitive kind of vision.

**13. Look at the four squares [■] that indicate where the following sentence could be added to the passage.**

*Molaria spinifera and H. Optata, both of which lived in water levels beyond the reach of light, fit into this category.*

**14. Directions: An introductory sentence for a brief summary of the passage is provided below. Complete the summary by selecting the THREE answer choices that express the most important ideas in the passage. Some sentences do not belong in the summary because they express ideas that are not presented in the passage or are minor ideas in the passage. This question is worth 2 points.**

**Answer Choices**

1. The ability of some unicellular organisms to detect light and change their behavior accordingly suggests that eyes did not originate with multicellular animals.
2. The earliest eyes apparently contained molecules that were capable of forming and focusing images.
3. Too few fossils from the Precambrian have been found to determine which if any Precambrian organisms had eyes.
4. Evidence from the Burgess Shale suggests that eyes of some early animals were similar to the eyes of living crustaceans.
5. Fossil evidence suggests that organisms in the Burgess Shale with faceted eyes developed later than organisms in the Burgess Shale with nonfaceted eyes.
6. The large size and possible complexity of the eyes of some organisms in the Burgess Shale suggest that their eyes were not the first eyes.

# Passage 3 Weak Electric Systems in Fish

Paragraph 1:

Some blind elephantnose fish produce weak electric signals that are used for detecting objects in their surroundings, a phenomenon called active electrolocation. These fish have specialized electric organs that discharge either in pulses or in a wave-like fashion, depending on the species. Although discharges follow one another almost continuously throughout the life of the fish, their power level is much too low to be detected by human handlers but potent enough to create a stable electric field around the body of the fish. When an object enters into this electric field, it causes **distortions** in the current that are detected by electroreceptor organs distributed over the fish's skin.

1.Which of the sentences below best expresses the essential information in the highlighted sentence in the passage. Incorrect choices change the meaning in important ways or leave out essential information.

1. Throughout the life of the fish, its electric discharges vary in power from undetectable to fairly potent.
2. Nearly continuous discharges undetectable by humans create a stable, low-level electric field around the body of the fish.
3. Human handlers cannot feel the electric discharges because the discharges are at such low power levels.
4. The discharges are so weak that they would have to be fired almost continuously to create a detectable electric field.

2. The word **distortions** in the passage is closest in meaning to

1. decreases
2. signals
3. concentrations
4. irregularities

Paragraph 2:

A weak electric system may have several uses, including the exploration of novel environments. For example, blind elephantnose fish can easily find the only opening that allows them to cross through a newly installed partition within their aquarium, even though they cannot see it with their eyes. Their electric sense must be implicated because when these individuals become electrically silent (unable to use their electric system through denervation of their electric organs), they can no longer find the opening.

3. Paragraph 2 describes an experiment with elephantnose fish that were electrically silent and therefore unable to

1. distinguish between new and familiar objects in their aquarium
2. swim around the partition in their aquarium
3. find their way through a hole in a barrier
4. see with their eyes

Paragraph 3:

During the 1970s, biologists became interested in the role of the weak electric system not only as a means of electrolocation but also as a means of electrical communication between individual fish. Communication is possible because the rate and waveform of the electric discharges can vary between species, between sexes, between individuals, or even between situations in the same individual. Moreover, some fish can **temporarily** interrupt their normally continuous train of discharges, and these pauses can be full of meaning. The effective range of communication by electric signals can reach a little over 1 meter depending on water resistance.

4. All of the following are mentioned in paragraph 3 as components of communication in electric fish EXCEPT

1. the rate of electric discharges
2. the direction in which discharges travel
3. the waveform of electric discharges
4. pauses between electric discharges

5. The word **temporarily** in the passage is closest in meaning to

1. deliberately
2. suddenly
3. partially
4. briefly

Paragraph 4:

In terms of functions, electric communication is strikingly similar to acoustical vocalization (vocal sounds). Some of these functions are concerned with reproductive activity. In some species, males switch to new electric calls during courtship, resuming their regular programming only after the mating season is over. In species in which each sex has its own distinctive pattern of discharges, females are attracted to the pattern of males, and males to the pattern of females. Females can even be induced to release their eggs in the **vicinity of electrodes** that imitate a male signal “the spark of love”. As expected, through natural selection, both males and females prefer the electric pattern of their own species to that of other species.

6.The author provides the information that Females can even be induced to release their eggs in the **vicinity of electrodes** that imitate a male signal in order to

1. emphasize the importance of electric signals in some fish mating behavior
2. argue that many fish are not very particular when choosing a mate
3. show that electric signals alone do not provide adequate information for mate selection
4. imply that identifying a potential mate by its electric signal is more difficult than it might seem

Paragraph 5:

Other functions relate to aggression. **Aggressive individuals often precede their attacks with an increase in discharge rate**, whereas submissive fish may stop emitting altogether. This submissive behavior seems to work. Researchers have found that individuals rendered **electrically silent** through denervation of their electric organs are seldom attacked by dominant fish. Finally, individual recognition can also be based on electric signatures. In banded knifefish, territory neighbors recognize each other through individually distinctive discharge waveforms.

7. All of the following are mentioned in paragraphs 4 and 5 as ways fish communicate using discharge patterns EXCEPT:

1. Some fish increase their rate of discharge right before they attack.
2. Some fish reproduce the electric pattern of another species to hide from a predator.
3. Some male fish switch to a different electric call during mating season.
4. Some fish temporarily stop discharging as a sign of submission.

8. In saying that **Aggressive individuals often precede their attacks with an increase in discharge rate** the author means that

1. aggressive individuals often prepare for their attacks by increasing the discharge rate
2. aggressive individuals often intensify their attacks by increasing the discharge rate
3. attacks by aggressive individuals often increase when there is an increase in the discharge rate
4. an increase in the discharge rate often occurs before aggressive individuals attack

9. According to paragraph 5, becoming **electrically silent** can affect a fish by

A. causing it to become more aggressive

B. making it a more frequent target of attacks

C. damaging its organs for sending electric signals

D. making it less likely to be attacked by dominant fish

Paragraph 6:

The fact that weak electric fish can use their electric sense to communicate with one another leads to an interesting question: How can a fish distinguish between its own electric bursts and those from another fish. In blind elephantnose fish, the problem is solved by the presence of two types of electroreceptors. One of these two types is automatically and briefly shut down each time the fish discharges. Therefore, any signal picked up by these electroreceptors has to come from another animal. Elephantnose fish also have the habit of echoing the discharges of other individuals. They discharge their own electric organ a fixed time after sensing the electric signal of another fish. This response time is extremely short approximately 12 milliseconds probably the most rapid form of communication in the animal kingdom.

10. According to paragraph 6, one of the types of electroreceptors of the elephantnose fish shuts down at times in order to

A. avoid confusing its own signals with those of other fish

B. prevent the receptor from becoming damaged

C. distinguish between signals of short and long duration

D. enable the fish to produce echoes of the discharges of other fish

Paragraph 7:

Knifefish also display a **peculiar** behavior called the jamming avoidance response. This response allows knifefish to prevent interference with their electric system when they meet other knifefish. In order to avoid confusion, an electric fish must somehow keep track of the discharge rate of another knifefish while remaining aware of its own. If the two rates are too close, each fish alters its frequency of discharge so as to widen the gap between the two. In a sense, they do not want to get their wires crossed. In the laboratory, it is possible, using artificial signals, to force a knifefish to decrease its frequency of firing just by exposing it to a high but slowly decreasing signal rate or to increase its frequency of firing by switching to a low but slowly rising signal rate.

11.The word **peculiar** in the passage is closest in meaning to

1. clever
2. frequent
3. unusual
4. helpful

12.According to paragraph 7, what happens when a knifefish comes into contact with another knifefish that has a similar discharge rate

1. Both fish speed up their discharge rate, perhaps out of a sense of competition.
2. Both fish slow down their discharge rate so that they are better able to hear each other.
3. One fish increases its discharge rate while the other decreases it, making the signals less similar.
4. Each fish slowly changes its discharge rate until they match up perfectly.

Paragraph 7:

Knifefish also display a **peculiar** behavior called the jamming avoidance response. This response allows knifefish to prevent interference with their electric system when they meet other knifefish. ■In order to avoid confusion, an electric fish must somehow keep track of the discharge rate of another knifefish while remaining aware of its own. ■If the two rates are too close, each fish alters its frequency of discharge so as to widen the gap between the two. In a sense, they do not want to get their wires crossed. ■In the laboratory, it is possible, using artificial signals, to force a knifefish to decrease its frequency of firing just by exposing it to a high but slowly decreasing signal rate or to increase its frequency of firing by switching to a low but slowly rising signal rate. ■

13.. Look at the four squares that indicate where the following sentence could be added to the passage.

*Each fish in an encounter is discharging electric signals at a specific rate.*

Where would the sentence best fit Click on a square to add the sentence to the passage.

14.Drag your choices to the spaces where they belong. To review the passage, click on View Text .

Answer Choices

1. Some fish have special organs that produce a weak electric field around their body and have receptor organs that allow them to detect disruptions to this field.
2. Electrolocation is used primarily by fish who are blind, whereas electric communication is used by fish who are not equipped for acoustical vocalization.
3. Research suggests that the effective range of communication by electric signals can reach a little over 1 meter, depending on water resistance.
4. Distinctive discharge patterns allow fish with a weak electric system to identify each other by sex or species, or even recognize particular individuals.
5. Most fish with a weak electric system have two forms of electroreceptors so that they can detect both very fast and very slow discharge rates.
6. Fish can deliberately slow, speed up, or pause their rate of discharge in order to communicate and to avoid confusing their own signals with those of another fish.

# Passage 4 Milankovitch Cycles and Glaciation

Paragraph 1

Although the history of glaciation during the Pleistocene epoch (2 million to 10,000 years ago) is well established, we do not know with complete certainty why glaciation takes place. For over a century, geologists and climatologists have struggled with this problem, but it remains unsolved.

Paragraph 2

It is long known that Earth’s orbit around the Sun changes periodically, cyclically affecting the way solar radiation strikes the Earth, but the idea that these changes affect climate was first advanced by James Croll in the late 1800s. Later, Milutin Milankovitch elaborated the theory with calculations that convincingly argued that the cycles, now known as Milankovitch cycles, could cause climatic variations.

1. The word “elaborated” in the passage is closet in meaning to

1. corrected
2. defended
3. studied
4. developed

2. According to paragraph 2, Milankovitch was the first to do which of the following?

1. Introduce the idea that periodic changes in Earth’s orbit could influence Earth’s climate
2. Show that periodic changes in Earth’s orbit could be mathematically calculated
3. Provide calculations to show that periodic changes in Earth’s orbit could affect Earth’s climate
4. Propose that Earth’s orbit is not fixed but undergoes periodic changes

Paragraph 3

The Milankovitch cycles emerge from the way three cyclic changes in Earth’s orbit combine. One characteristic of Earth’s orbit is its *eccentricity*, the degree to which the orbit is an ellipse rather than a circle. Changes in the eccentricity of Earth’s orbit occur in a cycle of about 96,000 years. The *inclination*, or tilt, of Earth’s axis also varies periodically, moving between 22 degrees and 24.5 degrees. The tilt of Earth’s axis, toward the Sun at some times of the year and away from the Sun at other times, is responsible for the annual cycle of seasons. The greater the tilt, the greater the contrast between summer and winter temperatures. Changes in the tilt occur in a cycle 41,000 years long. Also, Earth *wobbles* as it spins, like a slightly unsteady top. The wobble cycle is completed once every 21,700 years. Changes in eccentricity, tilt and wobble do not affect the total amount of solar radiation Earth receives in a year, but they do affect how evenly or unevenly this radiation is disturbed over the course of a year. According to the Milankovitch theory, about every 40,000 years the three separate cycles combine in such a way that the *difference* between summer and winter temperatures is at a minimum. At this point winter temperatures are milder but so too are summer temperatures. As a result, less ice is melted in the summer than is formed in the winter, so glaciers build up and a period of glaciation results.

3. According to paragraph 3, Milankovitch’s theory holds that periods of glaciation result from a particular combination of changes in all the following EXCEPT

1. the shape of Earth’s orbit
2. the inclination of Earth’s axis
3. the wobble of Earth as it spins
4. the amount of time required for Earth’s rotation around the Sun

4. According to paragraph 3, Milankovitch’s theory predicts that glaciers build up most when

1. the least amount of solar heat is being delivered to Earth
2. winter temperatures are lowest
3. the difference between winter temperatures and summer temperatures is greatest
4. both winter temperatures and summer temperatures are relatively mild

Paragraph 4

Milankovitch worked out the ideas of climatic cycles in the 1920s and 1930s, but it was not until the 1970s that a detailed chronology of the Pleistocene temperature changes was determined that could test the predictions of this theory. A correspondence between Milankovitch cycles and climate fluctuations of the last 65 million years seems clear. Furthermore, studies of rock samples drilled from the deep-sea floor and the fossils contained in them indicate that the fluctuation of climate during the past few hundred thousand years is remarkably close to that predicted by Milankovitch.

5. A“chronology” is

1. a study of past events
2. a list that pairs past events with dates
3. an explanation of why past events happened when they did
4. an ordering of past events according to how long they lasted

6. Which of the following can be inferred from paragraph 4 about rock samples taken from the sea floor and the fossils they contain?

1. There is a correspondence between the fossils in the samples and climate fluctuations.
2. Milankovitch’s theory predicts when the samples will contain fossils.
3. It was not known until the 1970s that fossils were present in rocks taken from the sea floor.
4. There is no fossil record in the samples older than a few hundred thousand years.

7. The phrase “remarkably close” in the passage is closet in meaning to

1. sufficiently close
2. relatively close
3. extremely close
4. frequently close

Paragraph 5

A problem with Milankovitch’s explanation of glaciation arises from the fact that the variations in Earth’s orbit, and hence the Milankovitch cycles, have existed for billions of years. Thus we might expect that glaciation would have been a cyclic event throughout geologic time. In fact, periods of glaciation are rare. So there must be another factor acting together with the Milankovitch cycles that causes periods of glaciation. Once this additional factor makes the temperature low enough, the cyclic variations of the Milankovitch cycles will force the planet into and out of glacial epochs with a fixed regularity.

8. According to paragraph 5, which of the following is a problem with Milankovitch’s theory?

1. It assures that the astronomical cycles have been in existence for billions of years.
2. It cannot explain why glaciation has been a relatively rare occurrence in Earth’s history.
3. It cannot predict periods of glaciation in Earth’s distant past.
4. It assures that astronomical cycles have an effect on Earth’s climate even during periods when there is no glaciation.

Paragraph 6

Many hypotheses have been proposed for the additional cooling factor. Some suggest that variations in the Sun’s energy output could account for the ice ages. However, our present understanding of the Sun’s luminosity holds that it should have progressively increased, not decreased, over the course of Earth’s history. Still others argue that volcanic dust injected into the atmosphere shields Earth from the Sun’s rays and initiates an ice age. However, no correlation has been found between volcanic activity and the start of the last ice age. An increasingly attractive theory holds that decreases in atmospheric carbon dioxide starts the cooling trend that leads to glaciation. Carbon dioxide traps solar energy reflected from the Earth’s surface. If carbon dioxide levels decrease, less heat is trapped and Earth’s surface cools. Recent studies of the carbon dioxide content of gas bubbles preserved in the Greenland ice cap do in fact show that high carbon dioxide levels are associated with warm interglacial periods, and low levels with cold glacial periods.

9. The author discusses “our present understanding of the Sun’s luminosity” in order to

1. provide evidence that Milankovitch’s astronomical cycles cannot explain the occurrence of the ice ages
2. present an objection to a proposed explanation of the cause of ice ages
3. challenge the claim that long-term cooling can account for glaciation
4. introduce a problem that none of the proposed hypotheses about the causes of glaciation can answer

10. The word “initiates” in the passage is closet in meaning to

1. begins
2. accelerates
3. ends
4. avoids

11. According to paragraph 6, in addition to Milankovitch cycles, each of the following has been proposed as a contributing cause of ice ages EXCEPT

1. variations in the composition of the Greenland ice cap
2. variations in the Sun’s energy output
3. volcanic dust injected into the atmosphere
4. decreases in atmospheric carbon dioxide

12. It follows from the theory of the role of carbon dioxide discussed in paragraph 6, that

1. the decrease in temperature during the last ice age caused a decrease in atmospheric carbon dioxide
2. the atmosphere had higher carbon dioxide content during the last ice age than it had during the warm period immediately before it
3. the cooling of temperatures that led to the last ice age was brought about by a decrease in atmospheric carbon dioxide
4. there was less carbon dioxide in the atmosphere toward the end of the last ice age than there was at the beginning

Paragraph 5

A problem with Milankovitch’s explanation of glaciation arises from the fact that the variations in Earth’s orbit, and hence the Milankovitch cycles, have existed for billions of years. ■Thus we might expect that glaciation would have been a cyclic event throughout geologic time. In fact, periods of glaciation are rare. ■So there must be another factor acting together with the Milankovitch cycles that causes periods of glaciation. ■Once this additional factor makes the temperature low enough, the cyclic variations of the Milankovitch cycles will force the planet into and out of glacial epochs with a fixed regularity.■

13. Look at the four squares [■] that indicate where the following sentence could be added to the passage.

**This factor must precede an ice age and have the effect of slightly lowering Earth’s temperature.**

Where would the sentence best fit? Click on a square [■] to add the sentence to the passage.

14. Directions: An introductory sentence for a brief summary of the passage is provided below. Complete the summary by selecting the THREE answer choices that express the most important ideas in the passage. Some answer choices do not belong in the summary because they express ideas that are not presented in the passage or are minor ideas in the passage. This question is worth 2 points.

Drag your choices to the spaces where they belong. To review the passage, click on **View Text**.

|  |
| --- |
| **In the 1920s and 1930s, Milutin Milankovitch worked out an account of the cause of Earth’s glaciations.**  ●  ●  ● |

**Answer Choices**

1. Milankovitch argued that glaciations would result when three cycles that affect characteristics of Earth’s orbit combined in a certain way. （2,3）
2. Milankovitch’s predictions have been shown to be in agreement with periods of glaciation over the past 65 million years. （4）
3. Since ice ages are much less frequent than Milankovitch’s explanation predicts, some factor, such as low levels of atmospheric carbon dioxide, must also be involved in triggering glaciation. （6）
4. Milankovitch showed that changes in Earth’s orbit periodically length cold seasons and shorten warm ones so that more ice forms than melts and glaciers build up.
5. Dust from volcanic eruptions that blocks the Sun’s warming radiation has been proposed as an explanation alternative to Milankovitch cycles for the cause of ice ages.
6. Studies of gas bubbles preserved in the Greenland ice cap strongly suggest that Milankovitch cycles may also influence atmospheric carbon dioxide levels.