

Campbell's Biology, 9e (Reece et al.)
Chapter 28 Protists

The taxonomy of the protists is still in a state of flux. Thus, few items here test students' knowledge of protist taxonomy. Most test items relate to the characteristics and functions of protist structures, as well as to the protists' metabolic, evolutionary, and ecological (especially with respect to humans) features. There is an abundance of synthetic questions. Also featured are several sets of art questions tied together by reference to a figure or to experimental data. There are two new sets of scenario questions, one pertaining to *Giardia lamblia* and the other to the new "darling" of endosymbiosis, *Paulinella chromatophora*.

Multiple-Choice Questions

- 1) All protists are
A) unicellular.
B) eukaryotic.
C) symbionts.
D) monophyletic.
E) mixotrophic.

Answer: B

Topic: Concept 28.1

Skill: Knowledge/Comprehension

- 2) Biologists have long been aware that the defunct kingdom Protista is polyphyletic. Which of these statements is most consistent with this conclusion?

- A) Many species within this kingdom were once classified as monerans.
B) Animals, plants, and fungi arose from different protist ancestors.
C) The eukaryotic condition has evolved more than once among the protists.
D) Chloroplasts among various protists are similar to those found in prokaryotes.
E) Some protists, all animals, and all fungi share a protist common ancestor, but these protists, animals, and fungi are currently assigned to three different kingdoms.

Answer: C

Topic: Concept 28.1

Skill: Knowledge/Comprehension

- 3) According to the endosymbiotic theory of the origin of eukaryotic cells, how did mitochondria originate?

- A) from infoldings of the plasma membrane, coupled with mutations of genes for proteins in energy-transfer reactions
B) from engulfed, originally free-living proteobacteria
C) by secondary endosymbiosis
D) from the nuclear envelope folding outward and forming mitochondrial membranes
E) when a protoeukaryote engaged in a symbiotic relationship with a protocell

Answer: B

Topic: Concept 28.1

Skill: Knowledge/Comprehension

4) Which process could have allowed the nucleomorphs of chlorarachniophytes to be reduced, without the net loss of any genetic information?

- A) conjugation
- B) horizontal gene transfer
- C) binary fission
- D) phagocytosis
- E) meiosis

Answer: B

Topic: Concept 28.1

Skill: Knowledge/Comprehension

5) An individual mixotroph loses its plastids, yet continues to survive. Which of the following most likely accounts for its continued survival?

- A) It relies on photosystems that float freely in its cytosol.
- B) It must have gained extra mitochondria when it lost its plastids.
- C) It engulfs organic material by phagocytosis or by absorption.
- D) It has an endospore.
- E) It is protected by a case made of silica.

Answer: C

Topic: Concept 28.1

Skill: Knowledge/Comprehension

6) Which of the following was derived from an ancestral cyanobacterium?

- A) chloroplast
- B) mitochondrion
- C) hydrogenosome
- D) mitosome
- E) Two of the responses above are correct.

Answer: A

Topic: Concepts 28.1, 28.2

Skill: Knowledge/Comprehension

7) Which two genera have members that can evade the human immune system by frequently changing their surface proteins?

1. *Plasmodium*
2. *Trichomonas*
3. *Paramecium*
4. *Trypanosoma*
5. *Entamoeba*

A) 1 and 2

B) 1 and 4

C) 2 and 3

D) 2 and 4

E) 4 and 5

Answer: B

Topic: Concepts 28.2, 28.3

Skill: Knowledge/Comprehension

8) Which of the following pairs of protists and their characteristics is mismatched?

- A) apicomplexans–internal parasites
- B) golden algae–planktonic producers
- C) euglenozoans–unicellular flagellates
- D) ciliates–red tide organisms
- E) entamoebas–ingestive heterotrophs

Answer: D

Topic: Concept 28.3

Skill: Knowledge/Comprehension

9) Which of the following statements about dinoflagellates is true?

- A) They possess two flagella.
- B) All known varieties are autotrophic.
- C) Their walls are usually composed of silica plates.
- D) Many types lack mitochondria.
- E) Their dead cells accumulate on the seafloor, and are mined to serve as a filtering material.

Answer: A

Topic: Concept 28.3

Skill: Knowledge/Comprehension

10) You are given an unknown organism to identify. It is unicellular and heterotrophic. It is motile, using many short extensions of the cytoplasm, each featuring the 9 + 2 filament pattern. It has well-developed organelles and three nuclei, one large and two small. This organism is most likely to be a member of which group?

- A) foraminiferans
- B) radiolarians
- C) ciliates
- D) kinetoplastids
- E) slime molds

Answer: C

Topic: Concept 28.3

Skill: Application/Analysis

11) Which of the following is characteristic of ciliates?

- A) They use pseudopods as locomotory structures or as feeding structures.
- B) They are relatively specialized cells.
- C) They can exchange genetic material with other ciliates by the process of mitosis.
- D) Most live as solitary autotrophs in fresh water.
- E) They are often multinucleate.

Answer: E

Topic: Concept 28.3

Skill: Knowledge/Comprehension

12) Which process results in genetic recombination, but is separate from the process by which the population size of *Paramecium* increases?

- A) budding
- B) meiotic division
- C) mitotic division
- D) conjugation
- E) binary fission

Answer: D

Topic: Concept 28.3

Skill: Knowledge/Comprehension

13) Why is the filamentous morphology of the water molds considered a case of convergent evolution?

- A) Water molds evolved from filamentous fungi.
- B) Body shape reflects ancestor-descendant relationships among organisms.
- C) In both cases, filamentous shape is an adaptation for the absorptive nutritional mode of a decomposer.
- D) Filamentous body shape is evolutionarily ancestral for all eukaryotes.
- E) Both the first and second responses above are correct.

Answer: C

Topic: Concept 28.3

Skill: Knowledge/Comprehension

14) If we were to apply the most recent technique used to fight potato late blight to the fight against the malarial infection of humans, then we would

- A) increase the dosage of the least-expensive antimalarial drug administered to humans.
- B) increase the dosage of the most common pesticide used to kill *Anopheles* mosquitoes.
- C) introduce a predator of the malarial parasite into infected humans.
- D) use a "cocktail" of at least three different pesticides against *Anopheles* mosquitoes.
- E) insert genes from a *Plasmodium*-resistant strain of mosquito into *Anopheles* mosquitoes.

Answer: E

Topic: Concept 28.3

Skill: Application/Analysis

15) Diatoms are mostly asexual members of the phytoplankton. Diatoms lack any organelles that might have the 9 + 2 pattern. They obtain their nutrition from functional chloroplasts, and each diatom is encased within two porous, glasslike valves. Which question would be most important for one interested in the day-to-day survival of individual diatoms?

- A) How does carbon dioxide get into these protists with their glasslike valves?
- B) How do diatoms get transported from one location on the water's surface layers to another location on the surface?
- C) How do diatoms with their glasslike valves keep from sinking into poorly lit waters?
- D) How do diatoms with their glasslike valves avoid being shattered by the action of waves?
- E) How do diatom sperm cells locate diatom egg cells?

Answer: C

Topic: Concept 28.3

Skill: Synthesis/Evaluation

16) A large seaweed that floats freely on the surface of deep bodies of water would be expected to lack which of the following?

- A) thalli
- B) bladders
- C) holdfasts
- D) gel-forming polysaccharides

Answer: C

Topic: Concept 28.3

Skill: Knowledge/Comprehension

17) Which of the following is a characteristic of the water molds (oomycetes)?

- A) the presence of filamentous feeding structures
- B) zoospores that are spread by breezes
- C) the same nutritional mode as possessed by cyanobacteria
- D) a morphological similarity to fungi that is the result of common ancestry
- E) a feeding *Plasmodium*

Answer: A

Topic: Concept 28.3

Skill: Knowledge/Comprehension

18) Reinforced, threadlike pseudopods that can perform phagocytosis are generally characteristic of which group?

- A) radiolarians and forams
- B) gymnamoebas
- C) entamoebas
- D) amoeboid stage of cellular slime molds
- E) oomycetes

Answer: A

Topic: Concept 28.4

Skill: Knowledge/Comprehension

19) A snail-like, coiled, porous test (shell) of calcium carbonate is characteristic of which group?

- A) diatoms
- B) foraminiferans
- C) radiolarians
- D) gymnamoebas

Answer: B

Topic: Concept 28.4

Skill: Knowledge/Comprehension

20) The chloroplasts of land plants are thought to have been derived according to which evolutionary sequence?

- A) cyanobacteria → green algae → land plants
- B) cyanobacteria → green algae → fungi → land plants
- C) red algae → brown algae → green algae → land plants
- D) cyanobacteria → red algae → green algae → land plants

Answer: A

Topic: Concepts 28.1, 28.5

Skill: Knowledge/Comprehension

21) The chloroplasts of all of the following are thought to be derived from ancestral red algae, *except* those of

- A) golden algae.
- B) diatoms.
- C) dinoflagellates.
- D) green algae.
- E) brown algae.

Answer: D

Topic: Concept 28.5

Skill: Knowledge/Comprehension

22) A biologist discovers an alga that is marine, multicellular, and lives at a depth reached only by blue light. This alga probably belongs to which group?

- A) red algae
- B) brown algae
- C) green algae
- D) dinoflagellates
- E) golden algae

Answer: A

Topic: Concept 28.5

Skill: Knowledge/Comprehension

23) Green algae differ from land plants in that many green algae

- A) are heterotrophs.
- B) are unicellular.
- C) have plastids.
- D) have alternation of generations.
- E) have cell walls containing cellulose.

Answer: B

Topic: Concept 28.5

Skill: Knowledge/Comprehension

24) If the Archaeplastidae are eventually designated a kingdom, and if land plants are excluded from this kingdom, then what will be true of this new kingdom?

- A) It will be monophyletic.
- B) It will more accurately depict evolutionary relationships than does the current taxonomy.
- C) It will be paraphyletic.
- D) It will be a true clade.
- E) It will be polyphyletic.

Answer: C

Topic: Concept 28.5

Skill: Application/Analysis

25) The best evidence for not classifying the slime molds as fungi comes from slime molds'

- A) DNA sequences.
- B) nutritional modes.
- C) choice of habitats.
- D) physical appearance.
- E) reproductive methods.

Answer: A

Topic: Concept 28.6

Skill: Knowledge/Comprehension

26) Which pair of alternatives is highlighted by the life cycle of the cellular slime molds, such as *Dictyostelium*?

- A) prokaryotic or eukaryotic
- B) unicellular or multicellular
- C) diploid or haploid
- D) autotroph or heterotroph

Answer: B

Topic: Concept 28.6

Skill: Knowledge/Comprehension

27) Which of the following statements concerning protists is true?

- A) All protists have mitochondria, though in some species they are much reduced and known by different names.
- B) The primary organism that transmits malaria to humans by its bite is the tsetse fly.
- C) All apicomplexans are autotrophic.
- D) All slime molds have an amoeboid stage that may be followed by a stage during which spores are produced.
- E) Euglenozoans that are mixotrophic lack functional chloroplasts.

Answer: A

Topic: Concepts 28.2-28.6

Skill: Knowledge/Comprehension

28) Which of the following is correctly described as a primary producer?

- A) oomycete
- B) kinetoplastid
- C) apicomplexan
- D) diatom
- E) radiolarian

Answer: D

Topic: Concepts 28.2-28.6

Skill: Knowledge/Comprehension

29) You are given the task of designing an aerobic, mixotrophic protist that can perform photosynthesis in fairly deep water (for example, 250 m deep), and can also crawl about and engulf small particles.

With which two of the following structures would you provide your protist?

1. hydrogenosome
2. apicoplast
3. pseudopods
4. chloroplast from red alga
5. chloroplast from green alga

A) 1 and 2

B) 2 and 3

C) 2 and 4

D) 3 and 4

E) 4 and 5

Answer: D

Topic: Concepts 28.2-28.6

Skill: Synthesis/Evaluation

30) You are given the task of designing an aquatic protist that is a primary producer. It cannot swim on its own, yet must stay in well-lit surface waters. It must be resistant to physical damage from wave action. It should be most similar to a(n)

A) diatom.

B) dinoflagellate.

C) apicomplexan.

D) red alga.

E) radiolarian.

Answer: A

Topic: Concepts 28.2-28.6

Skill: Synthesis/Evaluation

31) Similar to most amoebozoans, the forams and the radiolarians also have pseudopods, as do some of the white blood cells of animals (monocytes). If one were to erect a taxon that included all organisms that have cells with pseudopods, what would be true of such a taxon?

A) It would be polyphyletic.

B) It would be paraphyletic.

C) It would be monophyletic.

D) It would include all eukaryotes.

Answer: A

Topic: Concepts 28.4, 28.6

Skill: Synthesis/Evaluation

32) You are designing an artificial drug-delivery "cell" that can penetrate animal cells. Which of these protist structures should provide the most likely avenue for research along these lines?

A) pseudopods

B) apical complex

C) excavated feeding grooves

D) nucleomorphs

E) mitosomes

Answer: B

Topic: Concepts 28.2-28.6

Skill: Synthesis/Evaluation

33) A gelatinous seaweed that grows in shallow, cold water and undergoes heteromorphic alternation of generations is most probably what type of alga?

- A) red
- B) green
- C) brown
- D) yellow

Answer: C

Topic: Concepts 28.2-28.6

Skill: Application/Analysis

34) Which of the following are actual mutualistic partnerships that involve a protist and a host organism?

- A) cellulose-digesting gut protists—wood-eating termites
- B) dinoflagellates—reef-building coral animals
- C) *Trichomonas*—humans
- D) algae—certain foraminiferans
- E) all except that involving humans

Answer: E

Topic: Concept 28.7

Skill: Knowledge/Comprehension

35) Living diatoms contain brownish plastids. If global warming causes blooms of diatoms in the surface waters of Earth's oceans, how might this be harmful to the animals that build coral reefs?

- A) The coral animals, which capture planktonic organisms, may be outcompeted by the diatoms.
- B) The coral animals' endosymbiotic dinoflagellates may get "shaded out" by the diatoms.
- C) The coral animals may die from overeating the plentiful diatoms, with their cases of silica.
- D) The diatoms' photosynthetic output may over-oxygenate the water.

Answer: B

Topic: Concept 28.7

Skill: Knowledge/Comprehension

Art Questions

You are given five test tubes, each containing an unknown protist, and your task is to read the following description and match these five protists to the correct test tube.

In test tube 1, you observe an organism feeding. Your sketch of the organism looks very similar to Figure 28.1. When light, especially red and blue light, is shone on the tubes, oxygen bubbles accumulate on the inside of test tubes 2 and 3. Chemical analysis of test tube 3 indicates the presence of substantial amounts of silica. Chemical analysis of test tube 2 indicates the presence of a chemical that is toxic to fish and humans. Microscopic analysis of organisms in test tubes 2, 4, and 5 reveals the presence of permanent, membrane-bounded sacs just under the plasma membrane. Microscopic analysis of organisms in test tube 4 reveals the presence of an apicoplast in each. Microscopic analysis of the contents in test tube 5 reveals the presence of one large nucleus and several small nuclei in each organism.

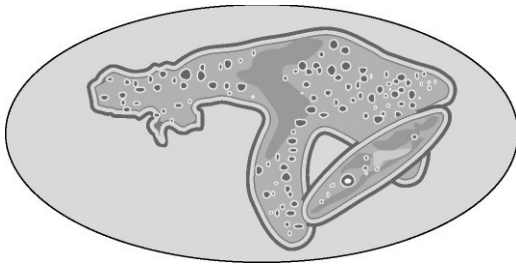


Figure 28.1

36) Test tube 2 contains

- A) *Paramecium*.
- B) *Navicula* (diatom).
- C) *Pfiesteria* (dinoflagellate).
- D) *Entamoeba*.
- E) *Plasmodium*.

Answer: C

Topic: Concept 28.3

Skill: Application/Analysis

37) Test tube 4 contains

- A) *Paramecium*.
- B) *Navicula* (diatom).
- C) *Pfiesteria* (dinoflagellate).
- D) *Entamoeba*.
- E) *Plasmodium*.

Answer: E

Topic: Concept 28.3

Skill: Application/Analysis

38) Test tube 5 contains

- A) *Paramecium*.
- B) *Navicula* (diatom).
- C) *Pfiesteria* (dinoflagellate).
- D) *Entamoeba*.
- E) *Plasmodium*.

Answer: A

Topic: Concept 28.3

Skill: Application/Analysis

39) Test tube 3 contains

- A) *Paramecium*.
- B) *Navicula* (diatom).
- C) *Pfiesteria* (dinoflagellate).
- D) *Entamoeba*.
- E) *Plasmodium*.

Answer: B

Topic: Concept 28.3

Skill: Application/Analysis

Scenario Questions

The next few questions refer to the following description and Table 28.1.

Diatoms are encased in Petri-platelike cases (valves) made of translucent hydrated silica whose thickness can be varied. The material used to store excess calories can also be varied. At certain times, diatoms store excess calories in the form of the liquid polysaccharide, laminarin, and at other times as oil. The following are data concerning the density (specific gravity) of various components of diatoms, and of their environment.

Table 28.1 Specific Gravities of Materials Relevant to Diatoms

| Material | Specific Gravity (kg/m³) |
|------------------|--|
| Pure water | 1,000 |
| Seawater | 1,026 |
| Hydrated silica | 2,250 |
| Liquid laminarin | 1,500 |
| Diatom oil | 910 |

40) Water's density and, consequently, its buoyancy decrease at warmer temperatures. Based on this consideration and using data from Table 28.1, at which time of year should one expect diatoms to be storing excess calories mostly as oil?

- A) mid-winter
- B) early spring
- C) late summer
- D) late fall

Answer: C

Topic: Concept 28.3

Skill: Synthesis/Evaluation

41) Judging from Table 28.1 and given that water's density and, consequently, its buoyancy decrease at warmer temperatures, in which environment should diatoms (and other suspended particles) sink most slowly?

- A) cold fresh water
- B) warm fresh water
- C) cold seawater
- D) warm seawater
- E) warm brackish water

Answer: C

Topic: Concept 28.3

Skill: Synthesis/Evaluation

42) Using dead diatoms to "pump" CO₂ to the seafloor is feasible only if dead diatoms sink quickly. Consequently, application of mineral fertilizers, such as iron, should be most effective at times when diatom valves

- A) are thickest, and laminarin is being produced rather than oil.
- B) are thickest, and oil is being produced rather than laminarin.
- C) are thinnest, and laminarin is being produced rather than oil.
- D) are thinnest, and oil is being produced rather than laminarin.

Answer: A

Topic: Concept 28.3

Skill: Synthesis/Evaluation

Giardia lamblia is an intestinal parasite of humans and other mammals that causes intestinal ailments in most people who ingest the cysts. Upon ingestion, each cyst releases two motile cells, called trophozoites. These attach to the small intestine's lining via a ventral adhesive disk. The trophozoites anaerobically metabolize glucose from the host's intestinal contents to produce ATP. Reproduction is completely asexual, occurring by longitudinal binary fission of trophozoites, with each daughter cell receiving two, haploid nuclei ($n = 5$). A trophozoite will often encyst as it passes into the large intestine by secreting around itself a case that is resistant to cold, heat, and dehydration. Infection usually occurs by drinking untreated water that contains cysts.

43) The trophozoites of *Giardia* were first observed in 1681 in the diarrhea stools of the first known person to view protists with a microscope, a person named

- A) Robert Koch.
- B) Robert Hooke.
- C) Isaac Newton.
- D) van Leeuwenhoek.
- E) Louis Pasteur.

Answer: D

Topic: Concept 28.1

Skill: Knowledge/Comprehension

44) Given that Flagyl produces only minor side effects (if any) in humans, and given the set of parasites that it kills, Flagyl's mode of action probably involves

- A) peptidoglycan.
- B) mitochondria or mitosomes.
- C) anaerobic metabolic pathways.
- D) nuclear envelopes.
- E) microtubules.

Answer: C

Topic: Concept 28.2

Skill: Application/Analysis

45) *Giardia's* mitosome can be said to be "doubly degenerate," because it is a degenerate form of _____, an organelle that is itself a degenerate form of _____.

- A) nucleus; archaean
- B) nucleus; bacterium
- C) mitochondrion; proteobacterium
- D) mitochondrion; spirochete
- E) chloroplast; cyanobacterium

Answer: C

Topic: Concepts 25.3, 28.1, 28.2

Skill: Knowledge/Comprehension

46) The mitosome of *Giardia* has no DNA within it. If it did contain DNA, then what predictions should we be able to make about its DNA?

- 1. It is linear.
- 2. It is circular.
- 3. It has many introns.
- 4. It has few introns.
- 5. It is not associated with histone proteins.
- 6. It is complexed with histone proteins.

- A) 1, 3, and 5
- B) 1, 4, and 5
- C) 2, 3, and 6
- D) 2, 4, and 5
- E) 2, 4, and 6

Answer: D

Topic: Concepts 27.1, 28.2

Skill: Application/Analysis

47) Given the putative ancestry of *Giardia's* mitosome, what should we predict is true of the mitosome?

- A) It has electron transport systems that use oxygen as the final electron acceptor.
- B) It has a double membrane.
- C) It has thylakoids.
- D) It contains microtubules, arranged in the "9 + 2 pattern."
- E) It contains 80S (eukaryotic) ribosomes.

Answer: B

Topic: Concepts 9.4, 10.1, 28.2

Skill: Application/Analysis

48) Given its mode of reproduction and internal structures, which of the following should be expected to occur in *Giardia* at some stage of its life cycle?

1. separation (segregation) of daughter chromosomes
2. crossing over
3. meiosis

A) 1 only

B) 3 only

C) 1 and 2

D) 1 and 3

E) 2 and 3

Answer: A

Topic: Concepts 12.2, 13.3, 28.2

Skill: Application/Analysis

49) Unlike most excavates, *Giardia* trophozoites have no oral groove and are unable to form food vacuoles. Thus, we should expect its nutrition (mostly glucose) to come from

A) its mitosomes.

B) endosymbiotic cyanobacteria.

C) the ventral disk by which it adheres to the intestinal lining.

D) osmosis involving aquaporins.

E) plasma membrane proteins that are transporters or pumps.

Answer: E

Topic: Concepts 7.3, 7.4, 28.2

Skill: Application/Analysis

50) Diplomonads, such as *Giardia*, contain two haploid nuclei per trophozoite. Thus, during the G₁ phase of the cell cycle, there should be a total of how many *unreplicated* chromosomes per trophozoite, and during the G₂ phase, how many *replicated* chromosomes per trophozoite?

A) 5; 5

B) 5; 10

C) 10; 10

D) 10; 20

E) 20; 20

Answer: C

Topic: Concepts 12.2, 28.2

Skill: Application/Analysis

51) During passage through the large intestine, a trophozoite will often secrete a case around itself, forming a cyst. Cysts contain four haploid nuclei. When cysts "hatch" within a new host, two trophozoites are released. Thus, which of the following must happen within the cyst, prior to hatching?

1. meiosis
2. nuclear division
3. S phase
4. binary fission

- A) 1 only
- B) 1 and 2
- C) 2 and 3
- D) 2 and 4
- E) 2, 3, and 4

Answer: E

Topic: Concepts 12.2, 13.3, 28.2

Skill: Application/Analysis

52) The cysts of *Giardia* are most analogous to the

- A) mitochondria of ancestral diplomonads.
- B) nuclei of archaeans.
- C) endospores of bacteria.
- D) capsids of viruses.

Answer: C

Topic: Concepts 19.1, 27.1, 28.2

Skill: Application/Analysis

53) If the mitosomes of *Giardia* contain no DNA, yet are descendants of what were once free-living organisms, then where are we likely to find the genes that encode their structures, and what accounts for their current location there?

- A) plasmids; conjugation
- B) plasmids; transformation
- C) nucleus; horizontal gene transfer
- D) nucleus; S phase

Answer: C

Topic: Concepts 27.6, 28.2

Skill: Application/Analysis

54) The primary treatment for giardiasis (infection with *Giardia*), as well as for trichomoniasis (infection with *Trichomonas vaginalis*) and for amoebic dysentery (infection with *Entamoeba histolytica*), is a drug marketed as Flagyl (generic name is metronidazole). The drug also kills anaerobic gut bacteria. Consequently, which of these are cues that Flagyl's mode of action has nothing to do with attacking or disabling the parasites' flagella, as the drug's name might imply?

1. It would also harm the flagellated lining of the human intestine.
2. *Entamoeba* possesses pseudopods, not flagella, yet it is killed by Flagyl.
3. Prokaryotic flagella and eukaryotic flagella are radically different from each other and unlikely to be harmed by the same chemical.
4. Not all anaerobic gut bacteria possess flagella, yet it kills these bacteria.

A) 1 and 2

B) 1 and 3

C) 2 and 3

D) 1, 2, and 4

E) 2, 3, and 4

Answer: E

Topic: Concepts 28.2, 28.6

Skill: Synthesis/Evaluation

Paulinella chromatophora is one of the few cercozoans that is autotrophic, carrying out aerobic photosynthesis with its two elongated "cyanelles." The cyanelles are contained within vesicles of the host cell, and each is derived from a cyanobacterium, though not the same type of cyanobacterium that gave rise to the chloroplasts of algae and plants.

55) The closest living relative of *P. chromatophora* is the heterotroph, *P. ovalis*. What type of evidence permits biologists to make this claim about relatedness?

A) morphological

B) ecological

C) biochemical

D) genetic

E) fossil

Answer: D

Topic: Concepts 26.2, 28.4

Skill: Application/Analysis

56) The closest living relative of *P. chromatophora* is the heterotroph, *P. ovalis*. *P. ovalis* uses threadlike pseudopods to capture its prey, which it digests internally. Which of the following, if observed, would be the best reason for relabeling *P. chromatophora* as a mixotroph?

A) a threadlike pseudopod

B) a pigmented central vacuole, surrounded by a tonoplast

C) a vacuole with food inside

D) a secretory vesicle

E) a contractile vacuole

Answer: C

Topic: Concepts 6.4, 28.4

Skill: Application/Analysis

57) *P. chromatophora* secretes around itself a test, or case, of plates made of silica. Which of the following is another rhizarian that would be in competition with *P. chromatophora* for the silica needed to make these plates, assuming limited quantities of silica in the environment?

- A) radiolarians
- B) foraminiferans
- C) all other amoeboid cells
- D) all other rhizaria
- E) diatoms

Answer: A

Topic: Concept 28.4

Skill: Knowledge/Comprehension

58) Which of the following represents the true significance of the finding that the cyanelles of *P. chromatophora* stem from a different type of cyanobacterium than gave rise to chloroplasts?

- A) This finding indicates that there is a second evolutionary lineage of photosynthetic eukaryotes.
- B) This finding represents the first time that primary endosymbiosis has been directly observed.
- C) This finding is the strongest evidence yet for the theory of endosymbiosis.
- D) This finding is an example of the phenomenon known as "serial endosymbiosis."
- E) This finding is the first evidence that eukaryotic cells do not necessarily digest prokaryotic cells that manage to gain access to their cytoplasm.

Answer: A

Topic: Concepts 28.1, 28.4

Skill: Synthesis/Evaluation

59) The genome of modern chloroplasts is roughly 50% the size of the genome of the cyanobacterium from which it is thought to have been derived. In comparison, the genome of *P. chromatophora*'s cyanelle is only slightly reduced relative to the size of the genome of the cyanobacterium from which it is thought to have been derived. What is a valid conclusion that can be drawn from this comparison?

- A) Lytic phage infections have targeted the chloroplast genome more often than the *P. chromatophora* genome.
- B) *P. chromatophora*'s cyanelle is the result of an evolutionarily recent endosymbiosis.
- C) The genome of the chloroplast ancestor contained many more introns that could be lost without harm, compared to the cyanelle's genome.
- D) All three of the conclusions above are valid.
- E) Two of the conclusions above are valid.

Answer: B

Topic: Concepts 28.1, 28.4

Skill: Application/Analysis

60) If true, which of the following would be most important in determining whether *P. chromatophora*'s cyanelle is still an endosymbiont, or is an organelle, as the term *cyanelle* implies?

- A) If *P. chromatophora* is less fit without its cyanelle than with it.
- B) If the cyanelle is less fit without the host cercozoan than with it.
- C) If there is ongoing metabolic cooperation between the cyanelle and the host cercozoan.
- D) If the magnesium-containing porphyrin ring in the cyanelle's chlorophyll molecules is built by the cyanelle, whereas the organic portion of the chlorophyll molecules is built by the host cercozoan.
- E) If there has been movement of genes from the cyanelle genome to the nuclear genome, such that these genes are no longer present in the cyanelle genome.

Answer: E

Topic: Concepts 28.1, 28.4

Skill: Synthesis/Evaluation

61) If true, which of the following is the best evidence that the cyanelles are providing nutrition (in other words, calories) to the surrounding cercozoan?

- A) If the cyanelle performs aerobic photosynthesis.
- B) If the vesicle membrane that surrounds each cyanelle possesses glucose-transport proteins.
- C) If the cyanelle performs aerobic respiration.
- D) If radiolabeled $^{14}\text{CO}_2$ enters the cyanelle and if, subsequently, radiolabeled glucose is present in cercozoan cytosol.
- E) If radiolabeled "heavy" water, $^2\text{H}_2\text{O}$, enters the cyanelle and if, subsequently, radiolabeled oxygen appears in cercozoan cytosol.

Answer: D

Topic: Concepts 10.2, 28.4

Skill: Synthesis/Evaluation

62) A crucial photosynthetic gene of the cyanobacterium that gave rise to the cyanelle is called *psaE*. This gene is present in the nuclear genome of the cercozoan, but is not in the genome of the cyanelle. This is evidence of

- A) reciprocal mutations in the cyanelle and nuclear genomes.
- B) horizontal gene transfer from bacterium to eukaryotes.
- C) genetic recombination involving a protist and an archaean.
- D) the origin of photosynthesis in protists.
- E) transduction by a phage that infects both prokaryotes and eukaryotes.

Answer: B

Topic: Concepts 26.6, 28.4

Skill: Application/Analysis

63) What must occur for asexual reproduction to be successful in *P. chromatophora*?

1. mitosis
2. S phase
3. meiosis
4. equal distribution of cyanelles during cytokinesis

- A) 1 only
- B) 1 and 2
- C) 1, 2, and 3
- D) 1, 2, and 4
- E) 2, 3, and 4

Answer: D

Topic: Concepts 12.2, 28.4

Skill: Application/Analysis

64) Including the membrane of the surrounding vesicle, how many *phospholipid* (NOT lipopolysaccharide) bilayers should be found around each cyanelle, and which one of these bilayers should have photosystems embedded in it?

- A) two; innermost
- B) two; outermost
- C) three; innermost
- D) three; middle
- E) three; outermost

Answer: A

Topic: Concepts 28.1, 28.4

Skill: Application/Analysis

The next few questions refer to the following description.

Healthy individuals of *Paramecium bursaria* contain photosynthetic algal endosymbionts of the genus *Chlorella*. When within their hosts, the algae are referred to as zoochlorellae. In aquaria with light coming from only one side, *P. bursaria* gathers at the well-lit side, whereas other species of *Paramecium* gather at the opposite side. The zoochlorellae provide their hosts with glucose and oxygen, and *P. bursaria* provides its zoochlorellae with protection and motility. *P. bursaria* can lose its zoochlorellae in two ways: (1) if kept in darkness, the algae will die; and (2) if prey items (mostly bacteria) are absent from its habitat, *P. bursaria* will digest its zoochlorellae.

65) Which term most accurately describes the nutritional mode of healthy *P. bursaria*?

- A) photoautotroph
- B) photoheterotroph
- C) chemoheterotroph
- D) chemoautotroph
- E) mixotroph

Answer: E

Topic: Concepts 28.1-28.7

Skill: Application/Analysis

66) Which term accurately describes the behavior of *Paramecium* species that lack zoochlorellae in an aquarium with light coming from one side only?

- A) positive chemotaxis
- B) negative chemotaxis
- C) positive phototaxis
- D) negative phototaxis

Answer: D

Topic: Concepts 28.1-28.7

Skill: Application/Analysis

67) Which term best describes the symbiotic relationship of well-fed *P. bursaria* to their zoochlorellae?

- A) mutualistic
- B) commensal
- C) parasitic
- D) predatory
- E) pathogenic

Answer: A

Topic: Concepts 28.1-28.7

Skill: Application/Analysis

68) The motility that permits *P. bursaria* to move toward a light source is provided by

- A) pseudopods.
- B) a single flagellum composed of the protein, *flagellin*.
- C) a single flagellum featuring the 9 + 2 pattern.
- D) many cilia.
- E) contractile vacuoles.

Answer: D

Topic: Concepts 28.1-28.7

Skill: Application/Analysis

69) A *P. bursaria* cell that has lost its zoochlorellae is said to be *aposymbiotic*. It might be able to replenish its contingent of zoochlorellae by ingesting them without subsequently digesting them. Which of the following situations would be most favorable to the reestablishment of resident zoochlorellae, assuming compatible *Chlorella* are present in *P. bursaria*'s habitat?

- A) abundant light, no bacterial prey
- B) abundant light, abundant bacterial prey
- C) no light, no bacterial prey
- D) no light, abundant bacterial prey

Answer: B

Topic: Concepts 28.1-28.7

Skill: Application/Analysis

70) A *P. bursaria* cell that has lost its zoochlorellae is *aposymbiotic*. If aposymbiotic cells have population growth rates the same as those of healthy, zoochlorella-containing *P. bursaria* in well-lit environments with plenty of prey items, then such an observation would be consistent with which type of relationship?

- A) parasitic
- B) commensalistic
- C) toxic
- D) predator-prey
- E) mutualistic

Answer: B

Topic: Concepts 28.1-28.7

Skill: Application/Analysis

71) Theoretically, *P. bursaria* can obtain zoochlorella either vertically (via the asexual reproduction of its mother cell) or horizontally (by ingesting free-living *Chlorella* from its habitat). Consider a *P. bursaria* cell containing zoochlorellae, but whose habitat lacks free-living *Chlorella*. If this cell subsequently undergoes many generations of asexual reproduction, if all of its daughter cells contain roughly the same number of zoochlorellae as it had originally contained, and if the zoochlorellae are all haploid and identical in appearance, then what is true?

- A) The zoochlorellae also reproduced asexually, at an increasing rate over time.
- B) The zoochlorellae also reproduced asexually, at a decreasing rate over time.
- C) The zoochlorellae also reproduced asexually, at a fairly constant rate over time.
- D) The zoochlorellae reproduced sexually, undergoing heteromorphic alternation of generations.
- E) The zoochlorellae reproduced sexually, undergoing isomorphic alternation of generations.

Answer: C

Topic: Concepts 28.1-28.7

Skill: Synthesis/Evaluation

End-of-Chapter Questions

The following questions are from the end-of-chapter “Test Your Understanding” section in Chapter 28 of the textbook.

72) Plastids that are surrounded by more than two membranes are evidence of

- A) evolution from mitochondria.
- B) fusion of plastids.
- C) origin of the plastids from archaea.
- D) secondary endosymbiosis.
- E) budding of the plastids from the nuclear envelope.

Answer: D

Topic: End-of-Chapter Questions

Skill: Knowledge/Comprehension

73) Biologists suspect that endosymbiosis gave rise to mitochondria before plastids partly because
A) the products of photosynthesis could not be metabolized without mitochondrial enzymes.
B) all eukaryotes have mitochondria (or their remnants), whereas many eukaryotes do not have plastids.
C) mitochondrial DNA is less similar to prokaryotic DNA than is plastid DNA.
D) without mitochondrial CO₂ production, photosynthesis could not occur.
E) mitochondrial proteins are synthesized on cytosolic ribosomes, whereas plastids utilize their own ribosomes.

Answer: B

Topic: End-of-Chapter Questions

Skill: Knowledge/Comprehension

74) Which group is *incorrectly* paired with its description?
A) rhizarians—morphologically diverse group defined by DNA similarities
B) diatoms—important producers in aquatic communities
C) red algae—acquired plastids by secondary endosymbiosis
D) apicomplexans—parasites with intricate life cycles
E) diplomonads—protists with modified mitochondria

Answer: C

Topic: End-of-Chapter Questions

Skill: Knowledge/Comprehension

75) Which protists are in the same eukaryotic supergroup as land plants?
A) green algae
B) dinoflagellates
C) red algae
D) brown algae
E) both green algae and red algae

Answer: E

Topic: End-of-Chapter Questions

Skill: Knowledge/Comprehension

76) In life cycles with an alternation of generations, multicellular haploid forms alternate with
A) unicellular haploid forms.
B) unicellular diploid forms.
C) multicellular haploid forms.
D) multicellular diploid forms.
E) multicellular polyploid forms.

Answer: D

Topic: End-of-Chapter Questions

Skill: Knowledge/Comprehension