

This exam consists of 45 questions. Each question is worth two points, and you'll get 10 bonus points for bubbling in your name properly. Please check to see that all the pages are present before you begin. Use a #2 pencil and bubble in all answers. Choose the best answer for each question. Your score will be posted on the UIC Blackboard site as soon as they are in. Good Luck!

1. Predict the expression of a *lacI* S mutant. A *lacI* S mutant synthesizes a repressor protein that cannot bind to the inducer lactose.
  - A. The *lac* genes would be expressed frequently and efficiently only in the absence of lactose and presence of glucose.
  - B. The *lac* genes would be expressed frequently and efficiently only in the presence of both lactose and glucose.
  - C. The *lac* genes would be expressed continuously.
  - D. The *lac* genes would never be expressed efficiently.
  - E. Expression of the *lac* genes would be solely dependent upon the presence or absence of glucose
  
2. IPTG (Isopropyl  $\beta$ -D-1-thiogalactopyranoside) is a chemical which can bind to the repressor protein of the *lac* operon but is not broken down by  $\beta$ -galactosidase (or any other enzyme relative to this problem). You have two *E. coli* cultures with fully functional *lac* operons. In one culture you add lactose and in the second you add an equivalent amount of IPTG. There is no glucose present in either culture. What would you expect to be the level of gene expression in both cultures?
  - A. Both cultures have continuous expression of the *lac* operon for a very long time.
  - B. Both cultures have initial expression of the *lac* operon, but expression in the lactose-added culture ends while expression of the IPTG-added culture is continuous.
  - C. Both cultures have initial expression of the *lac* operon, but expression in the IPTG-added culture ends while expression of the lactose-added culture is continuous
  - D. Both cultures have initial expression of the *lac* operon, but expression in both cultures soon ends
  - E. There is no expression in the IPTG-added culture
  
3. Which of the following mutations will result in a *lac* operon in which expression is ONLY dependent upon lactose concentrations, not glucose concentrations.
  - A. A mutant repressor protein which cannot bind to lactose
  - B. An mutant operator to which the repressor protein cannot bind
  - C. A mutant repressor protein to which lactose permanently binds
  - D. A mutant promoter to which RNA polymerase easily binds
  - E. None of the above mutations produce a *lac* operon in which expression is ONLY dependent upon lactose concentrations, not glucose concentrations

4. The *lac* operon is an example of a(n) \_\_\_\_\_ operon. The *trp* operon is an example of a(n) \_\_\_\_\_ operon
- |                           |                             |
|---------------------------|-----------------------------|
| A. inducible; inducible   | B. inducible; repressible   |
| C. repressible; inducible | D. repressible; repressible |
5. Which of the following is NOT necessary for proper expression of a eukaryotic gene
- A. Histone Acetyl Transferase (HAT) remodeling the chromatin
  - B. TFIID binding to the basal promoter of the eukaryotic gene
  - C. Removal of introns from the mRNA
  - D. A transcription factor binding to a silencer
  - E. All of the above are necessary for proper expression of an eukaryotic gene
6. What would happen to a eukaryote if the gene which produces TATA-binding protein (TBP) were mutated so that the TBP could no longer bind to the basal promoter?
- A. The organism would quickly die
  - B. The organism would have about a 50% chance of living
  - C. The organism would live, but it would have reduced function
  - D. The mutation would not have a significant effect on the organism
  - E. The organism would thrive with this mutation
7. You discover a protein that you call PxcII. You discover that this protein has zinc fingers. What assumptions could you make about this protein?
- A. The protein binds to the basal promoter of eukaryotic genes
  - B. The protein is a transcription factor
  - C. The protein can bind to DNA, but you cannot assume any other function
  - D. The protein is involved in stabilizing mRNA
  - E. You cannot make any assumptions about this protein

Questions 8 to 9 all relate to a  $2n = 8$  cell

8. The cell illustrated below is in what stage of cell division?
- A. Metaphase I
  - B. Metaphase II
  - C. Anaphase I
  - D. Anaphase II
  - E. Metaphase of Mitosis
9. The cell illustrated below is in what stage of cell division?
- A. Metaphase I
  - B. Metaphase II
  - C. Anaphase I
  - D. Anaphase II
  - E. Anaphase of Mitosis

10. During which stage(s) of meiosis does crossing over occur?  
 A. Prophase I            B. Metaphase I            C. Prophase II            D. Metaphase II  
 E. A & C
11. What is the product of meiosis?  
 A. Two genetically identical cells            B. Two genetically unique cells  
 C. Four genetically identical cells            D. Four genetically unique cells
12. Why does the frequency of non-disjunction increase exponentially with a woman's age?  
 A. Older women typically mate with older men - the problem is with the sperm, not the eggs  
 B. Older women frequently do not get proper nutrition which affects spindle formation  
 C. There is a limited supply of enzymes regulating meiosis, and when you get older, there are fewer in your system than when you were younger  
 D. All of a woman's eggs are suspended in metaphase I during fetal development. Older women have been exposed to more hazards and toxins, so mistakes in separation are more common  
 E. Let's face it, everything goes to hell when you get older, so why should this be any different?
13. Which of the following mutations will cause an increase in cell division in eukaryotes  
 I. Mutations which cause increased expression of proto-oncogenes  
 II. Mutations which cause decreased expression of proto-oncogenes  
 III. Mutations which cause increased expression of tumor-suppression genes  
 IV. Mutations which cause decreased expression of tumor-suppression genes  
 A. I only            B. I, III only            c. IV only            D. II, IV only  
 E. I, IV only
14. A cell lining the inside of an artery is knocked loose and floating in the blood. Why won't this cell start growing and form a tumor?  
 A. The PDGFs (Platelet-Derived Growth Factors) prevent cell division  
 B. Contact inhibition - the cell is not in contact with another cell, so this would prevent cell growth  
 C. Anchorage dependence - the cell is not in contact with a substratum, so this would prevent cell growth  
 D. Both B & C  
 E. A, B, and C
15. Which of the following (A-D) is NOT a valid difference between plants and animals? If all are valid differences, then choose E  
 A. Plants perform a different type of meiosis than animals  
 B. Plants retain numerous areas of undifferentiated cells whereas these are rare in animals  
 C. In plants, meiosis and gametogenesis are not linked, in animals the two are linked  
 D. Plants are much less mobile than animals  
 E. All of the above are valid differences between plants and animals

Use the key below to answer questions 16 - 18

- |                      |                        |                    |
|----------------------|------------------------|--------------------|
| I. Parenchyma cell   | II. Sieve-tube element | III. Vessel        |
| IV. Collenchyma cell | V. Xylem parenchyma    | VI. Fiber          |
| VII. Sclerid         | VIII. Tracheid         | IX. Companion cell |

16. Which of the above cells transport water in the xylem tissue?  
A. VI only                      B. VI, VII only                      C. VI, VII, V only  
D. III, VIII only                      E. III, V, VIII only
17. Which of the above are involved of transport of photosynthate?  
A. II, IX only                      B. I, II, IX only                      C. III, VIII  
D. II, III, VIII, IX                      E. II, III, V, VIII, IX
18. How many of the above cells are living at functional maturity?  
A. Three      B. Four      C. Five      D. Six      E. Seven
19. What is the function of the endodermis?  
A. Regulation of what enters into the xylem  
B. Protection of the vascular tissue  
C. The endodermis prevents water from leaking out of the xylem  
D. The endodermis helps the phloem unload food in the roots  
E. None of the above
20. Which of the following cells is incorrectly matched with its tissue type?  
A. Xylem parenchyma: vascular tissue  
B. Leaf mesophyll: ground tissue  
C. Pericycle: meristematic tissue  
D. Endodermis: dermal tissue  
E. Sieve-tube element: vascular tissue
21. Which of the following would you not expect to see in a lily (monocot)  
A. Flowers with six tepals (petals)                      B. Leaves with parallel venation  
C. Root apical meristems                      D. Primary xylem  
E. Taproot
22. The diagram below is an example of what type of plant structure?  
A. Monocot root  
B. Dicot root  
C. Monocot stem  
D. Herbaceous dicot stem  
E. Woody dicot stem

23. A seed is a ripened:
- A. Egg                      B. Egg sac                      C. Ovule                      D. Ovary  
E. Carpel

Use the key below to answer questions 24 to 27

- I. Mosses (Bryophyta)                      III. Pines (Coniferophyta)  
II. Ferns (Pteridophyta)                      IV. Flowering plants (Angiosperms)

24. This/these plants have sporangia and release spores into the wind:  
A. I only      B. II only      C. I, II only      D. III, IV only      E. I, II, III only
25. This/these plants produce seeds:  
A. I only      B. IV only      C. III, IV only      D. II, III, IV only      E. I, II, III, IV
26. . The sporophyte is the dominant stage of the life cycle in this/these plants:  
A. I only      B. IV only      C. III, IV only      D. II, III, IV only      E. I, II, III, IV
27. This/these plants have vascular tissue:  
A. I only      B. IV only      C. III, IV only      D. II, III, IV only      E. I, II, III, IV
28. Which of the following structures is incorrectly matched with its function?  
A. Egg sac - female gametophyte, production of egg cells  
B. Anther - production of male gametophyte  
C. Ovary - becomes the fruit  
D. Stigma - protection of ovule  
E. Petals - identification fo the flower by animals (advertising)
29. Which of the following statements (A-D) about seed plants is FALSE? If statements A-D are true, then choose E.  
A. All seed plants have ovaries  
B. All seed plants produce pollen  
C. Double fertilization is seen in flowering plants but not in pine trees  
D. Viable seeds consist of a seed coat, and embryo, and food for the embryo  
E. All of the above statements about seed plants are TRUE
30. As you age, your blood vessels become more rigid and this will affect many aspects of your circulation. How many of the below possible changes are TRUE.
- I. Your blood pressure will decrease  
II. Your blood velocity will decrease  
III. The efficiency of gas exchange will decrease  
IV. The efficiency of food absorption in the circulatory system will decrease  
V. The blood volume will increase
- A. One      B. Two      C. Three      D. Four      E. Five
31. Which blood vessels have the thinnest walls?  
A. Arteries      B. Arterioles      C. Capillaries      D. Venues      E. Veins

32. This chamber of the heart has very thin walls and contains deoxygenated blood.
- A. Right Atrium                      B. Right Ventricle  
C. Left Atrium                        D. Left Ventricle
33. Arrange the gasses and fluids in order of greatest to least partial pressure of O<sub>2</sub>.
- I. Air                                      II. Blood Entering Alveolar Capillaries  
III. Aortal Blood                      IV. Body Tissues
- A. I, II, III, IV              B. I, III, II, IV              C. I, III, IV, II              D. IV, II, III, I
34. Someone has a genetic disease where they can not produce functional carbonic anhydrase. How will this affect respiratory functions?
- A. They will not be able to produce functional hemoglobin  
B. They will have a much reduced ability to gather oxygen from the air  
C. They will have a much reduced ability to remove and transport CO<sub>2</sub> from the tissues  
D. The pH of the blood will decrease, causing the blood to become too acidic  
E. This genetic disease will not affect respiratory functions
35. What do you think would happen if a human fetus produced the same type of hemoglobin as its mother?
- A. Nothing, this is what is supposed to happen  
B. There would be an immune response and the fetus could die  
C. The mother would lose too much oxygen to the fetus  
D. The fetus would have a difficult time obtaining oxygen from the placenta  
E. None of the above

Use the key below for questions 36 and 37 (remember to choose the best answer)

- I. Mouth                                  II. Stomach                      III. Small Intestine  
IV. Large Intestine                  V. Rectum

36. Which of the following organs utilizes mechanical digestion?
- A. I only                                  B. I, II only                      C. I, II, III only  
D. II, III only                            E. I, II, III, IV only
37. Which of the following organs utilizes chemical digestion?
- A. III only                                B. II, III only                      C. I, II, III only  
D. I, II, III, IV only                  E. I, II, III, IV, V
38. Why does the small intestine have so many villi?
- A. To increase absorptive surface area  
B. The villi “brush” the food and this helps to mechanically break down food  
C. Each villus is a gland which secretes digestive enzymes  
D. The villi provide a safe haven for the *E. coli* in your small intestine  
E. None of the above

39. To activate a memory or virgin cytotoxic T Cell, it must receive activation from:
- A. An antigen presenting cell
  - B. An Effector Helper T Cell
  - C. Direct contact with a pathogen
  - D. A & B
  - E. B & C
40. Which cell type is incorrectly matched with its function?
- A. Mast Cells - increase capillary permeability near a wound
  - B. B Cells - produce antibodies
  - C. Helper T Cells - produce and secrete chemicals which activate virgin or memory Cytotoxic T and B Cells, creating large numbers of effector and memory cells
  - D. Antigen-presenting Cell - display foreign antigens for Helper T Cells
  - E. All of the above are correctly matched with their function
41. Your immune response time typically is slow when you are first invaded by a pathogen. However, if you are later invaded by the same pathogen, your immune response time is much faster. This is due to the presence of:
- A. Macrophages with increased sensitivity to this pathogen
  - B. Memory populations of Helper T, Cytotoxic T, and B Cells
  - C. Increased macrophage numbers
  - D. Increased pathogen sensitivity in the macrophages and neutrophils
  - E. All of the above
42. Place the following sequence in order to best describe a cell-mediated immune response:
- I. Activated Helper T-cells secrete chemicals to further activate memory or virgin Cytotoxic T-cells
  - II. The pathogen is consumed by a macrophage
  - III. Effector Cytotoxic T-cells hunt and destroy the pathogen
  - IV. The macrophage forms an antigen-MHC complex, becoming an antigen-presenting cell
  - V. The body is invaded by a pathogen
  - VI. The virgin or memory Helper T-cells and Cytotoxic T-cells with complementary receptors become activated by binding to the antigen-MHC complex of the antigen-presenting cell
- A. I, II, III, IV, V, VI
  - B. V, II, IV, VI, I, III
  - C. V, II, VI, IV, I, III
  - D. V, IV, VI, II, I, III
43. What observation enabled to Edward Jenner to experiment and develop a vaccination for smallpox?
- A. People who got cowpox frequently died, but if they didn't die the first time, they were usually immune to cowpox
  - B. Survivors of smallpox frequently had children who were immune to smallpox
  - C. Sarah the milkmaid and her milkmaid friends who had previously been infected with cowpox were largely immune to smallpox
  - D. Blossom the cow possessed a strain of smallpox that was very weak
  - E. Survivors of cowpox were then frequently immune to small pox

44. Which of the following statements (A-D) about the skin and mucous membranes is FALSE? If statements A-D are true, then choose E.
- A. There are colonies on non-pathogenic bacteria living on the skin, which make it difficult for pathogenic bacteria to survive on the skin
  - B. The skin has a high pH
  - C. The skin is dry, which inhibits bacterial growth
  - D. Mucous membranes are sticky and secrete lysozymes, which can kill bacteria
  - E. All of the above statements about the skin and mucous membranes are TRUE
45. Which of the following statements (A-D) about antibodies is FALSE? If statements A-D are true, then choose E.
- A. Antibodies are produced by effector B-Cells
  - B. Antibodies bind to specific antigens, marking them for phagocytes
  - C. Some antibodies can bind to pathogens and directly kill them
  - D. Some antibodies can reduce the mobility of pathogens
  - E. All of the above statements are TRUE