# **DRIVING QUESTION 2**

## 8 What aspects of height make it a polygenic trait?

Answer: Many genes contribute to height. As there are multiple genes contributing to the phenotype, height is a polygenic trait.

### 9 Which of the following inheritance patterns includes an environmental contribution?

- a. polygenic
- b. X-linked recessive
- c. X-linked dominant
- d. multifactorial
- e. none of the above

Answer: d

#### 10 What is the difference between polygenic inheritance and multifactorial inheritance?

Answer: In polygenic inheritance, multiple genes influence the phenotype. Multifactorial traits are those on which environment has an influence.

#### 11 How does incomplete dominance differ from codominance?

Answer: In incomplete dominance, heterozygotes have a phenotype that is intermediate between the phenotypes of the homozygous dominants and the homozygous recessives. In codominance, heterozygotes display traits of both alleles present.

## 12 If you are blood type A-positive, to whom can you safely donate blood? Who can safely donate blood to you? List all possible recipients and donors and explain your answer.

Answer: If you are type A-positive, then you can donate to other A-positive people as well as to AB-positive people. If you are A-positive, you can receive type O-negative, O-positive, A-positive, and A-negative blood.

## 13 If two women have identical alleles of the suspected more than 400 height-associated genes, why raight one of those women be 5 feet, 5 inches tall and the other 5 feet, 8 inches tall?

Answer: The environment can influence height. If the two women did not have the same dieta while growing up, they may not reach the same height. Similarly, if one of the women develops osteoporosis, she may used over time.

#### 14 Look at Infographic 12.10. How do the data given suppo h thesis that both genes and the environment influence at least some cases of clinical depres

Answer: The hypothesis that both genesated the environment influence it least some cases of clinical depression is supported by data showing that a substantially larger pace it age of people with two opics of the short allele have depression when they experience more than three stressful the experience. It genes were the object of the only determining factor, then all people with four or more stressful redardless of spessful hie experiences. If stressful it experiences were the only determining factor, then all people with four or more stressful includes they inherited.

#### 15 Look at Infographic 12.10. At approximately how many stressful experiences does the homozygous short-allele genotype begin to influence the depression phenotype?

Answer: It appears that three or more stressful experiences influence the depression phenotype.

#### 16 From what you have read in this chapter, how can you account for two people with the same genotype for a predisposing disease allele having different phenotypes?

Answer: The two people could have different alleles at other genes that influence the phenotype, or they could have different environmental influences (e.g., diet, stressful experiences, sun exposure) that could influence their phenotype.

- 17 A serious car crash on a freeway has resulted in multiple injuries causing substantial blood loss in three members of a family—a mother, a father and their 2-year-old daughter. The local blood bank will be challenged to supply blood, as their supplies of all blood types were drained after the roof of a shopping plaza collapsed the week before and many transfusions were required.
  - a. The EMTs must give blood immediately to all three members of the family. What blood type should they use (consider both ABO blood type and Rh factor)? Explain your answer.
  - b. Both parents carry a blood donor card. The mother is O-negative and the father is A-positive. From this information, what (if any) additional blood types (beyond your answer to part a) can be given to either parent? Explain your answer.
  - c. Does knowing the parents' blood types give you enough information about the daughter's possible blood type to use a different blood type for her transfusion? Why or why not? (Hint: Consider possible blood types for the daughter and the implications of, for example, using A-negative donor blood. Could you guarantee that this would be safe?)

Answer:

- a. Type O-negative is the universal donor, so this blood type should be used when no information is available about the blood types of the recipients.
- b. As the mother is O-negative, she can receive only O-negative blood. As the father is A-positive, he can also receive O-positive blood, A-positive blood, and A-negative blood.
- c. We know that the daughter will have inherited one O allele from her mother and one Rh-negative allele. However, we don't know if her father is heterozygous for the A allele (e.g., AO) or homozygous (AA). We also don't know if he is homozygous or heterozygous for the Rh gene (+/+ or +/-). If he is a double heterozygote, then the daughter could be O-negative. If she is O-negative, then she can receive only O-negative donor blood—any other blood type would be attacked by her immune system. Because we don't know the father's genotype, it is not safe to use any blood type other than O-negative.

# **DRIVING QUESTION 3**

# 18 What is the normal chromosome number for each of the following?

a. a human egg

.....

- b. a human sperm
- c. a human zygote

Answer: a. 23; b. 23; c. 46

# 19 When looking at a karyotype, for example to diagnose trisomy 21 in a fetus, is it possible to use that analysis also to tell if the fetus has inherited a cystic fibrosis allele from a carrier mother?

Answer: Karyotype analysis can be used to detect trisomy 21 because an extra chromosome is easily visible at this level. However, cystic fibrosis is caused by mutations that change the nucleotide sequence of the gene—these changes cannot be detected by simply looking at the chromosomes.

# 20 Which of the following can result in trisomy 21?

- a. an egg with 23 chromosomes fertilized by a sperm with 23 chromosomes
- b. an egg with 22 chromosomes fertilized by a sperm with 23 chromosomes
- c. an egg with 24 chromosomes, two of which are chromosome 21, fertilized by one with 23 chromosomes
- d. an egg with 23 chromosomes fertilized by a sperm with 24 chromosome 21 which are chromosome 21

Answer: c and d

21 From what you have read in this chapter, which of the possibilities in Question 20 is most likely? Explain your answer.

Answer: Most value of theory 21 occur because of a vert to sum on during meiosis in egg development that results in an egg with 24 chromosomes two of which are chromosome 21.

22 What factors would lead you to consider prenatal genetic testing? In your opinion, what is the value of having this information? Use the table below to help organize your thoughts, then make a conclusion about the use of prenatal genetic testing.

Factor	Value
Consider known risks (e.g., family history, mother's age).	Consider how the information may be used.

Answer: Factors to consider include the age of the mother, abnormal prenatal tests, a previous child born with a genetic disorder or birth defect, and the family history of both parents. Opinions will vary about the value of the information obtained through prenatal genetic testing.

Answer: First pair, 5 differences; second pair, 0 differences; third pair, 4 differences; fourth pair, 1 difference. Pan troglodytes appears to be most closely related to humans, and Canis lupus familiaris appears to be the least closely related to humans.

## 21 Fossils allow us to understand the evolution of many lineages of plants and animals. They therefore represent a valuable scientific resource. What if Tiktaalik (or an equally important transitional fossil) had been found by amateur fossil hunters and sold to a private collector? Do you think there should be any regulation of fossil hunting to prevent the loss of valuable scientific information from the public domain?

ANSWERS WILL VARY: Some considerations include the public sharing of important scientific data (much in the way the results of federally funded research are available to the field); whether the fossils were found on public lands or private lands; and whether the removal of the fossils caused harm to the site (or to the fossils themselves, if not properly stabilized when removed).

# **Chapter 16 Life on Earth**

# **DRIVING QUESTION 1**

## 1 What do uranium-238, carbon-14, and potassium-40 have in common?

Answer: They are all radioactive isotopes that decay into other elements at constant rates.

2 To date what you suspect to be the very earliest life on Earth, which isotope would you use: uranium-238, carbon-14, or potassium-40? Explain your answer.

Answer: You would use uranium-238, which has the longest half-life of the three (4.5 billion years). Isotopes with shorter half-lives may no longer be present in very ancient samples, having completely decayed.

3 Place the following evolutionary milestones in order from earliest (1) to most recent (7), providing a provimate dates to support your answer.

Answer: (1) the first probabilities (~2.5 billion years ago); (2) an expression oxygen in the atmosphere (~2.5 billion multicellular e key ter (1.2 billion years ago); (1) the verification explosion (~545 million years ago); (5) the first ago); (6) the Pirmian extinction (~248 million years ago); (7) the extinction of dinosaurs (~65 million years ago); oxygen in the atmosphere (~2.5 billion years ago); (3) the first phan explosion (~545 million years ago); (5) the first animals (~540 million years

## 4 Consider a rock formed at about the same time as Earth was formed.

a. How old is this rock?

b. How much of the original uranium-238 is likely to be left today in that rock?

Answer:

- a. The rock is approximately 4.5 billion years old.
- b. Approximately half of the original uranium-238 is left (after one half-life)
- 5 Diverse animal fossils are found dating from the Cambrian Period but not earlier. Why might these organisms have made their first appearance in the fossil record only then, even though their ancestors may have been living, and evolving, for a long time before the Cambrian? (Think about what kinds of new structures might have evolved during the Cambrian Period that would have allowed these organisms to leave fossils.)

Answer: The ancestors of these organisms may have been primarily soft-bodied organisms that did not leave fossils. The development of shells and other hard body parts would allow fossilized remains of these organisms to be left in the fossil record at this time.

6 You are a paleontologist with a particular interest in early microbes. A microbiologist has brought you a fossilized cell that appears to be prokaryotic. They claim that they used potassium-40 dating to date the fossil to 3.9 billion years ago. If the analysis is accurate, what percent of potassium-40 should remain in the specimen? If you used uranium-238 dating to verify, what proportion of uranium-238 should remain in the specimen?

Answer: A 3.9-billion-year-old fossil has experienced three potassium-40 half-lives. This means that approximately 12.5% of the original potassium-40 remains. The same 3.9-billion-year-old fossil has experienced somewhat less than one uranium-238 half-life. A little over 50% of the original uranium-238 would remain.

# 12 Halophilic archaea are able to prevent osmotic water loss from their cells, even in high-salt environments. What is one mechanism by which they could prevent water loss and thrive in high-salt environments?

Answer: By increasing their solute concentration, they can match the solute concentration in a high-salt environment. If their internal solute concentration is the same as that of the environment, there will be no net gain or loss of water from cells.

## 13 If Neisseria gonorrhoeae had no pili, would it still be a successful pathogen? Explain your answer.

Answer: No. These pathogens use their pili to adhere to cells of the body and to evade host defenses. Without their pili, the bacteria would not succeed in establishing infections.

# **DRIVING QUESTION 3**

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# 14 List the features that make Lost City a particularly harsh environment. For each feature, give a brief explanation of why it is inhospitable for many organisms.

Answer: High temperatures—when most organisms encounter temperatures higher than their optimum temperatures, their proteins will denature (that is, lose their shape and therefore their function) and their membranes will destabilize. High pressure—most organisms would be crushed by the pressure at Lost City. High pH—the high pH at Lost City leads to the deaths of most organisms.

# 15 If you were a prokaryotic organism and wanted to be successful at Lost City, what energy source must you be able to use?

a. sunlight

- b. oxygen
- c. hydrogen gas
- d. electricity
- e. None of the above is available at Lost City.

Answer: c

## 16 What is the significance of methane at Lost City? (Think about both the origin of life and the susten use of early life.)

Answer: The methane and other simple hydrocarbons at Lost City can be produced both abiotically and biot ally TLs means that the earliest organisms at Lost City had at least two energy sources, H<sub>2</sub> and methane. A diverse communities of a means could develop, some producing methane, some using methane.

# 17 If methane were not produced abiotically at Lost City, what were be the implications for early life?

Answer: Many of the living organisms at Lost Cry el, or methane as their energy and cathon source. Without abiotic methane, it may be harder to hypothesize that life would have primed at these kinds of Le is in owe co, with hydrogen gas as an energy source and CO<sub>2</sub> as a carbon source, it is still possible to use to have formed at Lost Cry, but perhaps different organisms would be present.

18 Would you expect to find photosyntheic of this is at Lost City? Explain your answer.

Answer: No. Sunlight does not penetrate the ocean as far as the depth of Lost City, so photosynthesis is not possible.

# 19 Do you think that the scientists studying Lost City should be concerned about introducing microbial contaminants from their submersibles onto the towers of Lost City? How probable is this, given the conditions at Lost City and on the surface? If such an event could happen, what would be the implications?

Answer: Because the conditions at Lost City are so extreme and harsh, it is unlikely that any microbes on the surfaces of the submersibles could survive, much less thrive, in those conditions. So the risk appears to be very low. On the other hand, microbes are diverse and adaptable. If a newly introduced microorganism were to successfully divide and establish itself, it could potentially displace "native" microbes, fundamentally changing the microbial community at Lost City. The entire ecosystem of Lost City could be disrupted. While the risk is low, the possible consequences are high and should be considered.

20 Some of the chimneys at Lost City are actively venting. These chimneys have hot (80°–100°C) interiors that lack oxygen and have a pH range of 9–11. The exterior surfaces of the active chimneys are cooler (~7°C), contain oxygen, and have a pH of ~8.

The inactive chimneys at Lost City are no longer venting hot fluids. Compared to the actively venting chimneys, their interiors are much cooler (7°–20°C), lack oxygen, and have a pH of 8–10. The exteriors of the inactive chimneys are very similar to the exteriors of the active chimneys.

From the properties of the organisms given in the table below, complete the table to indicate where in Lost City each of these organisms is most likely to be found.

# 1 About mosquitoes:

- a. How is Plasmodium falciparum dependent on the Anopheles mosquito?
- b. What is the evolutionary relationship between Anopheles mosquitoes and Plasmodium falciparum? (Hint: Consider their current classifications.)

Answer:

- a. Plasmodium falciparum requires the Anopheles mosquito in order to complete its life cycle.
- b. Anopheles mosquitoes are insects in the supergroup Opisthokonts and Plasmodium falciparum is a member of the Rhizaria supergroup.
- 2 Historically, *Phytophthora infestans* was classified as a fungus and *Pneumocystis carinii* and *Trypansoma brucei* were classified as protists. Review and explain the basis for their current classifications.

Answer: *Phytophthora infestans* has been reclassified as a Stramenopila, on the basis of molecular evidence. *Pneumocystis carinii* is currently classified as a fungus, on the basis of genetic evidence. *Trypansoma brucei* is classified as a member of the Excavata supergroup.

3 What are the practical implications of the reclassification of *Pneumocystis carinii*? Be specific in your answer.

Answer: *Pneumocystis carinii* was formerly classified as an animal-like protist. It is now classified as a fungus. This classification has allowed the use of more appropriate drugs (antifungal drugs) to treat the pneumonia caused by this organism.

- 4 Insecticides and drugs are part of antimalarial efforts. For each of the substances listed below, state whether it is directed against the mosquito or the parasite, and describe any current challenges to its use.
  - a. artemisinin
  - b. DDT
  - c. quinine

Answer:

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- a. Artemisinin is directed against the parasite. Resistance is emerging.
- b. DDT is directed against the mosquito. Resistance is emerging.
- c. Quinine is directed against the parasite. Resistance is emerging.
- 5 Why is climate change an important factor to consider in the context of malar

uman

Answer: As climates warm, the mosquito vector of malar an expand its range, introducing melaria into areas that were previously free of the disease.

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# DRIVING QUESTION 1

## 1 The ancestors of modern humans evolved in a high-UV environment. What does this suggest about their skin color?

Answer: Darker skin confers protection from UV destruction of folate, while still permitting vitamin D synthesis in a high-UV environment. Their skin color was likely dark.

# 2 In the course of human evolution, which of the following environmental factors likely influenced whether a population had mostly light-skinned individuals or mostly dark-skinned individuals?

- a. average annual temperature
- b. average annual rainfall
- c. levels of UV light
- d. the vitamin D content of the typical diet
- e. mitochondrial DNA inheritance

Answer: c

# **DRIVING QUESTION 3**

# 15 What percentage of DNA sequences do all humans share?

- a. 0%
- b. 25%
- c. 50%
- d. 75%
- e. >99%

Answer: e

# 16 Of the following traits that are associated with being human, which evolved most recently?

- a. upright walking
- b. the ability to control fire
- c. social communication
- d. tool use

e. a big brain

Answer: e

# 17 Place the following ancestors in order of earliest (1) to most recent (5).

# Homo sapiens

Last common ancestor of chimpanzees and humans

# Australopithecus

Ardipithecus ramidus

# Homo erectus

Answer: (1) last common ancestor of chimpanzees and humans; (2) Ardipithecus ramidus; (3) Australopithecus (4) Homo erectus; (5) Homo sapiens

18 Where would the last common ancestor of gorillas and humans fit in the Goldering in your answer to Question 17? Explain.

Answer: The last common ancestor of gorillas and human would be even more and ent that the last common ancestor of chimpanzees and humans. Chimpanzees and humans are the most flowed related of the living primes.

19 Why would individual cust a opithicines who could make and use tools have had a selective advantage (that is, higher fitness or e adviduals who crue have to a vor use tools?

Answer: Tool use is important for hunting and preparing food. Those who could use tools would presumably have better nutrition and be less likely to starve. Better nutrition would contribute to higher fitness, especially when food was not easily available.

20 Ardi was partially arboreal (that is, her species could live in trees). The ability to move around in trees was facilitated by an opposable big toe that would help grip branches. Once ancient hominids moved permanently to a grounded lifestyle, would there have been any selective pressure to maintain an opposable big toe? Explain your answer.

Answer: If an opposable big toe conferred advantage on the ground, it would have been maintained by natural selection. As the descendants of these ancient hominids do not have an opposable big toe, there must not have been a selective advantage to maintain it in grounded populations.

# 21 Members of the genus Australopithecus walked upright, and their fossilized footprints show no evidence of an opposable big toe.

- a. What foot structure and lifestyle might have been selected for if early hominid evolution occurred in a forested environment? In a grasslands environment? Would you predict any differences because of the selective pressures in each environment? Why or why not?
- b. What other traits would you expect to be favored in a forested environment? In open grasslands?

Answer:

- a. If early hominids had evolved in a forested environment, foot structure might still show evidence of an opposable big toe to assist in tree climbing and moving along branches, particularly if tree climbing provided access to food. In a grasslands environment, an opposable big toe would not be useful because there are no trees to climb. Instead, the foot, leg, and pelvis would be adapted for walking and running.
- b. In a forested environment it would be helpful to have good vision in low-light conditions, a good sense of balance (for tree climbing), upper body strength (for tree climbing), and perhaps height (to see over underbrush and saplings). In a grasslands environment, darker skin coloration or hair would be important to avoid excessive UV degradation of folate (in an environment with limited access to shade). Speed (in running) would be an advantage (to avoid predators and chase prey). Good distance vision would be useful to see out across the landscape (to detect predators or prey).