Science Olympiad
Bio-Process Lab Test
Davidson Invitational Tournament

Team Name: _____

Team Number: _____

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Directions:

- Make sure you have a calculator, as it will be needed for some questions.

- The test will be split into sections concerning various important topics in biology.

- You are only allowed what the rules manual permits for this event regarding notes and resources

- Good luck on the test!

For grading use only

Page:	2	3	4	5	6	7	8	9
Points:	12	8	6	14	12	5	32	33
Score:								
Page:	10	11	12	13	14	15		Total
Points:	22	9	23	24	23	10		233
Score:								

Cell Biology

1. (1 point) What is the powerhouse of the cell?

Membrane Structure

2. (1 point) What is the model that describes the fluidity of the cell membrane?

3. (2 points) Describe the difference between integral membrane proteins and peripheral membrane proteins

There are two specific phases of the cell membrane: The Liquid-ordered (LO) and Liquid-Disordered (LD) state. The liquid-ordered state describes whenever the membrane is typically more crystalline, and the liquid-disordered state describes when the membrane is more fluid. Given that entropy is defined as the amount of disorder within a system, answer the following questions:

4. (2 points) Would the liquid-ordered or liquid-disordered phase of the cell membrane have more entropy, and why?

5. (1 point) Which phase would predominate at **lower** temperatures?

6. (1 point) Which phase would predominate at higher temperatures?

Photosynthesis

7. (2 points) Write the chemical equation for photosynthesis?

8. (1 point) What organelle is primarily responsible for photosynthesis in plants?

9. (1 point) What is the pigment in chloroplasts that gives plants their green color?

10. (2 points) Referring to the previous question, what are the two main subtypes of this pigment?

_____   _____

As a budding botanist, you are on your quest to determine what makes photosynthesis work most efficiently. You decide to create an absorption spectrum using a spectrophotometer. In this experiment, white light is first separated into colors by a prism. Then, the different colors of light are passed through the sample. The transmitted light then strikes a tube, resulting in electricity. The current is measured, which can determine the absorbed amount of light. Your results are shown below:
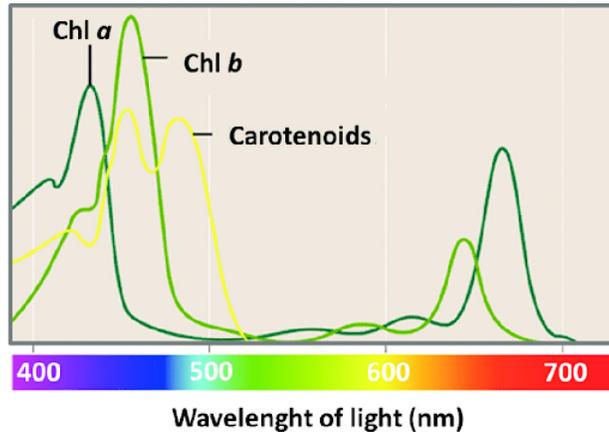
11. (1 point) Roughly which wavelength of light(color) does chlorophyll b best absorb? Answer to the nearest nanometer.

_____

12. (1 point) Roughly what color of light is best absorbed by carotenoids? Answer to the nearest nanometer.

_____

Signaling Pathway

13. (2 points) What is a G protein?

_____

14. (1 point) True or false: G proteins are suppressed by GTP.

    A. True

    B. False

15. (1 point) True or False: Scaffold proteins are large, relay proteins that bring many other proteins in a signaling pathway closer together that typically decrease signalling rate.

    A. True

    B. False

16. (3 points) Compare and contrast paracrine, autocrine, and endocrine signaling.

17. (1 point) The endothelium of blood vessels releases nitric oxide into its surrounding environment to relax nearby smooth muscle cells, dilating the vessel. What type of signaling is this an example of?

18. (2 points) Bacteria utilize a process known as quorum sensing. What is the function of this process?

Biochemistry

19. (2 points) Describe the difference between aldoses and ketososes.

20. (2 points) Which two monosaccharides make up maltose?

21. (1 point) What term best describes DNA strands that are oriented in opposite directions in the genome?

22. (1 point) What does the reagent, Ninhydrin, detect?

23. (2 points) Describe the color transition in Benedict's reagent when it reacts with sucrose. Why is this?
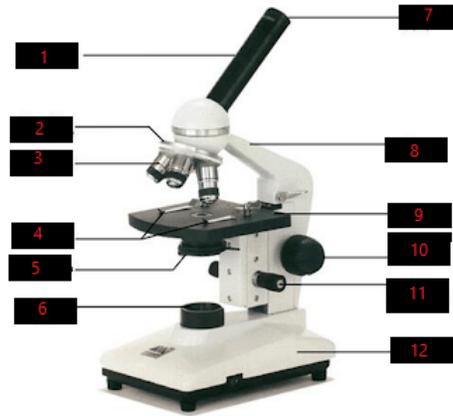
24. (2 points) What does Biuret's reagent detect?

25. (2 points) Describe the difference between saturated and unsaturated fats.

26. (2 points) List two differences between DNA and RNA (besides "RNA is single stranded").

Microscopes

Label the parts of the following microscope:

27. (1 point) What does the number 1 represent?

_____

28. (1 point) What does the number 2 represent?

_____

29. (1 point) What does the number 3 represent?

_____

30. (1 point) What does the number 4 represent?

_____

31. (1 point) What does the number 5 represent?

_____

32. (1 point) What does the number 6 represent?

_____

33. (1 point) What does the number 7 represent?

_____

34. (1 point) What does the number 8 represent?

_____

35. (1 point) What does the number 9 represent?

_____

36. (1 point) What does the number 10 represent?

_____

37. (1 point) What does the number 11 represent?

_____

38. (1 point) What does the number 12 represent?

_____

39. (1 point) What is the benefit of using a light microscope as compared to an EM?

40. (1 point) What is the minimum resolution needed for light microscopes in nanometers?

41. (2 points) What is the function of the rheostat?

42. (1 point) Differential interference contrast microscopes display the sections as a result of the differences in what variable?

Genetics

43. (8 points) Analyze the pedigree below.
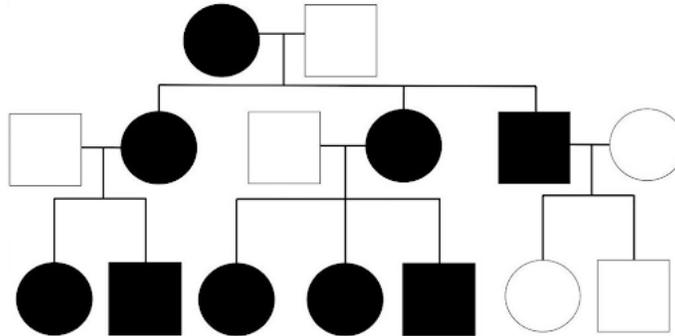
  (a) (2 points) What is the likely mode of inheritance in this pedigree?

  (b) (3 points) What is the probability of the II-3 male having an affected child?

  (c) (3 points) What is the probability of the III-3 female having an affected child?

44. (8 points) Dr. John Sillbun is trying to cross the most beautifully colored roses to give to his next date, Luah Lim. He crosses purebred magenta roses with purebred yellow roses, and all the resulting offspring are magenta roses. He crosses these magenta roses with each other to obtain the following ratio of rose colors:
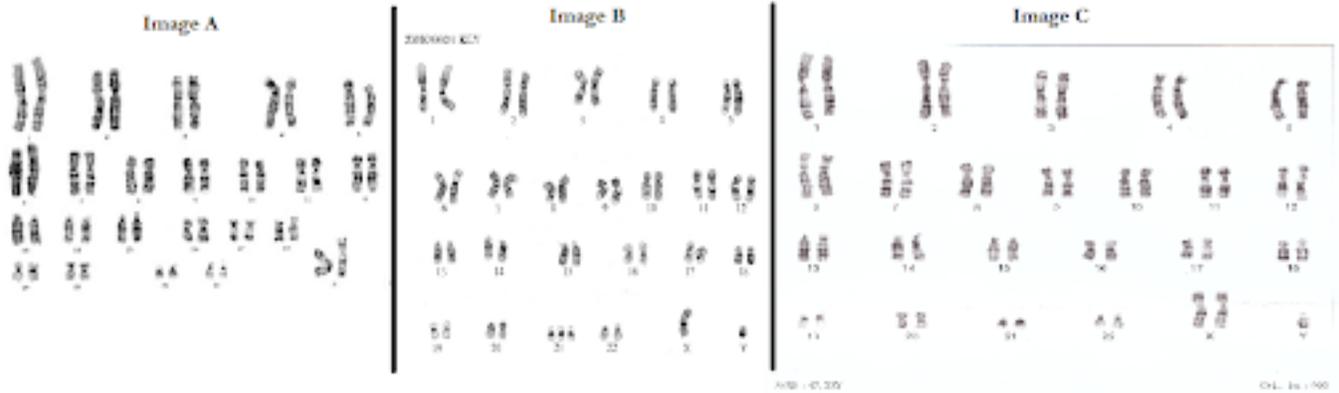
Flower Colors	Number of Roses
Magenta	113
Blue	37
Yellow	50

  (a) (2 points) What type of gene interaction is this?

  (b) (3 points) What is the synthesis pathway for these pigments?

  (c) (3 points) If a purebred blue flower is crossed with a yellow purebred flower, what is the probability of obtaining another blue flower?

45. (9 points) Analyze the karyotypes given below.

(a) (3 points) What is the syndrome shown in image A?

_____

(b) (3 points) What is the syndrome shown in image B?

_____

(c) (3 points) What is the syndrome shown in image C?

_____

46. (11 points) A purebred small, glowing jellyfish is crossed with a purebred large, dull jellyfish. All of their offspring are small, glowing jellyfish. These small, glowing jellyfish are then crossed with the large, dull jellyfish. The results of this cross are shown below:

Phenotype	Number
Small, glowing	65
Large, dull	61
Small, dull	34
Large, glowing	40

(a) (2 points) How many genes are involved in this cross?

_____

(b) (2 points) What is this cross an example of?

_____

$$X^2 = \sum \frac{(\text{Observed value - Expected value})^2}{\text{Expected value}}$$

   (c) (4 points) Determine the chi square value using the formula above. Note that the null hypothesis (used to calculated the expected values) is if the two genes are independent/unlinked. Round to the nearest tenth.

   (d) (3 points) What is the distance between the relevant genes? _____

47. (4 points) A mother has a child, but she does not know which of the three people is the father. Answer the following questions regarding DNA profiling below.
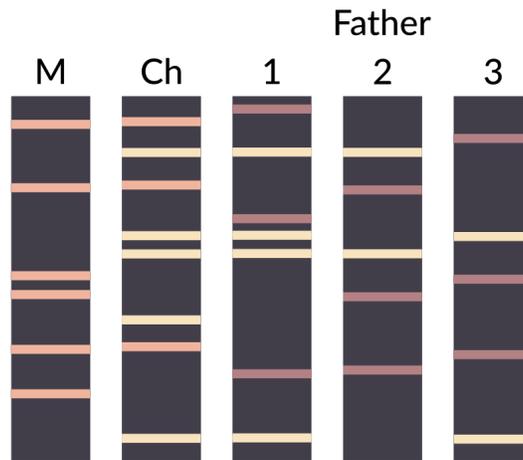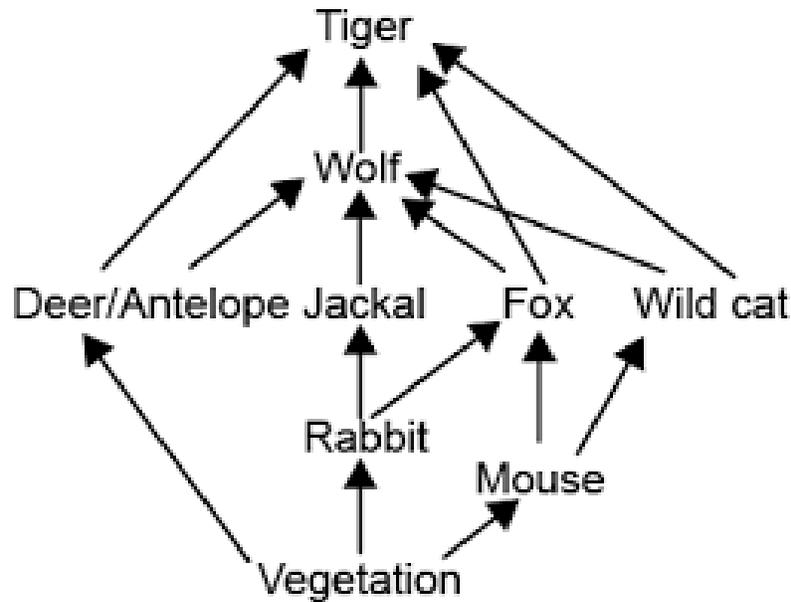

   (a) (2 points) What is an STR?

   (b) (2 points) Which person is the father?

48. (7 points) Describe the steps in polymerase chain reaction and how it is used to amplify DNA.

Ecology

Use the following image to answer the next three (3) questions

49. (1 point) List all of the primary producers in this ecosystem.

_____

50. (2 points) Which of the following is not a secondary consumer?

      A. Wolf

      B. Jackal

      C. Fox

      D. Deer

51. (2 points) If the vegetation receives 6000 Kilojoules of energy, how much energy would the wild cat receive?

      A. 6000 Kilojoules

      B. 600 Kilojoules

      C. 60 Kilojoules

      D. 6 Kilojoules

52. (2 points) If there are 2000 wolves in a 10km by 10km farm, then what is the density of wolves in the farm (in $wolves/km^2$)?

_____

53. (2 points) After a forest fire, which form of succession occurs?

      A. Primary

      B. Secondary

      C. Tertiary

      D. None of the above
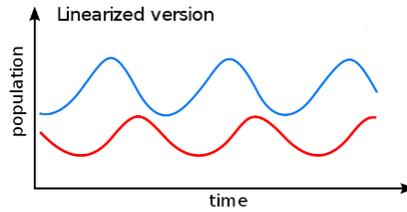
Use the image above to answer the next two (2) questions

54. (3 points) What is the name of this model

_____

55. (4 points) What do the blue and red lines represent?

  (a) (2 points) Red Line: _____

  (b) (2 points) Blue Line: _____

56. (2 points) If the number of wolves in an ecosystem increased, what would be expected to be the result on the number of moose (the prey of the wolves)?

    A. The moose population would increase

    B. The moose population would decrease

    C. The moose population would stay the same

    D. None of the above

57. (4 points) One day, scientist William Sol captures and tags 100 birds of species X. The next day, he returns to find another 100 birds, with 20 tagged birds among them. How many birds are in the total population?

_____

58. (2 points) In one sentence or less, differentiate between obligate and facultative symbiosis.

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59. (2 points) Allelopathy is a process where certain trees, such as the black walnut, release chemicals into the surrounding environment. The chemicals inhibit the growth of other nearby plants and give the original plant more space to grow. What type of ecological interaction is this an example of.

_____

60. (2 points) The senita moth pollinates the senita cactus. The moth lands on the petals of the flowers and lays eggs, and the flowers receive pollen from other flowers. What type of ecological interactions is this an example of.

_____

Tools and Analysis

61. (2 points) What is a thistle funnel used to do?

62. (2 points) Attaching a barbed hose fitting and short glass tube to the neck of an Erlenmeyer Flask makes it a _____?

63. (2 points) The main difference between a Hirsh Funnel and Buchner Funnel is the _____ of the walls.

64. (2 points) In a Liebig Condenser, water is circulated in the jacket to carry away the
_____?

65. (2 points) Attaching an addition concentric glass tube to a Liebig Condenser makes it a
_____ Condenser.

66. (2 points) A Thiele Tube is a test tube made in what shape?

67. (2 points) Soxhlet Extractors extract what class of macromolecules?

68. (2 points) What is the difference between Class A and B Graduated Cylinders?

69. (2 points) In a Chromatography Column, what compounds are the mixtures passed through?

70. (2 points) What are Burretes mainly used for?

71. (2 points) Although Graduated Pipettes are accurate,_____
Pipettes are much more accurate (to 4 decimals).

72. (2 points) A _____
Flask is rarely used nowadays because condensers do the same job much more effectively.

Use the following data set for the next 6 questions. Plants were grown with either no treatment, molecule X, molecule Y, or both. The heights of the seedlings are listed below

Treatment	Height
None	15cm
None	14cm
None	17cm
None	21cm
None	11cm
None	13cm
None	16cm
None	15cm
X	9cm
X	5cm
X	8cm
X	14cm
X	7cm
X	8cm
Y	22cm
Y	25cm
Y	19cm
Y	21cm
Y	22cm
Y	20cm
X and Y	9cm
X and Y	7cm
X and Y	10cm
X and Y	11cm
X and Y	8cm
X and Y	9cm

73. (1 point) What is the control group in this experiment?

   _____

74. (5 points) What is the mode, median, and mean height of the plants treated that were not treated with anything?

   (a) (1 point) Mode _____

   (b) (2 points) Median _____

   (c) (2 points) Mean _____

75. (2 points) Would you expect the mean or the median of the heights of plants grown with molecule X to be higher (hint: you do *not* need to solve for either value)? Why?

   _____

76. (2 points) What is the range of heights in plants grown with molecule Y?

   _____

77. (4 points) What are all of the treatments in this experiment. What are the experimental units?

   (a) (2 points) Treatments _____

   (b) (2 points) Experimental Units _____

78. (4 points) The soil of one of the plants is analyzed and the OH concentration is measured as 10^{-9} M. What is the pH of the soil? If the pH of all of the other plants' soil is 7, then should this plant's properties be included in the final result along with the other plants?

79. (6 points) Molecule X and Y are both part of the same signaling pathway. What can you conclude about the effects of molecules X and Y on plant growth? The effects of the molecules on each other.