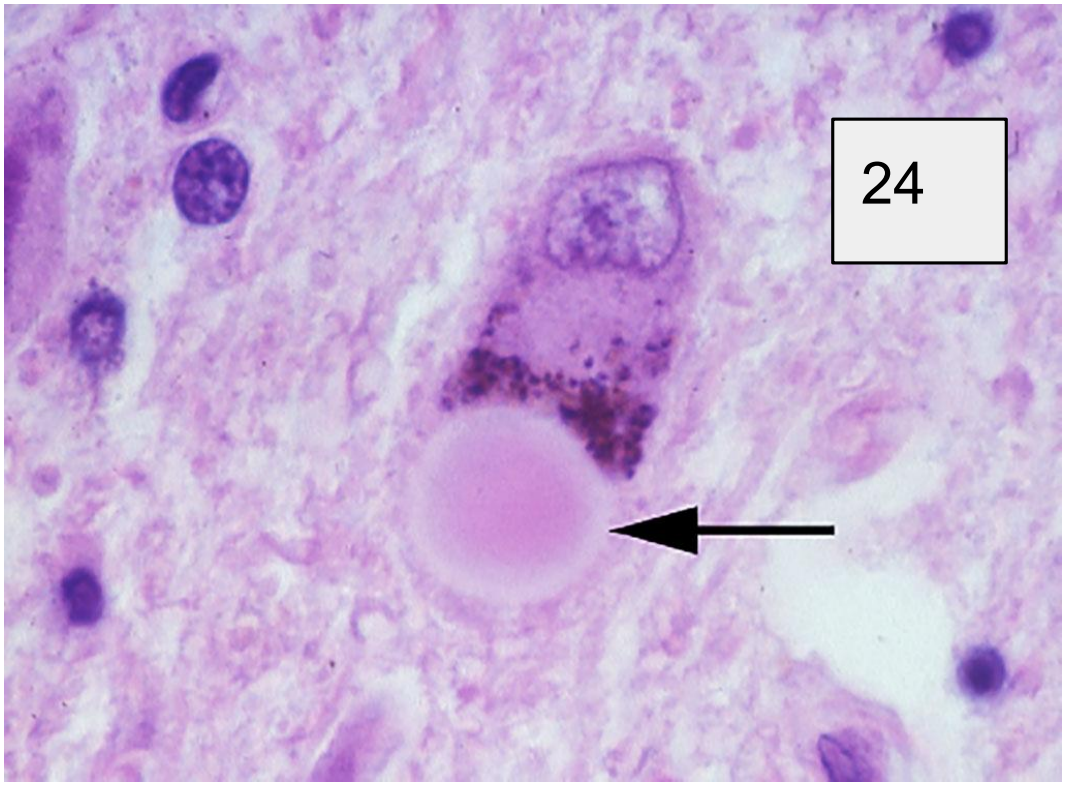
Microbe Mission

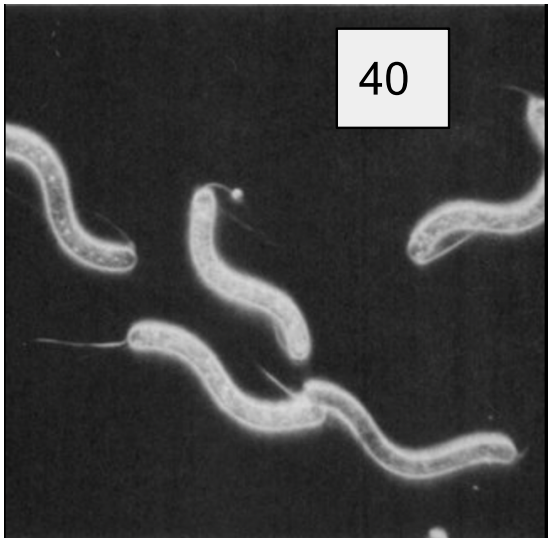
Brown Science Olympiad Div B Invitational
February 11, 2023

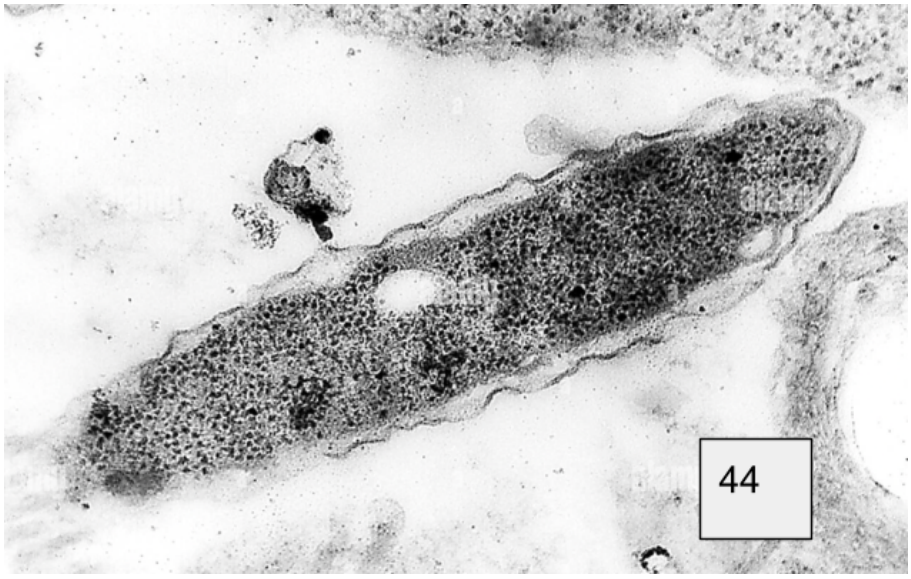
Instructions:

1. You may use one 8.5" x 11" sheet of paper with information on one/both sides.
2. You may use stand-alone, non-programmable, non-graphing calculators.
3. You do not have to show your work unless you are explicitly asked to do so. Partial credit may be awarded if correct work is shown in these cases.
4. Round all calculations to the tenths place, if necessary.
5. Tiebreakers will be given by the quality of short answer responses in numerical order.
6. All questions are worth 1 point unless marked otherwise.
7. Put your team name and team number at the top of all answer sheets.
8. Write all answers on the answer sheets provided; answers written on the exam/image sheets will not be graded.
9. When stated, refer to images on the image sheet to answer certain questions, eg. **Image #24**.
10. Good luck!

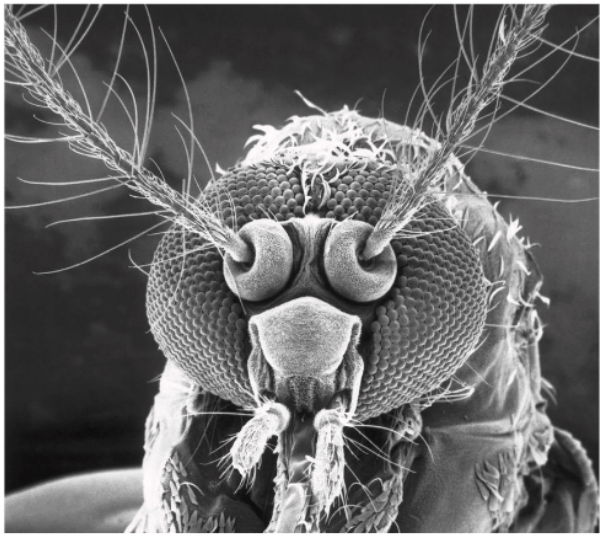

24


33



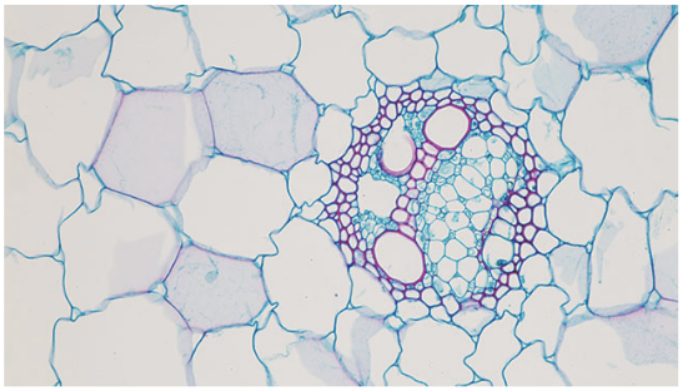


47a.

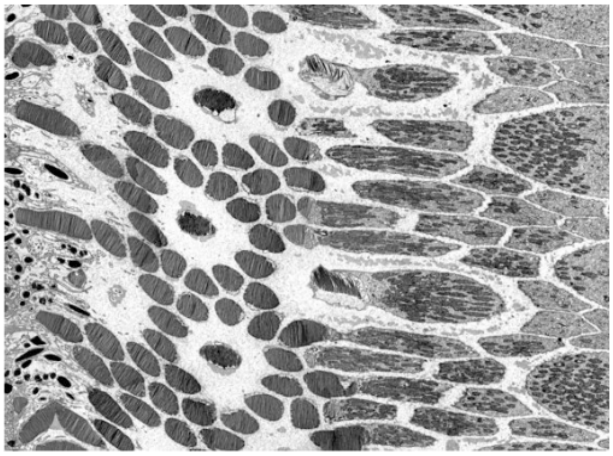


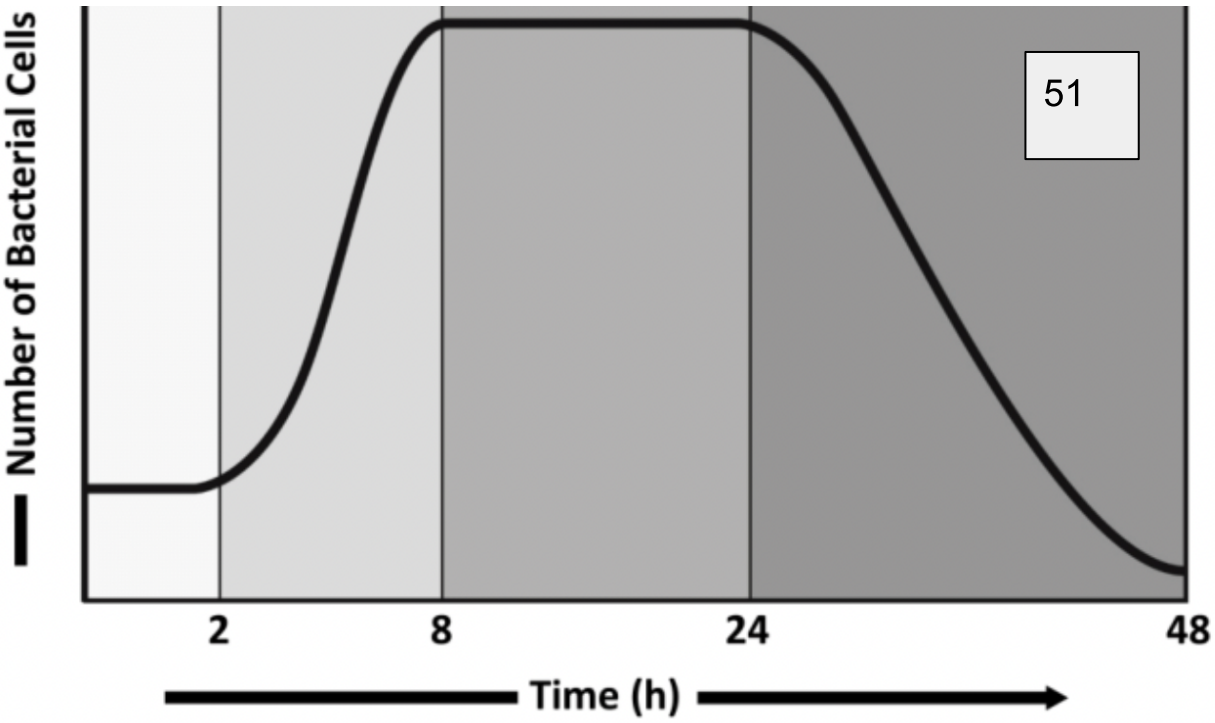
47b.

47c.



47d.




Number of Bacterial Cells
51
2
8
24
48
Time (h)

Section I [40 pts]:

1. A Giemsa stain is used primarily to diagnose which of the following [1 pt]:
   (a) Plasmodium infection
   (b) Giardiasis
   (c) Cholera
   (d) Rocky Mountain Spotted Fever
   (e) Both B) and c)

2. Surgical forceps are an example of a critical medical device. Which decontamination classification is most appropriate for surgical forceps [1 pt]?
   (a) High-level disinfection
   (b) Sanitization
   (c) Sterilization
   (d) Cleaning
   (e) Both A) and c)

3. Which of the following describes a difference between gram negative and gram positive bacteria (select all that apply) [2 pts]?
   (a) Gram positive bacterial cells have a thicker layer of peptidoglycan
   (b) There is no outer membrane in gram positive bacteria
   (c) Lipopolysaccharide is present in gram positive bacteria
   (d) Teichoic acid is present in gram positive bacteria
   (e) Gram positive cells have a wavy cell wall

4. Which toll-like receptor (TLR) can bind to gram negative bacteria (select all that apply)? [1 pt]
   (a) TLR1
   (b) TLR2
   (c) TLR3
   (d) TLR4
   (e) TLR5

5. Which Toll-Like receptors can bind to gram positive bacteria (select all that apply)? [1 pt]
   (a) TLR1
   (b) TLR2
   (c) TLR3
   (d) TLR4
   (e) TLR5

6. Match each technique with its application: [2.5 pts]

a. Plaque assay	a. Separate DNA based on size and visualize it
b. Histopathology	b. Quantify infectious virus
c. Gel electrophoresis	c. Visualize changes in the structure of a tissue
d. Streak plate technique	d. Make many copies of a gene
e. PCR	e. Make a pure bacterial culture

7. Which of the following is not a component of viral phages [1 pt]?
   (a) Collar
   (b) Flagella
   (c) Base plate
   (d) Tail fibers
   (e) Capsid head

8. Under stressful conditions such as exposure to UV radiation, the prophage exits _____ DNA and enters the _____ cycle: [1 pt]
   (a) Host cell; Lytic
   (b) Phage; Lytic
   (c) Host cell; Lysogenic
   (d) Phage; Lysogenic

9. You obtain a freshwater sample from your local pond and you decide to analyze your sample using microscope cell counting and agar cultures. You observe that the number of bacteria you observe using microscopy is _____ than the number of colonies observed on your culture plate. You hypothesize this result is due to the production of hydrogen peroxide during autoclaving of your culture materials. Catalase is an enzyme that breaks down hydrogen peroxide and you decide to rerun your culture plates with supplemented catalase. With your new plates, you observe _____ colonies than the plates without catalase. [1 pt]
   (a) Less; more
   (b) Less; more
   (c) Greater; more
   (d) Greater; less

10. You have just finished a hard workout in the gym and you feel fatigue in your muscles. In this oxygen deprived environment, how will your muscles produce ATP? [1 pt]
    (a) Citric Acid Cycle
    (b) Ethanol Fermentation
    (c) Lactic Acid Fermentation
    (d) Electron Transport Chain
    (e) Yeast Growth

11. What is the purpose of cristae folding within the mitochondria (select all that apply)? [1 pt]
    (a) To enable production of more ATP
    (b) To enhance ATP production through glycolysis
    (c) To enhance ATP production through the citric acid cycle

(d) To enhance ATP production through the electron transport chain

(e) Store large amounts of glucose as glycogen

12. What is the goal of Acetyl CoA in the process of aerobic respiration? [1 pt]

(a) Shuttle NADH to the electron transport chain

(b) Involved in water splitting

(c) Digestion of lipids into triglycerides

(d) Essential protease in destroying cysteine bonds that denature the tertiary structure of proteins

(e) Modifying pyruvate before it enters the citric acid cycle

13. What important cation drives the electrochemical gradient in the electron transport chain to allow for ATP production? [1 pt]

(a) H^+

(b) Li^+

(c) Mg^{2+}

(d) Ca^{2+}

(e) Al^{3+}

14. Bruno decided to hike a mountain one day. In the beginning of his hike, he noticed towering trees and lush vegetation on all sides, but when he approached higher elevation the trees began receding to a barren cold rockland. Nearly absent from life, which of the following organisms could have persevered and reproduced in this cold climate? [1 pt]

(a) Halophile

(b) Thermophile

(c) Piezophile

(d) Psychrophile

(e) All could live in this climate

15. Which of the following reasons explains why the above extremophile could persevere in colder temperatures (select all that apply) [2 pts]

(a) The phospholipid bilayer contains more saturated fatty acids to enable a more rigid structure of temperature stability

(b) A greater number of beta sheets as opposed to alpha helices in proteins

(c) Reduce production of proline to alter conformational protein structure

(d) Conducts thermal hysteresis by binding to ice crystals

(e) A high number of disulfide bonds to establish protein tertiary structure

16. What category of extremophiles is able to inhabit the space between rock layers and rely on the minerals from rocks to ensure their survival? [2 pts]

17. Match which of the following symbiotic relationships are mutualism, commensalism, parasitism, competition, or predator-prey (some may be used more than once) [2.5 pts]

a. Mutualism	a. Barnacles living on the underside of a whale
b. Commensalism	b. Orchids growing in a tree
c. Parasitism	c. A botfly nesting and laying eggs inside humans
d. Competition	d. Doctor Fish eating calluses at a spa
e. Predator-prey	e. A lion chasing an antelope

18. *Candida auris* is a pathogenic infection that can have complications in the bloodstream and other parts of the body. What type of pathogen is this? [1 pt]
    (a) Virus
    (b) Fungi
    (c) Parasite
    (d) Bacteria
    (e) Prokaryote

19. In what part of the body was the first case of *Candida auris* isolated from? [1 pt]
    (a) Ear canal
    (b) Below the tongue
    (c) Between toes
    (d) Nasal cavity
    (e) Surrounding the heart

20. List a test that doctors could perform to check if you have *Candida auris*: [2 pts]

21. True or False: People diagnosed with *Candida auris* will always display symptoms characteristic to a bacterial infection. [1 pt]

22. What are two organisms that Wolbachia species are known to infect? [1 pt]
    (a) Arthropods, Echinoderms
    (b) Echinoderms, Nematodes
    (c) Cnidaria, Nematodes
    (d) Nematodes, Arthropods
    (e) All of the following can be infected by Wolbachia

23. What is the importance of SNARE complexes? (select all that apply) [1 pt]
    (a) Vesicle exocytosis
    (b) Receptor mediated endocytosis
    (c) Movement of proteins along the internal cytoskeleton
    (d) Release of acetylcholine
    (e) Flagging cellular components for degradation

24. What does **#Image 24** from the brain tissue depict that has been associated with brain disorders? [1 pt]

25. What is the microbial aggregate composed of predominantly? [1 pt]
    (a) Alpha synuclein
    (b) Tau protein
    (c) Amyloid beta protein
    (d) Apolipoproteins
    (e) All of the above

26. Which of the following are not symptoms associated with the buildup of these microbial aggregates (select all that apply)? [2 pt]
    (a) Visual hallucination
    (b) REM sleep disorders
    (c) Sleepwalking
    (d) Memory problems
    (e) Brain encephalitis

27. In this stage of bacteriophage reproduction, degradation of the host cell's DNA occurs and metabolic processes are directed towards initiating phage synthesis: [1 pt]
    (a) Maturation
    (b) Biosynthesis
    (c) Attachment
    (d) Transcription

28. A disease, commonly known as "Beaver fever", is known to colonize the lumen of the small intestine. Which of the other agents below matches the mode of transmission of beaver fever? [1 pt]
    (a) HIV
    (b) Vibrio cholerae
    (c) Influenza A
    (d) MRSA

29. One fine day, Bruno was looking at his hand and saw an abnormal fluid-filled lump that appeared out of nowhere. Which of the following might Bruno have? [1 pt]
    (a) Dermoid Cyst
    (b) Lipoma
    (c) Sebaceous cyst
    (d) Pilomatrixoma
    (e) Ganglion cyst

30. List a potential non-surgical treatment that Bruno could use for his abnormal bump: [2 pts]

31. Influenza A is an example of an _____ virus. These viruses are able to evolve quickly due to mutations of the _____ proteins. [1 pt]
    (a) RNA; capsid
    (b) RNA; antigen
    (c) DNA; capsid
    (d) DNA; antigen

32. The Jarisch-Herxheimer Reaction (JHR) is a clinical phenomenon that can occur with a specific class of bacteria in response to antibiotic treatment. It was first described in the literature in the late 1800s, when a dermatologist noticed a transient exacerbation of skin lesions in a syphilis patient after beginning treatment. It has also been documented with treating lyme disease. Which of the following classes of bacteria are associated with the JHR? [1 pt]
    (a) Cocci
    (b) Bacilli
    (c) Sarcina
    (d) Spirochete

Section II [40 pts]:

Use #Image 33 from the image sheet to answer Questions 33-34.

33. Identify the specific pathogen that causes this disease highlighted in the image. [2 pts]
34. Identify the host, vector, and environment associated with this infection. [4 pts]

Bruno is unfortunately not feeling too good. For the last couple of days, he has had progressive and worsening abdominal pain. Fevers, chills, and nausea accompanied this. After going to brush his teeth one morning, he notices that his eyes appear yellow in the mirror. Through his concern, he decided to see a doctor who took an x-ray of his liver who reports that his liver function has been severely compromised.

35. What disease might he have? [2 pts]
36. List two ways that Bruno could have gotten this disease transmitted to them? [3 pts]

Use #Image 37 from the image sheet to answer Questions 37-38.

37. Bruno's liver appears like the right image based on the doctor's scan. What condition does this indicate and what are the two symptoms that can arise? [4 pts]
38. What are the four developmental stages of the condition described in Question 37. Describe each one in one sentence or less. [6 pts]
39. List two forms of reasonable lifestyle or medical treatments that can be prescribed to help treat this condition independent of the scenario described above? [4 pts]

Use Image #40 from the image sheet to answer Questions 40-43.

40. What is the genus of this bacteria? [2 pts]
41. Is it gram positive or gram negative? [1 pt]
42. What are two diseases that this bacteria can cause? [3 pts]
43. What are the names of the other two spiral bacteria? [3 pts]

Use #Image 44 from the answer sheet to answer Questions 44-46.

44. What type of microscope imaged this legionella bacterial specimen? [2 pts]

45. What is the shape of this bacterium? [2 pts]

46. A cell recognizes this bacterial specimen through receptors on the cell surface leading to phagocytosis. What is a way that this bacteria can avoid degradation? [4 pts]

For Question 47, look at the images identified 47a-47d on the image sheet and classify which microscope type took each image. [2 pts each, 8 pts total]

47. Classify which microscope type took an image of the following pictures: [2 pts each, 8 pts total]

48. What is the cell surface receptor that can bind to the COVID-19 spike protein? [2 pts]

49. What are the two modes of entry that COVID-19 can use to enter the cell. Describe each mode of entry in 1-2 sentences? [6 pts]

50. Chloroquine is an inhibitor of endosomal acidification. How would administering this drug into cells play an effect in covid infection, and how specifically does it cause this effect? [6 pts]

Use Image #51 from the image sheet to answer questions 51-52.

51. List the four stages of bacterial growth in order as highlighted by the different colors in the above image: [4 pts]

52. What could have led to the sharp drop in the last phase of the bacterial growth curve? [1 pt]

53. What are two key chemical elements (i.e. uranium) that are required for cell survival? [2 pts]

54. Bruno has been dealing with a lot of medical issues recently. This time, he identifies a huge pain in his intestine triggered by inflammation after eating some hamburger from a very unsanitary restaurant. Don't question why Bruno does these things. What kind of disease does he likely have this time? [2 pts]

55. What are two causes of this disease? [2 pts]

56. Algal blooms in the ecosystem are usually caused by what specific bacterium? [2 pts]

57. Bruno notices that one of the nearby lakes that used to be full of fish in previous years. However, recently, it has become covered in an algal bloom that turned the water murky. No fish seem to be present in this lake anymore. What is the biological term of this area, and why are there a lack of fish? [3 pts]

ANSWER SHEET

Team Name: _____ Team Number: _____

1. _____
2. _____
3. _____
4. _____
5. _____
6. (a) _____
   (b) _____
   (c) _____
   (d) _____
   (e) _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. (a) _____
    (b) _____
    (c) _____
    (d) _____
    (e) _____
18. _____
19. _____
20. Answer below:

21. _____
22. _____
23. _____

Team Name: _____ Team Number: _____

24. _____

25. _____

26. _____

27. _____

28. _____

29. _____

30. Answer below:

31. _____

32. _____

33. _____

34. Answer below:

35. _____

36. Answer below:

Team Name: _____ Team Number: _____

37. Answer below:

38. Answer below:

39. Answer below:

40. _____

41. _____

42. _____

43. _____

44. _____

45. _____

Team Name: _____ Team Number: _____

46. Answer below:

47. (a) _____
    (b) _____
    (c) _____
    (d) _____

48. _____

49. Answer below:

50. Answer below:

Team Name: _____ Team Number: _____

51. Answer below:

52. Answer below:

53. _____

54. _____

55. Answer below:

56. _____

57. Answer below: