

Cellfie:



**2025 Purdue Science Olympiad Invitational**  
**Microbe Mission B Test**

Names: \_\_\_\_\_

Team Name & Number: \_\_\_\_\_

Rules

- Teams are allowed one 8.5 X 11.5 "cheat sheet" (which must be sealed by tape or laminated) and two stand-alone non-programmable, non-graphing calculators.
- Tie-Breakers (TB) will be used sequentially to break ties between two scores. TBs will count toward your total score as well.
- All multiple choice questions are 2 points unless denoted otherwise.
- Feel free to contact Anishka Jain ([jain685@purdue.edu](mailto:jain685@purdue.edu)) with questions about the test.

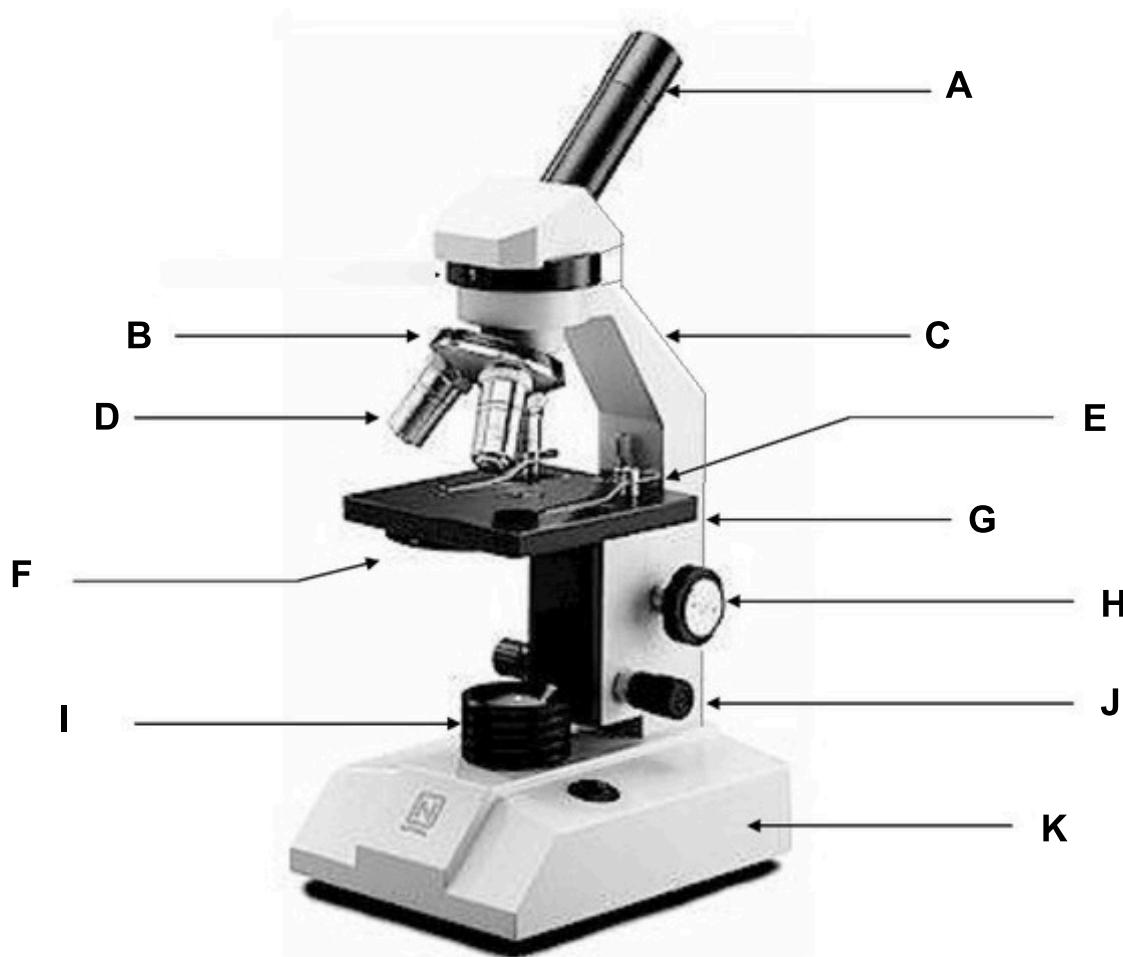
Score: \_\_\_\_\_ / 110

Placement: \_\_\_\_\_

TBs Correct: \_\_\_\_\_

## Part I: Microscopy

1. Label all structures of the following light microscope (A-K, 0.5 points each).



<b>A</b>	Eyepiece/ocular
<b>B</b>	Revolving Nosepiece
<b>C</b>	Neck
<b>D</b>	Objective
<b>E</b>	Stage Clip
<b>F</b>	Iris Diaphragm
<b>G</b>	Stage
<b>H</b>	Coarse Adjustment Knob
<b>I</b>	Light Source
<b>J</b>	Fine Adjustment Knob
<b>K</b>	Base

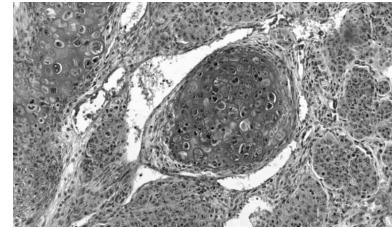
2. Using the previous diagram, label the function of each structure (A-K, 0.5 points each).

<b>A</b>	Magnifies and allows the user to view the subject (MUST INCLUDE BOTH)
<b>B</b>	Allows the user to change the magnification of the objectives
<b>C</b>	Supports the microscope/acts as a handle
<b>D</b>	Magnifies the subject
<b>E</b>	Holds slide in place
<b>F</b>	Adjusts the intensity of light
<b>G</b>	Supports the slide
<b>H</b>	Allows for quick focusing by moving the objective lens or stage up and down

I	Provides illumination
J	fine focus the image when viewing at the higher magnifications
K	Supports the entire microscope

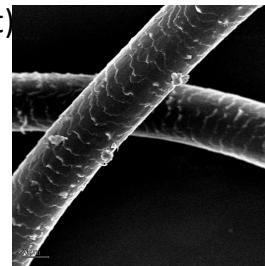
3. What type of microscopy is this? (2 pt)

- a. Bright-field
- b. Dark-field
- c. Phase contrast
- d. TEM
- e. SEM



4. What type of microscopy is this? (2 pt)

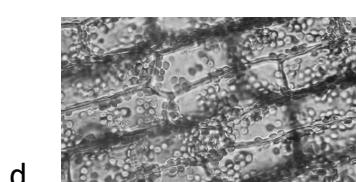
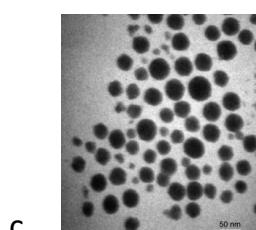
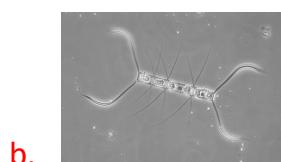
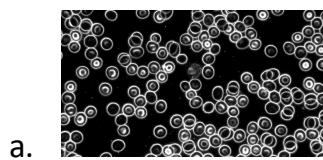
- a. Bright-field
- b. Dark-field
- c. Phase contrast
- d. TEM
- e. SEM



5. What type of microscopy is known for providing high-resolution images of thin specimens using a beam of subatomic particles transmitted through the sample? (2 pt)

- a. Bright-field
- b. Dark-field
- c. Phase contrast
- d. TEM
- e. SEM

6. Select the image that represents phase contrast microscopy: (2 pt)



7. What type of microscopy is known for light scattering at oblique angles, allowing for visualization of fine details in unstained specimens? (2 pt)

- a. Bright-field
- b. **Dark-field**
- c. Phase contrast
- d. TEM
- e. SEM

8. You are studying a specimen of *S. Cerevisiae* under a microscope. What would be the best combination of magnification (ocular and objective) to study this fungus? (2 pt, TB)

- a. 10x and 4x
- b. 10x and 10x
- c. **10x and 40x**
- d. 10x and 100x
- e. Trick question, *S. Cerevisiae* isn't a fungus!

## Part II: Structure and Morphology

9. Which bacterial structure is primarily responsible for horizontal gene transfer through conjugation? (2 pts)

- a. Ribosome
- b. Pili
- c. Capsule
- d. Plasmid
- e. Sex Conduit

10. Which structure is essential for bacteria to attach to surfaces and form biofilms? (2 pts)

- a. Flagella
- b. Pili
- c. Capsule
- d. Cell wall
- e. Plasmid

11.



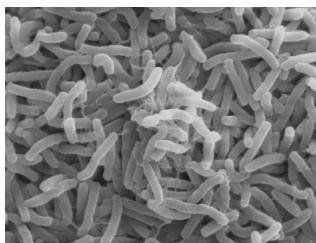
These bacteria have undergone the Gram staining procedure and have resulted in a purple stain. The bacteria are gram \_\_\_\_\_ and have a \_\_\_\_\_ peptidoglycan cell wall. (2 pts)

- a. negative; thin
- b. negative; thick
- c. positive; thin
- d. positive; thick

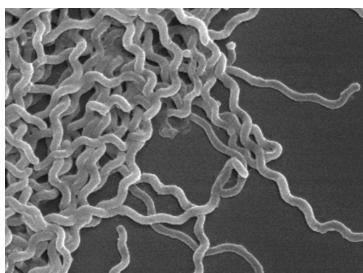
12. Which structure allows some bacteria to survive extreme conditions by forming a dormant state? (2 pts)

- a. Flagellum
- b. Teichoic acid
- c. Capsule
- d. Endospore
- e. Ether linkages

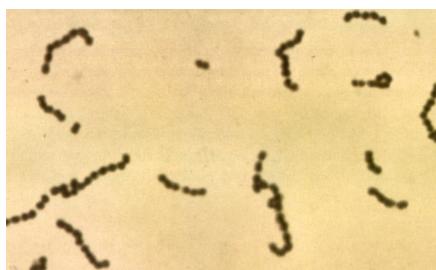
For questions 13-16, use the images to identify the type of bacterial cell structure. (2 pts each)



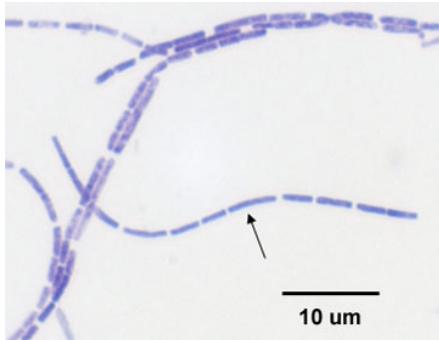
13. vibro



14. spirochete



15. streptococcus



16. streptobacillus

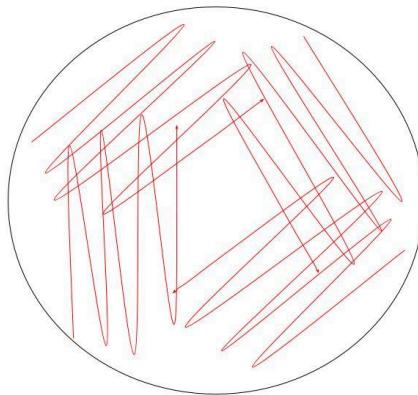
17. What is the scientific name for the bacteria depicted in question #13? (2 pts) (TB)

*vibrio cholerae*

### Part III: Culture and Growth

18. Use arrows to demonstrate the streaking method on an agar plate below: (2 pts)

4 quadrants, each connecting to the successive quadrant



<- Insert blank circle for blank test

19. What is a primary cause of microbial population explosions leading to algal blooms in aquatic ecosystems? (2 pts)

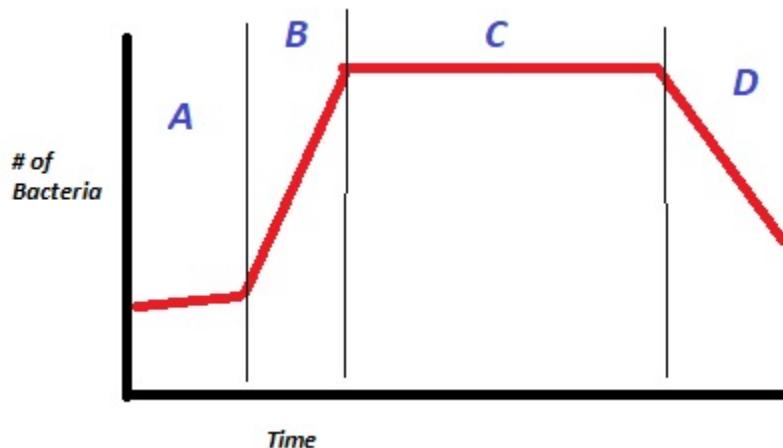
- a. Low nutrient levels
- b. Increased temperature
- c. Excessive nutrient runoff, such as nitrogen and phosphorus
- d. High levels of dissolved oxygen

20. The following are steps to stain bacteria to see which bacteria are positive and negative. Which two steps are wrong? (2 pts)

1. Prepare a microscope slide by drawing a circle onto the slide using a wax pencil.
  2. Sterilize inoculation loop and add deionized water to the circle. Spread water using inoculation loop.
  3. Sterilize inoculation loop and pick a colony from a petri dish.
  4. Spread the colony onto the circle.
  5. Heat-fix the slide by passing it above the Bunsen Burner three times.
  6. Apply Safranin to the slide. Wait 1 minute for the dye to settle. Wash off excess dye.
  7. Apply Gram's Iodine to decolorize the slide. Wait 1 minute to settle. Wash off excess iodine.
  8. Apply Crystal Violet to the slide. Wait 1 minute for the dye to settle. Wash off excess dye.
- a. 2 and 6  
b. 6 and 8  
c. 6 and 7  
d. 7 and 8

22.

(1 pt each)



a. lag phase

b. log phase

c. stationary phase

d. death phase

23. Using the previous question, what phase would correspond with  $dN/dt = 0$ ? (2 pts)  
(TB)

stationary phase

24. If a bacterium completes binary fission every 20 minutes, starting with one bacterium, how many bacteria would there be after 3 hours? (2 pts)

$2^9 = 512$  bacteria

25. Why is binary fission more prone to mutations compared to eukaryotic cell division?  
(4 pts)

Binary fission occurs in prokaryotes, which often lack the complex proofreading mechanisms found in eukaryotic cells during DNA replication. This increases the likelihood of mutations.

26. Which of the following is an example of selective plating? (2 pts) (TB)

- a. Blood Agar
- b. Mannitol Salt Agar
- c. Nutrient Agar
- d. None of the above

27. What is the main purpose of differential plating? (4 pts)

To distinguish and identify different types of microorganisms based on their unique growth characteristics

## **Part IV: Metabolism and Applications**

22. What makes thermophilic microbes valuable in industrial applications? (4 pts)

They produce enzymes that function at high temperatures, useful in industrial processes.

23. Why do some microbes use fermentation even when oxygen is available? (2 pts)

- a. Fermentation produces more ATP than respiration.
- b. Fermentation allows them to recycle NAD<sup>+</sup> without the electron transport chain.
- c. Fermentation produces carbon dioxide as an energy source.
- d. Fermentation occurs only in photosynthetic microbes.

24. Which metabolic process is most commonly used by microbes in deep-sea hydrothermal vents? (2 pts) (TB)

chemolithotrophy or chemosynthesis

25. Which compound is produced in the final step of the electron transport chain in aerobic respiration? (2 pts)

- a. ATP
- b. Glucose
- c. Water
- d. Lactic acid

26. In the fermentation of glucose to lactic acid, what is the primary role of NAD<sup>+</sup>? (4 pts)

To oxidize NADH and regenerate glycolysis [NEEDS BOTH]

27. Name two metabolic processes that occur in the cytoplasm of microbial eukaryotes. (4 pts) (TB)

Glycolysis, Fermentation, Pentose Phosphate Pathway, Protein Synthesis (translation).

[Two metabolic processes that occur in the cytoplasm]

28. What is the role of coenzyme A in cellular respiration? (4 pts)

to transport and activate acetyl groups [forms acetyl-CoA].

29. In the anaerobic breakdown of glucose, what is the maximum number of ATP molecules produced through fermentation? (2 pts)

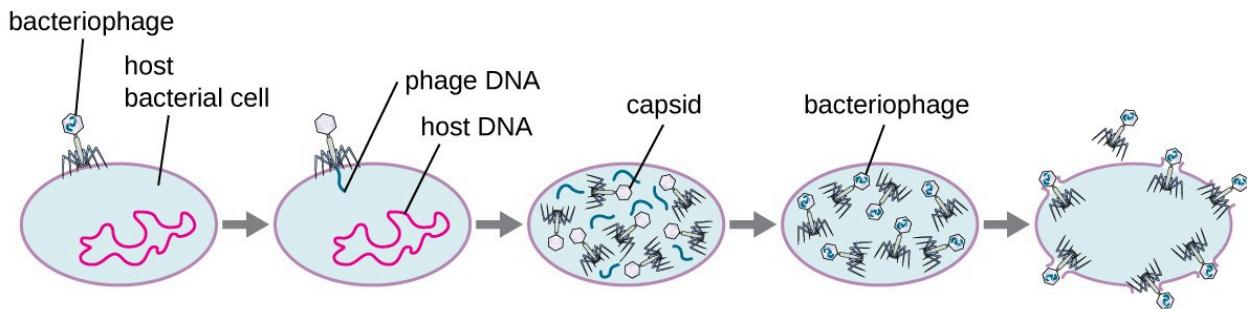
2 ATP molecules

30. Which of the following statements about anaerobic respiration is true? (2 pts)

- a. Anaerobic respiration uses oxygen as the final electron acceptor.
- b. Anaerobic respiration typically generates more ATP than aerobic respiration.
- c. **Anaerobic respiration uses inorganic molecules other than oxygen as electron acceptors.**
- d. Anaerobic respiration occurs only in eukaryotic cells.

## Part V: Evolution and Energy

22. Name the following steps of the viral life cycle in order. (1 pt each)



Attachment   Penetration      Biosynthesis      Maturation      Lysis

23. Which of the following best supports the endosymbiotic theory? (2 pts)

- a. Bacteria can survive in extreme environments.
- b. Mitochondria and chloroplasts have their own circular DNA.
- c. Viruses can infect both prokaryotic and eukaryotic cells.
- d. Archaea and bacteria share a common ancestor.

24. Why were cyanobacteria crucial to the development of life on Earth? (2 pts)

Cyanobacteria produce oxygen through photosynthesis.

25. The genetic mechanism primarily responsible for the rapid spread of antibiotic resistance genes between bacterial species is: (2 pts)

- a. Binary fission
- b. Transformation
- c. Transduction
- d. Conjugation

26. Which microbial process is responsible for the production of methane in anaerobic environments? (2 pts)

Methanogenesis

27. How do mycorrhizal fungi contribute to plant-microbe ecology? (2 pts)

- a. They produce oxygen as a byproduct of photosynthesis.
- b. They fix atmospheric nitrogen into usable forms for plants.
- c. **They increase the surface area of plant roots for nutrient absorption.**
- d. They act as decomposers, breaking down organic matter.

28. What evidence best supports the hypothesis that archaea are more closely related to eukaryotes than to bacteria? (2 pts)

- a. Both archaea and eukaryotes use circular chromosomes.
- b. **Archaea share similar RNA polymerase and ribosomal structures with eukaryotes.**
- c. Both archaea and eukaryotes form endospores under stress.
- d. Archaea and eukaryotes share the same lipid composition in their membranes.

29. Describe an example of microbial mutualism. (4 pts)

[Organism 1 benefits, organism 2 is unaffected]

Bacteria eat dead skin cells from on humans