CELL BIOLOGY
GEORGIA STATE SCIENCE OLYMPIAD
APRIL 2, 2005

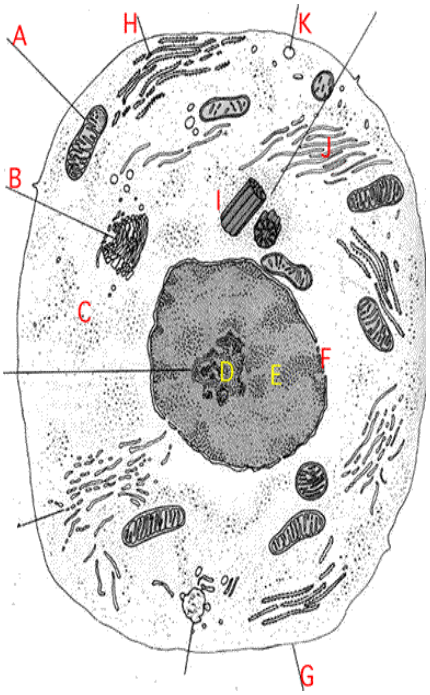
Station A. Questions 1-9

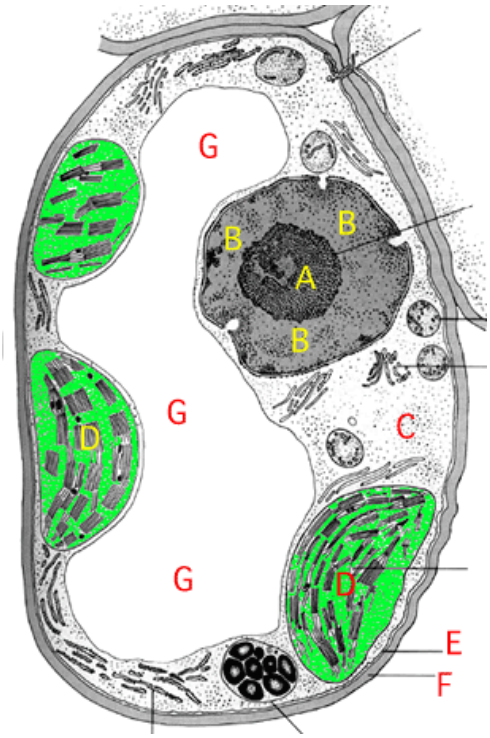
<u>For questions 1-5, use the figure on the left. For questions 6-9, use the figure on the right</u>.

1. Write the letter that corresponds to nucleus.
2. Write the letter that corresponds to mitochondrion.
3. Write the letter that corresponds to free ribosomes.
4. Write the letter that corresponds to lysosomes.
5. Write the letter that corresponds to cell membrane.

<u>For questions 6-9, use figure on right.</u>

6. Write the letter that corresponds to chloroplast.
7. Write the letter that corresponds to cell wall.
8. Write the letter that corresponds to vacuole.
9. Write the letter that corresponds to nucleus.





Station B Questions 10-19

10-19. A drug company has produced drugs that affect many different cellular processes in the following ways. Which organelle is most likely to be the site of action or most likely to be affected for the following drugs? Organelles can either be used more than once or not all. You are to record only one answer per drug action. USE CAPITAL LETTERS.

A. nucleus
B. Vacuole
C. Cilia
D. Smooth endoplasmic recticulum
E. Rough endoplasmic reticulum
F. Mitochondria
G. Chloroplast
H. Lysosome
I. Ribosome
J. Answer not given

10. Prevents water regulation in plants.

11. Interferes with the metabolism of many antibiotics taken orally.

12. Prevents enzymes from being made.

13. Interferes with formation of mictrotubules.

14. Increases RNA production.

15. Increases absorption of red and blue light.

16. Stimulates ATP production and formation of water.

17. Interferes with production of digestive enzymes in the pancreas.

18. Prevents DNA duplication.

19. Interferes with Krebs cycle.

Station C. Questions 20-27

20-23 Use the following letters to describe the molecules in the Table below. Record only one answer per molecule. Some answers may be used more than once; others not at all.

A. Double stranded DNA
B. Single stranded DNA
C. Double stranded RNA
D. Single stranded RNA
E. Either single or double stranded DNA

Molecule	%Adenine	%Guanine	% Thymine	%Cytosine	%Uracil
1	19	31	19	31	0
2	23	27	27	23	0
3	19	19	0	31	31
4	25	25	25	25	0

20. molecule 1

21. molecule 2

22. molecule 3

23. molecule 4

24. If a standard double stranded DNA molecule of 200 base pairs has 34 guanines, how many adenines does it have?

25. A gene has 1.4 x104 base pairs. If transcription occurs at the rate of 70 bases/sec, how long will it take to transcribe this gene? Express answer in minutes!

**26. The acetylcholine receptor is a protein that spans the plasma membrane and extends into the cytoplasm and extracellular space. Which of the following amino acid compositions most likely describes this receptor?

A. exclusively hydrophilic amino acids
B. exclusively hydrophobic amino acids
C. regions of hydrophilic amino acids and regions of hydrophobic amino acids
D. one hydrophilic region and one hydrophobic region

27. Suppose a single-celled organism has a microtubular defect that results in non-motility. Which of the following cell types will be unaffected by this defect?

A sperm
B. algae
C. protozoans
D. bacteria

Station D Questions 28-38

28-37 True/False. Use the capital letters T or F for each of your answers.

28. In cellular respiration, most of the ATP is made in the electron transport system.

29. Oxygen is formed during the light independent reactions of photosynthesis.

30. Glucose must be phosphorylated before it can begin to be broken down.

31. Pyruvate is the end product of the Krebs cycle.

32. CO2 is used in the light independent reactions.

33. Glycolysis occurs in the mitochondria.

34. Hydrogen carriers are needed in cellular respiration but not in photosynthesis.

35. lants do not use a Krebs cycle.

36. Electrons used in photosynthesis ultimately come from the breakdown of water.

37. ATP is produced by creating an electric current caused by the movement of hydrogen ions.

38. What molecule does iodine react with to produce a blue-black color?

Station E. Questions 39-48

39-40. Consider the following information:

1g of fat = 9 calories
1 g of protein = 4 calories
1 g of carbohydrate = 4 calories

39. How many calories are in a food that has 20 g of fat, 5 g of protein, and 20 g of carbs?

40. What percent of the calories in the above food comes from carbohydrates?

41-43. Match the biological macromolecule with the correct monomer.

A. polysaccharide B. fat
C. protein D. nucleic acid

41. simple sugar

42. glycerol

43. amino acid

44. nucleotide

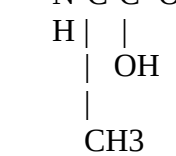
45-48 Match the biological molecule with its correct structure/formula

A. amino acid B. fatty acid
C. nucleotide D. monosaccharide

45.

46. $C_4H_8O_4$

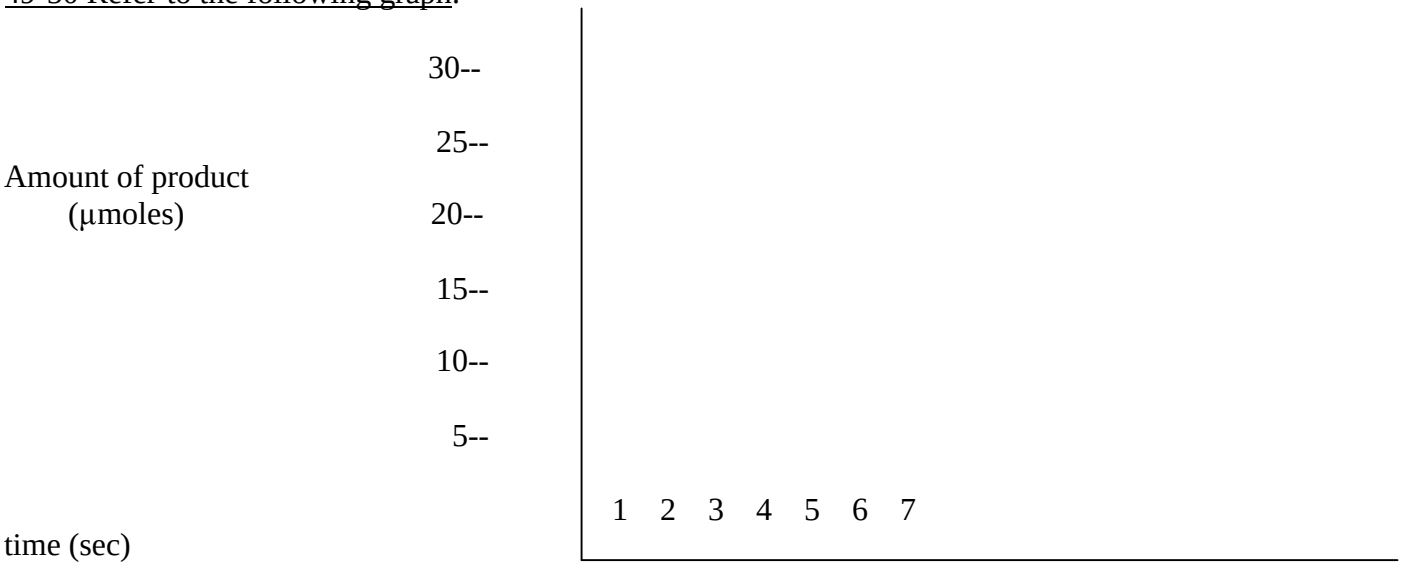
47.



48. phosphate-sugar-base

Station F. Questions 49-55

49-50 Refer to the following graph.



49. How much product is produced at 2 seconds?

50. What is the total amount of product produced during the first 5 seconds of the reaction?

51. The strand of DNA that is transcribed has the following sequence:
5' G C C A T C A A G C 3'
What is the sequence of RNA made from this strand?

A. 5' G C C A U G U U C G 3'
B. 5' G C U U G A U G G 3' *
C. 5' G C A A G U A G G C 3'
D. 5' C G G U A G U U C G 3'

52. What is the name of the molecule that brings amino acids to the ribosome?

53- 54. You will need to use the genetic code to answer these questions.

Part of a protein has the following sequence: ala-thr-ser-phe-tyr

Mutants are isolated from single base changes that have the following sequences:

Mutant 1 sequence: ala-thr-trp-phe-tyr

Mutant 2 sequence: ala-met-ser-phe-tyr

53. What is the serine (ser) codon used in the normal gene?

54. What is the threonine (thr) codon in the normal gene?

55. A protein has 600 amino acids. What is the minimal length of the RNA needed to make this protein?

Station G. Questions 56-61

*56. Three different human cells, A, B, C, are exposed to hormone X. Type A cells begin to divide, Type B cells remain unchanged, and type C cells begin to secrete a slimy substance. What would be a reasonable hypothesis for these observations?
A. The cells have been exposed to the hormone for different lengths of time.
B. The cells each have different genes.
C. The cells have different receptor molecules in their membranes.
D. Hormone X changes the pH of the medium.

57. A scientist exposes plants to various wavelengths of light and measures the rate of photosynthesis for each wavelength. What is an appropriate control for this experiment?
A. plants exposed to white light
B. plants exposed only to green light
C. plants exposed only to UV light.
D. plants exposed only to blue light.

**58. A water plant is placed in a test tube of water, and bubbles appear on the leaves when the plant is exposed to light. What is the most probable composition of the bubbles?
A. H_2
B. CO_2
C. O_2
D. N_2

59-60 Refer to this information: Newly fertilized sea urchin eggs were incubated in radioactive thymidine for 30 minutes. At the end of this time, the embryos are collected, exposed to photographic emulsion, and then examined with a light microscope. Twenty-five (25)% of the cells have darkened areas over the nucleus.

**59. Radioactive thymidine is used to determine if the cells were synthesizing
A. Membranes
B. DNA
C. RNA
D. Protein

60. If the cell cycle of the sea urchin is 8 hrs long, what is the approximate length of the S phase?
A. 100 minutes
B. 120 minutes
C. 150 minutes
D. 200 minutes

**61. Solution 1 has a pH of 3 and solution 2 has a pH of 8. Which of the following statements describes the amount of hydrogen ions in the two solutions?
A. Solution 1 has 5 times as many hydrogen ions as solution 2
B. Solution 1 has 15 times as many hydrogen ions as solution 2
C. Solution 1 has 50 times as many hydrogen ions as solution 2
D. Solution 1 has 105 times as many hydrogen ions as solution 2.

Station H. Questions 62-73. Match the following techniques/equipment with a possible use. Each numbered question will have only one answer. Some answers may be used more than once, others not all. Use capital letters.

A. Electrophoresis
B. Centrifugation
C. Light microscope
D. Scanning electron microscope
E. Transmission electron microscope
F. Metric ruler
G. Spectrophotometer
H. Paper chromatography
I. Answer not given

62. Examining the surface of cells.

63. Looking at the internal structure of chloroplasts.

64. Watching cells with flagella move.

65. Determining the speed of snails.

66. Separating proteins based on charge.

67. Determining how much of a colored product is produced.

68. Separating pigments of a leaf.

69. Determining how much water a plant needs.

70. Determining which kinds of cell have the largest number of lysosomes.

71. Isolating nuclei from cells.

72. Measuring the amount of gas produced by an enzyme.

73. Separating different organelles in a cell.

Station I. Questions 74-78

74. A DNA molecule has 108 base pairs. If the Molar mass of a base pair is 10-4 g, what is the mass in grams of this DNA molecule?

75. The total length of a gene is 6 x 104 base pairs. The protein made by this gene has 1000 amino acids. What percent of the base pairs is used to make this protein?

76. A drug inhibits the function of the Golgi apparatus. Which of the following cells will be least affected by this drug?

A. bacteria
B. protists
C. plants
D. animals

77. A cell is found with a cell wall and a nucleus, but it is not photosynthetic. What kind of cell is it?

A. bacterial
B. animal
C. fungal
D. plant

78. Another cell is found to be motile and photosynthetic, and to have various membranous structures inside of the cell. What organelles are most likely to be present in this cell?

A. nucleus, ribosome, flagella
B. nucleus, chloroplast, flagella
C. chloroplast, ribosome, but no mitochondria,
D. nucleus, chloroplast, but no mitochondria.

Station J. Questions 79-86

79. Which of the following represents the correct order of electron flow during photosynthesis?

A. water to chlorophyll to NADPH
B. water to NADPH to chlorophyll
C. chlorophyll to water to NADPH
D. chlorophyll to NADPH to water

80-86. Match the process with its function. Some processes may be used more than once, others not all. Each function will have only one answer. Use capital letters.

A. Light dependent reactions
B. Light independent reactions
C. Glycolysis
D. Krebs cycle
E. Electron transport system

80. Make ATP from light.

81. Breakdown glucose into smaller carbon compounds.

82. Make sugar from CO2.

83. Make ATP and water.

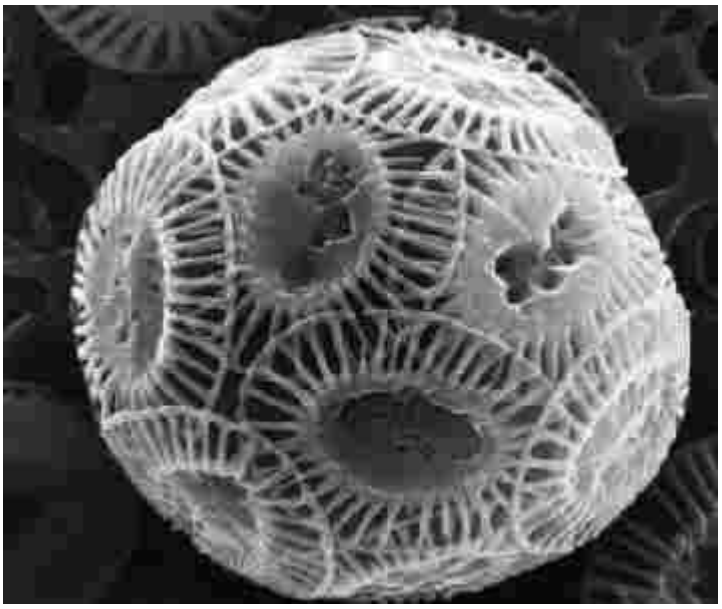
84. Make ATP and split water.

85. Remove H+ from carbon compounds.

86. Produce pyruvic acid.

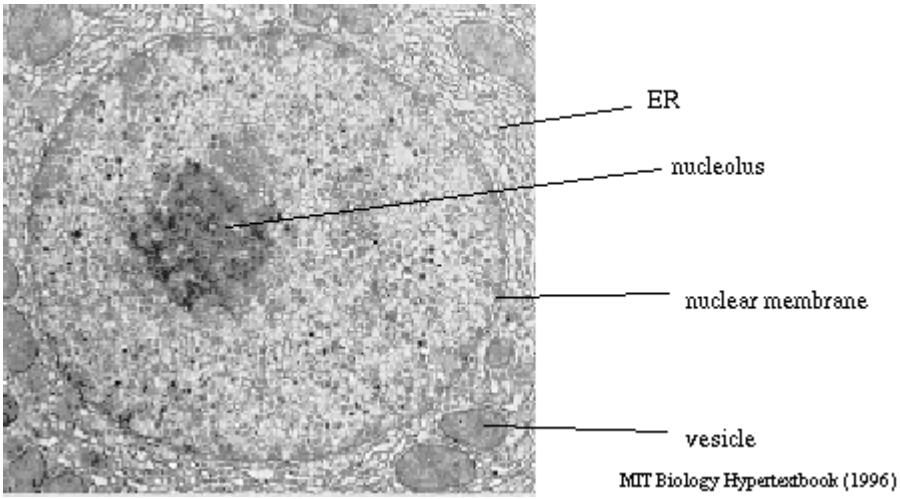
Station K. Questions 87- 94

87. What is the approximate diameter of the organism in the picture?



50µ m

88. What is the approximate diameter of the nucleus of the cell in the picture below?



1µ m

89. A spherical virus has a diameter of 200nm. What is the volume of this virus? Use 22/7 as the value of pi. Express answers in meters, not nm.

90-94. Use as answers: C3 plant, C4 plant, or CAM plant

90. Kind of plant most likely to be found in a moist environment.

91. Kind of plant most likely to be found in a semi-dry environment.

92. Kind of plant most likely to be found in deserts.

93. Kind of plant that needs its stomata open the longest amount of time.

94. This kind of plant captures CO2 at night, and makes glucose during the day.

Station L. Questions 95- 99

95. A piece of RNA for the middle portion of a gene has the following sequence:

*

5' A C G G G U G A C A A U G A C U C A U G C 3'

What is the amino acid sequence of the encoded protein?

A. thr-gly-asp-asn-ala-ser-cys
B. thr-val-asp-pro-asp-ser-cys
C. thr-gly-asn-asp-ala-ser-cys
D. answer not given

96. What will be the consequence if the A indicated by * is changed to U?

A. One amino acid will be changed.
B. Many amino acids will be changed.
C. The protein will have only 2 amino acids.
D. The protein will have only 5 amino acids.

97. What will the consequence be if a C is added just prior to the A*?

A. Many subsequent amino acids will be changed.
B. Only one amino acid will be changed.
C. No amino acids will be changed.
D. The protein will be shorter than normal.

98. Which of the following is true of newly replicated DNA?

A. It will contain one original strand and one newly synthesized strand.
B. It will contain two newly synthesized strands.
C. It will contain 2 strands that will each contain original and newly synthesized regions.

99. You wish to isolate an enzyme that produces a colored product from mitochondria. What is the correct order of steps to accomplish this goal?

A. omogenize, centrifuge, electrophorese, use spectrophotometer
B. homogenize, electrophorese, use spectrophotometer, centrifuge
C. electrophorese, use spectrophotometer, homogenize, centrifuge
D. centrifuge, electrophorese, use spectrophotometer, homogenize

Station M. Questions 100-108

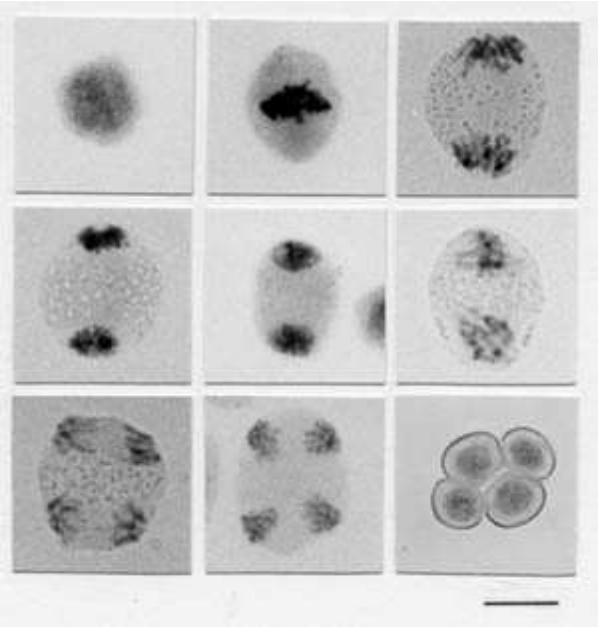
100-102. Skin cells of an organism have 16 chromosomes. How many chromosomes would you expect to see in:

100. Liver cells?

101. Sperm cells?

102. Nerve cells?

103. What process is indicated by the following figure?
   A. Mitosis
   B. Meiosis I
   C. Meiosis II
   D. Both Meiosis I and Meiosis II



**104. An organism has the following chromosome composition: AA', BB', CC', where the ' represents paternal chromosomes. Which of the following combinations in gametes is the result of normal meiosis?

   A. A'BC
   B. ABB'
   C. AA'C'
   D. A'C'C

**105. An organism has a diploid number of 6. How many different chromosomal combinations are possible in its gametes?

A. 4
B. 8
C. 12
D. 16

106. Refer to the stages of mitosis in the figure below. What sequence of cells represents the correct chronological sequence of events that occur during mitosis?

A. A, B, C, D
B. A, C, B, D
C. B, A D, C
D. B, C, D, A

A B C D

**107-108. Cells of an onion root tip were examined and the following cells in various stages were reported:

Interphase 25
Prophase 8
Metaphase 4
Anaphase 3
Telophase 1
Total 40

**107. What approximate % of cells is not dividing?

A. 35
B. 45
C. 55
D. 65

**108. If mitosis in onion cells is 80 minutes long, how long is prophase?

A. 20 min
B. 30 min
C. 40 min
D. 50 min

Station N. Questions 109-113

109. During what stage of the cell cycle is each chromosome composed of 2 chromatids?
   A. G1
   B. G2
   C. S
   D. G0

*110. Which of the following is unique to only meiosis and not mitosis?
   A. homologous chromosomes pair
   B. homologous chromosomes move to the center of the cell.
   C. chromatids become separated during anaphase
   D. homologous chromosomes attach to separate spindles

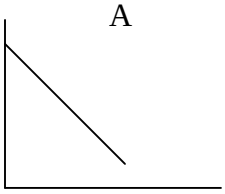
111-112. A scientist isolated Enzyme A and found that each gram of enzyme was associated with 2mg of iron. The affects of iron concentration on enzyme activity was tested in different tubes and the results appear in the table below:

Amount of iron (mg)	Molecules of product produced
1	400
2	100
3	44
4	25
5	16

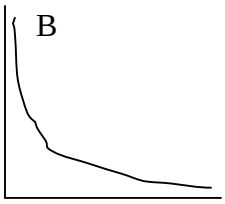
111. What amount of iron represents the control tube?

112. Which of the following graphs, A, B, or C, best represents the results of the above table? In all cases, y axis is amount of product and x axis is amount of iron.

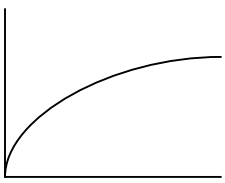
A



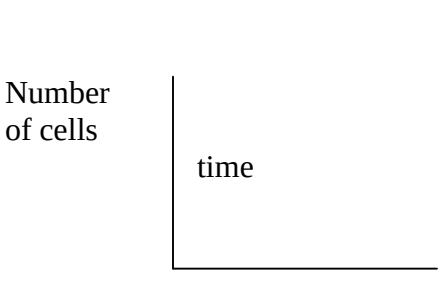
B



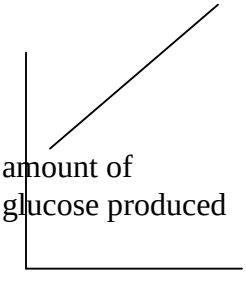
C



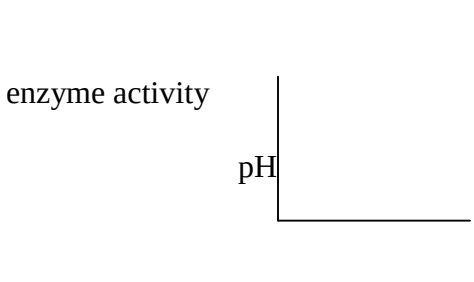
113. Which of the following graphs, A, B, or C, is incorrectly drawn?



A



B

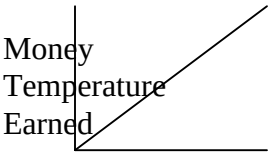


C

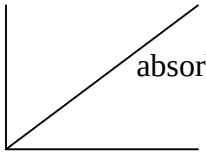
114-116 Choose from the following choices to indicate the error in each graph. Choices may be used more than once, or not all. Each graph will have only one answer.

A. Independent and dependent variables plotted on the wrong axes.
B. Improper units indicated
C. Bar graph should be used
D. Spacing between points is not constant
E. Answer not given

114.



115.



116.