

University of Maryland Science Olympiad

2025 Invitational



Microbe Mission

Team Number: _____

School/Team Name: _____

Participant Names: _____

Instructions:

Please fill in your team number and team name on top of every page. Please show your work for partial credits. Good Luck!

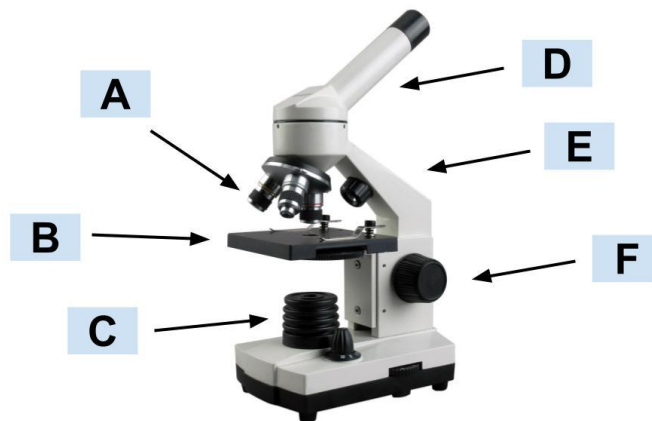
Final Score: _____

Section 1: Microscopy: (20 pts. total)

1. [1 pt] Which microscope is the best for resolving a sample's surface and composition?

- A. Bright field microscope
- B. Phase contrast microscope
- C. Differential-interference microscope
- D. Transmission electron microscope
- E. Scanning electron microscope

2. [6 pts] Label the parts of the light compound microscope below:



A.

B.

C.

D.

E.

F.

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3. [1 pt] The ocular of a microscope is 12x and the objectives are 40x. What is the total magnification?

- A. 52x
- B. 520x
- C. 48x
- D. 480x
- E. 960x

Use the image below to answer questions 4-5:

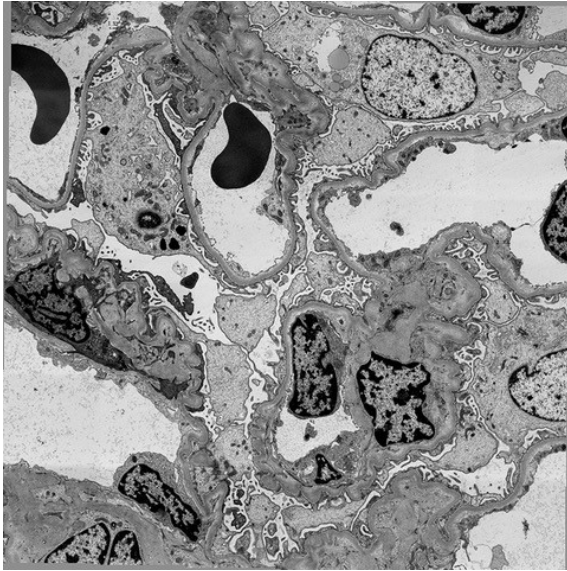


4. [1 pt] What type of microscope was used to take this image?

- A. Phase contrast microscope
- B. Scanning electron microscope
- C. Bright field microscope
- D. X-ray microscope
- E. Neutron microscope

5. [1 pt] What disadvantage of this microscope can be observed from the image?

6. [1 pt] Identify the type of microscope used to take this image of kidney tissue:



7. [1 pt] A sample appears to occupy $\frac{1}{5}$ of the field of view under 100x magnification. If the FOV at 100x is 2 mm, what is the approximate size of the sample?

- A. 0.4 mm
- B. 0.2 mm
- C. 0.5 mm
- D. 1.0 mm
- E. Not enough info.

8. [2 pts] Which two microscopes are capable of visualizing the internal structure of a sample without physically slicing it?

9. [1 pts] What is a key advantage of X-ray microscopes over electron microscopes?

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10. [2 pts] What are two advantages of a scanning helium ion microscope over a traditional electron microscope?

11. [1 pt] Which type of lens causes light rays to diverge?

- A. Biconvex
- B. Plano-convex
- C. Biconcave
- D. Cylindrical
- E. Convex-concave

12. [1 pt] How does the index of refraction influence the appearance of a mirage on hot days?

- A. Hot air increases light speed, bending it sharply
- B. Lower index of hot air bends light towards the ground
- C. Cold air bends light away from the ground
- D. Hot air makes light travel straight
- E. Index of refraction has no effect

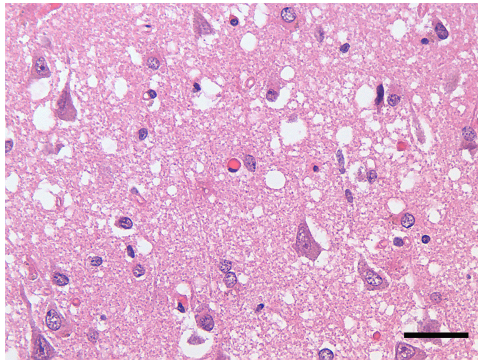
13. [1 pt] A microscope has a 100x objective and a 10x eyepiece, with a field of view of 0.5 mm at 100x magnification. If the magnification is increased to 500x using the same eyepiece, what will be the new field of view?

Section 2: Acellular Microbes and Agents: (24 pts. total)

14. [1 pt] Which prion disease is not associated with humans?
- A. Creutzfeldt-Jakob Disease (CJD)
 - B. Kuru
 - C. Scrapie
 - D. Fatal Familial Insomnia (FFI)
 - E. None of the above.
15. [1 pt] Which of the following is not a known characteristic of prion proteins (PrP)?
- A. Contains both alpha-helices and beta-sheets in its secondary structure
 - B. Anchored to the plasma membrane via a GPI moiety
 - C. Composed of 208 amino acids in its mature form
 - D. Requires nucleic acids for replication
 - E. Exhibits high affinity for copper ions
16. [6 pts] Name 3 prion diseases and briefly describe their effects.
17. [1 pt] Which of the following histological findings is characteristic of TSEs?
- A. Lewy bodies
 - B. Intracellular viral inclusions
 - C. Vacuolation of nervous tissue
 - D. Formation of syncytia
 - E. Necrosis of myelin sheaths
18. [3 pts] How do prion-like proteins differ from prions? Which of the 6 components in the chain of infection does a prion-like protein lack?

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19. [6 pts] Identify the key features in this histological image indicative of prion disease. Explain how these features are formed.



20. [2 pts] A virus infects a host by integrating its DNA into host cell DNA. Name this type of virus and provide an example.

21. [1 pt] Which of the following is not a correct pairing in the Baltimore classification system?

- A. Class I – Double-stranded DNA viruses
- B. Class II – Single-stranded RNA viruses
- C. Class III – Double-stranded RNA viruses
- D. Class IV – Positive-sense single-stranded RNA viruses
- E. Class VII – DNA retroviruses

22. [1 pt] Which virus has an icosahedral capsid?

- A. Rabies virus
- B. Tobacco mosaic virus
- C. Poliovirus
- D. HIV-1
- E. Smallpox virus

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23. [1 pt] The hepatitis D virus is considered a satellite because it requires which helper virus?

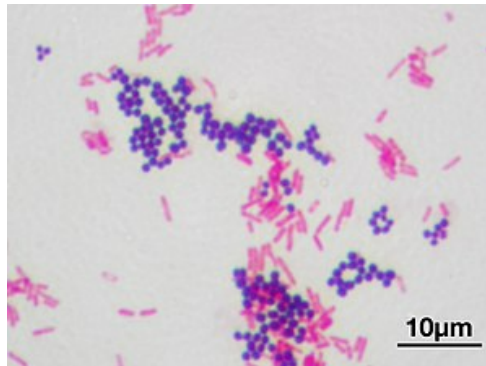
- A. HIV
- B. Hepatitis C virus
- C. Hepatitis B virus
- D. Epstein-Barr virus
- E. Influenza virus

24. [1 pt] Which two famous virophages belong to the family *Lavidaviridae* and depend on giant viruses belonging to the genus *Mimivirus*?

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Section 3: Prokaryotic and Eukaryotic Microbes: (X pts total)

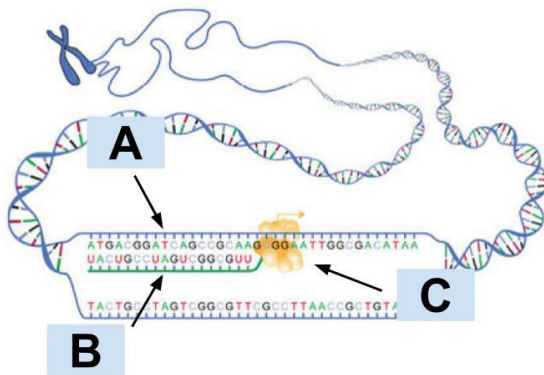
Use the image below to answer questions 25-26:



25. [1 pt] Identify the cell shape of the gram-positive bacteria.
26. [1 pt] Identify the cell shape of the gram-negative bacteria.
27. [1 pt] A prokaryotic cell has a circular DNA molecule, but you discover a smaller DNA molecule that carries antibiotic resistance genes. What is this structure called?
28. [2 pts] Some bacteria form endospores under unfavorable conditions. What advantage do endospores provide?
29. [3 pts] List 3 features that make prokaryotes different from eukaryotes.

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Use the image below to answer questions 30-31:



30. [1 pt] Identify the process shown in the image.

31. [3 pts] Label the parts of the image.

A.

B.

C.

32. [1 pt] Which type of RNA is being produced that's responsible for carrying the genetic information from the DNA to the ribosome?

A. tRNA

B. mRNA

C. rRNA

D. miRNA

E. snRNA

33. [1 pt] Why is Gram staining not effective for classifying acid-fast bacteria?

A. Acid-fast bacteria lack a cell wall.

B. Acid-fast bacteria have a thick peptidoglycan layer.

C. Acid-fast bacteria have a complex outer lipid layer with mycolic acids.

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- D. Acid-fast bacteria have no outer membrane.
- E. Acid-fast bacteria lack a nuclear membrane.

34. [2 pts] How does conjugation differ from transduction?

35. [1 pt] Which bacterial flagellar arrangement involves multiple flagella localized to one end of the cell?

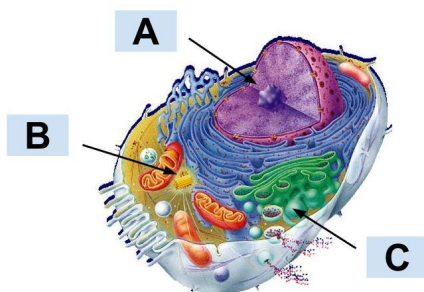
- A. Monotrichous
- B. Multitrichous
- C. Lophotrichous
- D. Peritrichous
- E. Amphitrichous

36. [2 pts] What is the energy source for most bacteria flagella? How is this energy source achieved?

37. [2 pts] Name two processes eukaryotic signature proteins in archaea are involved in.

38. [tiebreaker] What were likely the first land plants and why?

39. [6 pts] Identify the organelles in the eukaryotic cell below and briefly describe their function:



A.

B.

C.

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40. [2 pts] Name the major sterol found in fungus membranes. Name the major sterol found in animal membranes.

41. [2 pts] Which two fungal phylums undergo plasmogamy before karyogamy?

42. [1 pt] Which fungal pathogen contributes to dandruff by metabolizing sebum?

- A. *Malassezia globosa*
- B. *Penicillium chrysogenum*
- C. *Histoplasma capsulatum*
- D. *Pneumocystis*
- E. *Saccharomyces cerevisiae*

43. [tiebreaker] Which of the following protists is multicellular and makes up kelp forests?

- A. Radiolarians
- B. Foraminifera
- C. Oomycetes
- D. Red algae
- E. Brown algae

44. [2 pts] Name two photosynthetic protists.

45. [1 pt] Which characteristic is true for all flatworms?

- A. They have a coelom.
- B. They are hermaphroditic.
- C. They lack respiratory and circulatory systems.
- D. They have segmented bodies.
- E. They use a cloaca for excretion.

46. [1 pt] What distinguishes roundworms (Nematodes) from flatworms (Platyhelminthes)?

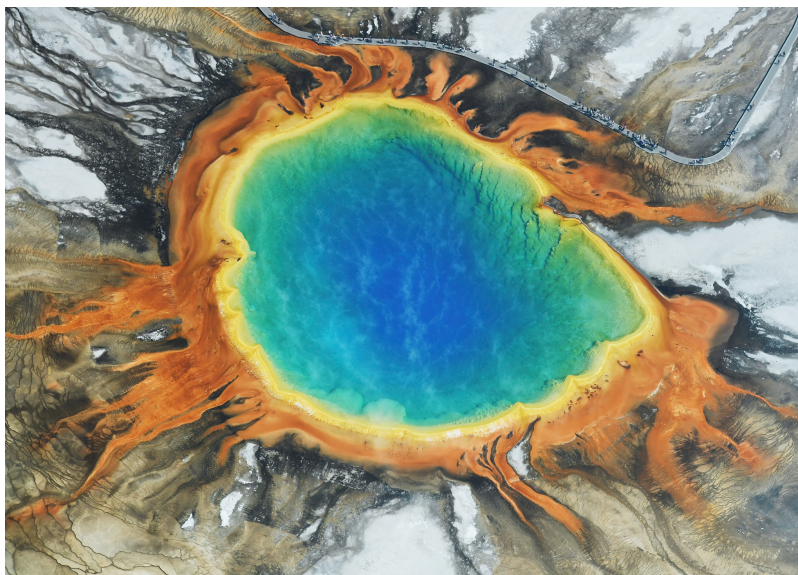
- A. Bilateral symmetry
- B. Lack of a coelom
- C. Presence of a pseudocoelom
- D. Absence of a cuticle
- E. Incomplete digestive tract

47. [1 pt] Name the structure that helps plant-parasitic roundworms pierce cell walls.

48. [1 pt] What is the difference between the digestive systems of flatworms and roundworms?

- A. Flatworms have two openings, roundworms have one.
- B. Roundworms have two openings, flatworms have one.
- C. Both have a complete digestive tract.
- D. Roundworms digest externally, flatworms digest internally.
- E. Flatworms lack a digestive system, while roundworms do not.

49. [1 pt] Name the type of extremophile that would be found in this type of environment:



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- A. Halophile
- B. Thermophile
- C. Xerophile
- D. Capnophile
- E. Piezophile

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Section 4: 24-25 Microbes and Pathogenic Agents: (16 pts total)

Use the key for "Type of Microbe" to answer questions 50-54.

Type of Microbe

- A. virus
- B. bacteria
- C. protozoan
- D. fungus

50. Which type of microbe causes Hepatitis B? _____

51. Which type of microbe causes HIV? _____

52. Which type of microbe causes tuberculosis? _____

53. Which type of microbe causes toxoplasmosis? _____

54. Which type of microbe causes polio? _____

Use the image below to answer questions 55-57.



55. [1 pt] Identify the organism shown in the image.

56. [1 pt] Where does the larval stage of this organism develop?

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57. [2 pts] What two conditions can this organism cause?

Use the image below to answer questions 58-60:



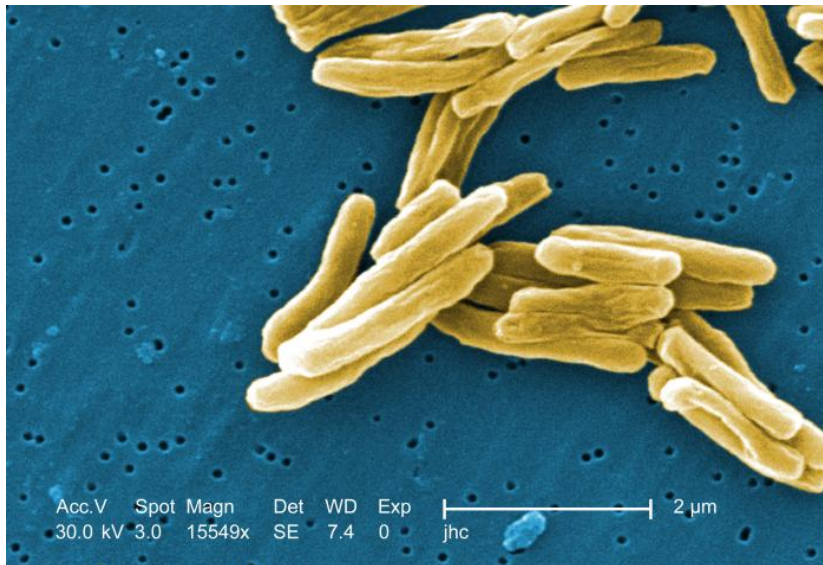
58. [1 pt] Identify the organism shown in the image.

59. [1 pt] Is it a gram-positive or gram-negative bacteria?

60. [1 pt] How does it disseminate throughout a population?

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Use the image below to answer questions 61-64:



61. [1 pt] Identify the organism shown in the image.

62. [1 pt] What is the shape of this organism?

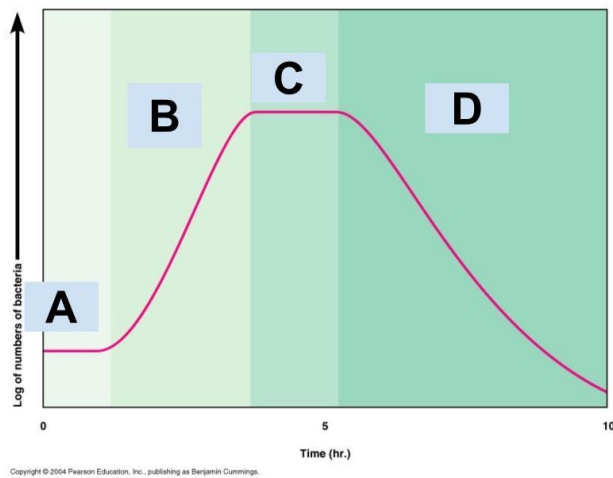
63. [1 pt] What disease does this organism cause?

64. [1 pt] Where in the body does this pathogen target?

Section 5: Metabolism, Growth Patterns, and Endosymbiosis: (17 pts total)

65. [1 pt] What do you call an organism that uses chemical energy and derives carbon/electrons from inorganic compounds?
- A. Photoorganoautotroph
 - B. Chemoorganoheterotroph
 - C. Chemoorganoautotroph
 - D. Chemolithoheterotroph
 - E. Chemolithoautotroph
66. [1 pt] Identify one organism that uses the metabolic strategy from the previous question.
67. [1 pt] What is the primary characteristic of obligate aerobes?
- A. They cannot tolerate oxygen.
 - B. They require oxygen for ATP production.
 - C. They grow best in environments with <0.5% oxygen.
 - D. They use fermentation to produce ATP.
 - E. They switch between aerobic and anaerobic metabolism.
68. [2 pts] What happens to fermentation in facultative anaerobes when oxygen becomes available? Identify the name of this effect.
69. [4 pts] Identify the parts of the microbial growth curve.

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A.

B.

C.

D.

70. [3 pts] List three pieces of evidence for the endosymbiosis theory of mitochondria and chloroplasts.

71. [2 pts] Identify the two ancestors of mitochondria and chloroplasts.

72. [tiebreaker, 2 points] In the endosymbiotic theory of eukaryogenesis, which two organisms merged to form the early eukaryote (be as specific as possible).

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73. [1 pt] What does the eocyte hypothesis propose about the tree of life?

- A. Life is divided into three domains: bacteria, archaea, and eukaryotes.
- B. Eukaryotes evolved directly from bacteria.
- C. Eukaryotes are a subgroup within archaea.
- D. Archaea evolved from eukaryotes.
- E. Eocytes are closer to bacteria than eukaryotes.