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Biology 10l W.P. Armstrong, Instructor

Exam # 4: Mendelian Genetics & Immunology

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Part I. Multiple Choice Questions 1 - 10:

The Following Choices Apply To Questions 1 - 6:

(a) suppressor T-cell
(b) effector T-cell
(c) killer T-cell
(d) B-cell (plasma cell)
(e) Langerhan's cell

1. **Encounters poison oak allergen deep in the epidermal layer of the skin and releases lymphokines during the elicitation phase.**

2. **Chemically attracted by lymphokines to site of allergen during the elicitation phase.**

3. **Migrates to a nearby lymph node with allergen on its membrane during the induction phase.**

4. **May be involved in cell-mediated homeopathic desensitization and natural immunity.**

5. **May be involved in natural immunity by producing antibodies against the poison oak allergen (an antibody-mediated immune response).**

6. **Which of the above cells are also referred to as "helper T-cells" in some immunology textbooks?**

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7. **Poison oak causes a severe cell-mediated immune response involving which of the following: [i.e. a painful rash is caused by one of the following]**
   (a) B-cells
   (b) T-cells
   (c) plasma cells
   (d) potent histamine toxin
   (e) immune (IgG) antibodies

8. **Name of the toxic allergen found in the resinous sap of poison oak:**
   (a) histamine
   (b) acetylcholine
   (c) catechol (specifically pyrocatechol)
   (d) quinone
   (e) urushiol

9. **The poison oak allergen belongs to which of the following classes of chemical compounds:**
   (a) alkaloid
   (b) terpene
   (c) steroid
   (d) phenolic
   (e) saponin

10. **Which of the following plants can cause a cell-mediated immune response resulting in a painful a rash?**
    (a) nettle
    (b) poison sumac
    (c) Japanese lacquer tree
    (d) poison ivy
    (e) cashew tree
    (f) mango
    (g) all of the above
    (h) all of the above except choice (a)

Part II. Multiple Choice Questions 11 - 34 :

11. **Term applied to a cell or organism in which only one member of each homologous chromosome pair is present:**
    (a) polyploid
    (b) diploid
    (c) tetraploid
    (d) haploid
    (e) anaploid
    (f) choices (a) and (b)

12. A type of human chromosomal anomaly characterized by the 21st autosome in triplicate
- **(a) Siamese twin**
- **(b) Trisomy X**
- **(c) Down's syndrome**
- **(d) Klinefelter's syndrome**
- **(e) Turner's syndrome**
- **(f) Mongolian syndrome**
- **(g) XYY syndrome**

13. Which of the following genes cause the dark extremities of Siamese cats and Himalayan rabbits?
- **(a) an epistatic gene that affects other melanin producing genes**
- **(b) a temperature-influenced gene that affects melanin production**
- **(c) an X-linked gene that affects melanin production in females (XX) only**
- **(d) an X-linked gene that effects melanin production in males and females**
- **(e) an X-linked gene that only functions when it is not on a Barr body**
- **(f) a sex-influenced gene that affects melanin production**
- **(g) all of the above choices are correct**
- **(h) choices (a) and (f) are correct**
- **(i) choices (c) and (f) are correct**

14. A type of human chromosomal anomaly characterized by an unpaired X chromosome and no Y chromosome.
- **(a) Siamese twin**
- **(b) Trisomy X**
- **(c) Down's syndrome**
- **(d) Klinefelter's syndrome**
- **(e) Turner's syndrome**
- **(f) Mongolian syndrome**
- **(g) XYY syndrome**

15. A type of human chromosomal anomaly that was once (incorrectly) associated with a potential for criminal behavior.
- **(a) Siamese twin**
- **(b) Trisomy X**
- **(c) Down's syndrome**
- **(d) Klinefelter's syndrome**
- **(e) Turner's syndrome**
- **(f) Mongolian syndrome**
- **(g) XYY syndrome**

16. How many different gametes can be produced from the following genotype? Note: The pairs of letters represent alleles on pairs of homologous chromosomes. Capital letters represent dominant alleles and small case letters represent recessive alleles. Assume that all of the genes are on separate chromosomes and there is no crossing over between homologous chromosomes.

Bb rr Ss Pp AA Tt yy nn Vv

- **(a) 8**
- **(b) 16**
- **(c) 32**
- **(d) 64**
- **(e) 128**
- **(f) 256**

17. The appearance of an organism, resulting from its genetic make-up and environment:
(a) expression
(b) progeny
(c) genotype
(d) karyotype
(e) phenotype
(f) prototype

18. Having two different alleles at the corresponding gene loci on homologous chromosomes. [i.e. members of the gene pair are dissimilar.]
(a) homozygous
(b) heterozygous
(c) dihybrid cross
(d) multiple allele inheritance
(e) polygenic inheritance
(f) monohybrid cross

19. Inheritance involving three or more different alleles at one corresponding pair of gene loci on a homologous pair of chromosomes.
(a) homozygous
(b) heterozygous
(c) dihybrid cross
(d) multiple allele inheritance
(e) polygenic inheritance
(f) monohybrid cross

20. Inheritance involving multiple genes located at two or more different gene loci on homologous pairs of chromosomes.
(a) homozygous
(b) heterozygous
(c) dihybrid cross
(d) multiple allele inheritance
(e) polygenic inheritance
(f) monohybrid cross

21. In the homozygous recessive disease sickle-cell anemia, substitution of the amino acid valine for glutamic acid in the hemoglobin molecule results in:
(a) an abnormally shaped hemoglobin molecule
(b) an excess of hemoglobin molecules in the blood
(c) red blood cells that carry additional oxygen
(d) red blood cells that carry carbon monoxide
(e) an increased number of red blood cells
(f) choices (a) and (c)

22. A foreign protein which, when introduced into the body of an animal it is foreign to, stimulates the formation of antibodies:
(a) antigen
(b) histone
(c) antibody
(d) plasma
(e) polypeptide
(f) glycoprotein

23. An individual with both male and female sexual organs:
- **(a) dioecious**
- **(b) heterosexual**
- **(c) gynandromorph**
- **(d) bisexual**
- **(e) hermaphrodite**
- **(f) choices (d) and (e)**

24. An example of an invertebrate animal in which the male has no Y chromosome, while the female has two X chromosomes:
- **(a) honey bee**
- **(b) termite**
- **(c) grasshopper**
- **(d) butterfly**
- **(e) moth**
- **(f) choices (d) and (e)**

25. An example of an animal in which the female has one unmatched pair of chromosomes while the male has all matched pairs of chromosomes:
- **(a) bird**
- **(b) grasshopper**
- **(c) honey bee**
- **(d) termite**
- **(e) fruit fly (Drosophila)**
- **(f) choices (d) and (e)**

26. An example of an animal in which the males are haploid (n) and the females are diploid (2n):
- **(a) bird**
- **(b) grasshopper**
- **(c) honey bee**
- **(d) termite**
- **(e) fruit fly (Drosophila)**
- **(f) choices (d) and (e)**

27. Number of chromosomes in a somatic cell of a human male with Klinefelter's syndrome?
- **(a) 23**
- **(b) 46**
- **(c) 47**
- **(d) 48**
- **(e) 92**
- **(f) 94**

Questions 28 - 29 refer to the following numerical choices:

(a) 3 (b) 6 (c) 8 (d) 10 (e) 12 (f) 18 (g) 20

(h) 32 (i) 36 (j) 42 (k) 56 (l) 64 (m) 128 (n) 256

28. Rh blood inheritance in humans involves three pairs of alleles (C & c), (D & d), and E & e) located at three different loci on homologous chromosome pair number one. Considering all three pairs of

alleles (two alleles per locus and three loci per chromosome), how many different genotypes are possible? [Note: This is NOT a multiple allele question because only one of two alleles can occupy a given locus on a chromosome.]

29. **Although most textbooks give 3 alleles for A-B-O blood inheritance in humans (A, B, & O), there are actually four alleles because two types of A have been identified (A_1 and A_2). Therefore, A-B-O blood inheritance in humans involves four alleles located at the same loci on homologous chromosome pair number nine. Considering all four alleles (four alleles per locus and one locus per chromosome), how many different genotypes are possible? [Note: This is a multiple allele question because one of four alleles can occupy a given locus on a chromosome.]**

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30. **Man whose name is usually associated with The Theory of Acquired Characteristics?**
    (a) Charles Darwin
    (b) Jean Lamarck
    (c) Gregor Mendel
    (d) Alfred Wallace
    (e) James Watson
    (f) Francis Crick
    (g) choices (e) and (f)

31. **Austrian monk who discovered the basic principles of genetics based on the results of his crosses with garden peas?**
    (a) Charles Darwin
    (b) Jean Lamarck
    (c) Gregor Mendel
    (d) Alfred Wallace
    (e) James Watson
    (f) Francis Crick
    (g) Choices (e) and (f)

32. **The number of different possible sperm in a human due to random assortment of the chromosomes during spermatogenesis?**
    (a) 23^2
    (b) 23^3
    (c) 46^2
    (d) 46^3
    (e) 2^{23}
    (f) 2^{46}
    (g) infinite

33. **The number of different possible sperm in a human due to random assortment of the chromosomes <u>and</u> crossing over during spermatogenesis?**
    (a) 23^2
    (b) 23^3
    (c) 46^2
    (d) 2^{23}
    (e) 2^{26}
    (f) 2^{46}
    (g) infinite

34. **Based upon the "one gene one polypeptide theory" and the Y-shaped model of an immune-type (IgG) antibody composed of two pairs of polypeptides (two long and two short), how many antibodies could theoretically be produced from 2000 genes.**
    (a) one thousand
    (b) two thousand
    (c) four thousand
    (d) ten thousand
    (e) 100 thousand
    (f) one million
    (g) one billion

Part III. Matching Choices For Questions 35 - 60:

Note: Use each of these 26 choices one time only.

a. Active	**n. IgG**
b. Allele	**o. IgM**
c. Antitoxin	**p. Immunotoxin**
d. Antivenin	**q. Incomplete Dominance**
e. Barr Body	**r. L-Chain**
f. Chromatid	**s. Monoclonal**
g. Dizygotic	**t. Monozygotic**
h. Equine	**u. Passive**
i. Gamma Globulin	**v. RhoGam**
j. Glycoprotein	**w. Serum**
k. H-Chain	**x. Toxoid**
l. Hemotoxin	**y. Vaccination**
m. Histone	**z. Vaccine**

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35. **Name of the biochemical polymer that applies to a macromolecule composed of both polypeptide and polysaccharide subunits. In cell membranes, this is an important macromolecule involved in cell recognition by the immune system.**

36. **General type of immunity that typically involves the intramuscular injection of ready-made antibodies obtained from another person or animal, such as a horse.**

37. **Antibodies produced in a laboratory by animals that have been exposed to the antigen of a specific disease-causing cell or virus.**

38. **An antibody-toxin conjugate that carries its particular protein toxin (lectin) directly to the site of a tumor.**

39. **A special serum that is administered to an Rh negative mother with 72 hours after she has delivered an Rh positive baby. The serum prevents the mother from producing her own anti-Rh antibodies which could seriously affect an Rh positive fetus during a future pregnancy.**

40. **A subcutaneous or intramuscular injection containing ready-made antibodies obtained from another person or animal, such as a horse.**

41. **The longer of two kinds of polypeptides that comprise the Y-shaped structure of an immune-type antibody.**

42. **The shorter of two kinds of polypeptides that comprise the Y-shaped structure of an immune-type antibody.**

43. **General type of immunity that typically involves a complicated antibody-mediated immune response against the antigens of a disease microbe.**

44. **One of the two members of a chromosome doublet that are still attached at the centromere.**

45. **One of the two X chromosomes within the nucleus of a female mammalian cell. Because of the very condensed form of this X chromosome, it stains dark and is visible under a light microscope, and was once used for gender verification among female athletes competing in the Olympics.**

46. **The label of origin on certain antiserums obtained from another animal that could potentially cause severe allergic reactions in hypersensitive recipients.**

47. **Another word for identical twins.**

48. **Another word for fraternal twins.**

49. **The protein fraction of human blood containing many different antibodies. It is commonly given to patients suffering from illnesses in which their immune system has been compromised. It is also given to boost the immune system of persons departing for a foreign country.**

50. **Protein in the venom of pit vipers that can destroy red blood cells and tissues in the vicinity of the bite, and can cause gangrene in the afflicted extremities.**

51. **The polyvalent serum administered for the bite of venomous reptiles, such as pit vipers, vipers, cobras and sea snakes.**

52. **The general term for a serum made from the toxin of a disease organism, such as the toxin from tetanus bacteria (Clostridium tetani).**

53. **A subcutaneous or intramuscular injection containing a weakened or dead strain of a disease microbe, or the genetically-engineered protein coat of the microbe.**

54. **The act of innoculating someone with the above preparation in previous question.**

55. **A protein associated with the nucleosomes of a chromosome.**

56. **One member of a gene pair that occurs at the same locus on homologous chromosomes.**

57. **Specific type of inherited antibodies associated with the A-B-O blood groups. These antibodies are already present in the blood plasma of certain A-B-O individuals, and are not produced in response to an antigen.**

58. **Specific immune-type antibodies produced in response to an antigen through a complex antibody-mediated immune reaction.**

59. **An exception to Mendel's basic principles of genetics in which a red snapdragon crossed with a white snapdragon results in a pink-flowered offspring rather than a red or white-flowered offspring.**

60. **The general term for a vaccine made from the toxin of a disease organism, such as the toxin from tetanus bacteria (Clostridium tetani).**

Part IV. Multiple Choice Questions 61 - 139:

Note: In the following "thinking questions" assume that the taster allele (T) is dominant over the recessive nontaster allele (t); the A and B alleles are dominant over the O allele; the Rh positive allele (+) is dominant over the recessive Rh negative allele (-); and the X-linked normal vision allele (+) is dominant over the recessive colorblind allele (o). Also assume that all of the genes occur on separate chromosomes and there is no crossing over. The relative proportions of X-bearing and Y-bearing sperm are produced in a 50-50 ratio.

Questions 61 - 62:

John and Mary decide to share their DNA and have a child. Both John and his father can taste PTC; however, John's mother has parents who are both nontasters. Mary's can taste PTC but her father is a nontaster. Mary's mother had a father who was also a nontaster.

61. **What is the chance of John and Mary having a taster child?**
(a) 1/4
(b) 3/4
(c) 3/16
(d) 9/16
(e) no chance

62. **Is Mary's mother:**
(a) heterozygous
(b) homozygous
(c) unable to determine from given information

Questions 63 - 66:

Mary's father is colorblind and her mother (Jane) has normal color vision. Mary's uncle Bob (Jane's brother) is also colorblind. Mary's grandparents on both sides of the family have normal color vision. The following choices (genotypes) refer to questions 63 - 66:

(a) X^+Y (b) X^oY (c) X^+X^+ (d) X^+X^o (e) X^oX^o

63. **What is Bob's genotype?**

64. **What is the genotype of Mary's grandfather (Jane's father)?**

65. What is the genotype of Mary's grandmother (Jane's mother)?

66. What is Jane's genotype (assuming Mary can only have colorblind sons)?

Questions 67 - 68:

The following two questions refer to a cross between two mulattoes (the offspring between a white and a black parent). Assume that four genes (A, B, C, D) control dark skin pigmentation (more melanin) and four genes (a, b, c, d) control light skin pigmentation (less melanin). Also assume that all the genes occur on separate chromosomes. This is an example of polygenic inheritance.

67. How many different possible gametes can each mulatto parent produce?
(a) 4
(b) 8
(c) 16
(d) 32
(e) 64
(f) 128

68. What fraction of the offspring would you expect to carry all eight dark genes?
(a) 1/64
(b) 1/128
(c) 1/256
(d) 9/64
(e) 27/64
(f) 27/256

Questions 69 - 72:

Human blood types are really phenotypes. In the A-B-O blood phenotypes, the A and B alleles are dominant over the O allele. Blood phenotype A has two genotypes (AA and AO). Blood phenotype B has two genotypes (BB and BO). Blood phenotype O has only one genotype (OO). Blood phenotype AB has only one genotype (AB).

In the simplified Rh inheritance involving one pair of alleles, the positive allele or gene (+) is dominant over the negative allele (-). Phenotype Rh positive blood has two genotypes (+ + and + -). Phenotype Rh negative blood has only one genotype (- -).

See The Genetics Of A-B-O Blood Types

Chrissy and John have a baby boy named Cinco. Chrissy did not need the RhoGam serum because there was no chance of her producing anti-Rh antibodies; not even if her baby's RBCs entered her circulatory system during her pregnancy or during delivery. John's mother is homozygous for Rh positive blood. The following choices refer to questions 69 - 72:

(a) Rh positive (b) Rh negative (c) + + (d) + - (e) - -

69. **What is Chrissy's Rh blood phenotype?**

70. **What is Cinco's Rh blood phenotype?**

71. **What is John's Rh blood phenotype?**

72. **What is John's Rh blood genotype?**

Questions 73 - 77:

Chrissy and John both have type A blood. There two children (Hannah and Cinco) also have type A. Chrissy's mother is O Positive and her father is A Negative. John's mother is type B. The following choices refer to questions 73 - 77:

(a) AA **(b)** AO **(c)** OO **(d)** AB **(e)** BB **(f)** BO **(g)** AA or AO

(h) AO or AB **(i)** OO or AB **(j)** OO or BO **(k)** AA or AB

73. **What is Chrissy's A-B-O blood genotype?**

74. **What is Cinco's A-B-O blood genotype?**

75. **What is John's A-B-O blood genotype?**

76. **What is Hannah's A-B-O blood genotype**

77. **What is the A-B-O blood genotype of John's mother?**

Questions 78 - 82:

Miss X has type A blood. She has two children from the same father with blood types O and B. Her good friend Bob has type O blood. Bob's good friend John has type B blood. The following choices refer to questions 78 - 82:

(a) Type A	**(f) AO**
(b) Type B	**(g) BB**
(c) Type O	**(h) BO**
(d) Type AB	**(i) OO**
(e) AA	**(j) AB**

78. **What is the father's blood phenotype?**

79. What is the father's blood genotype?

80. What is the blood genotype of the type B child?

81. Could Bob be the father? (i.e. theoretically)
(a) yes
(b) no
(c) unable to determine from given information

82. Could John be the father? (assume that John is homozygous type B)
(a) yes
(b) no
(c) unable to determine from given information

Questions 83 - 86:

Four babies were born in a hospital on the same night and their A-B-O blood phenotypes were later found to be O, A, B, and AB. For some unexplained reason, the identification of the babies was mixed up, much to the chagrin of the irate parents. Assign the correct letter of each the following four parents (couples) to each baby. The following choices refer to questions 83 - 86:

(a) AB & O (b) O & O (c) A & B (d) B & B

83. Parents of type O baby?

84. Parents of type A baby?

85. Parents of type B baby?

86. Parents of type AB baby?

Questions 87 - 90:

A PTC taster (John) with type A blood marries a taster woman (Mary) with type B blood. John's mother has type AB blood and his father has type B blood. Mary's mother has type O blood. John's father and Mary's father are nontasters. The following choices refer to questions 87 - 90:

(a) TTAA	**(h) TtAA**	**(o) ttAA**
(b) TTAO	**(i) TtAO**	**(p) ttAO**
(c) TTBB	**(j) TtBB**	**(q) ttBB**
(d) TTBO	**(k) TtBO**	**(r) ttBO**
(e) TTOO	**(l) TtOO**	**(s) ttOO**
(f) TTAB	**(m) TtAB**	**(t) ttAB**
(g) F or M	**(n) B or M**	**(u) M or T**

87. What is John's genotype?

88. What is the genotype of John's father?

89. What is the genotype of John's mother?

90. What is the fractional probability that this couple will have a nontaster boy with type B blood?
(a) 1/16
(b) 3/16
(c) 1/32
(d) 3/32
(e) 1/8
(f) 3/8
(g) 1/4
(h) 3/4

Questions 91 - 94:

An anthropologist is studying an isolated population of 500 people living in New Guinea. 49 percent of this tribal population have Rh negative blood. The following choices apply to questions 91 - 94:

(a) 9	**(f) 63**
(b) 25	**(g) 75**
(c) 42	**(h) 125**
(d) 45	**(i) 255**
(e) 51	**(j) 425**

91. What percent of this population have Rh positive blood?

92. What percent of this population are heterozygous Rh positive?

93. What percent of this population are homozygous Rh positive?

94. How many people in this population are homozygous Rh positive?

Questions 95 - 96:

The following choices refer to questions 95 - 96:

(a) 1/2	**(f) 5/8**
(b) 1/4	**(g) 7/8**
(c) 3/4	**(h) 1/16**
(d) 1/8	**(i) 3/16**

(e) 3/8 **(j) 5/16**

95. A couple plan to have three children. What is the fractional probability that the first child will be a boy and the other two girls? [In other words, the order of their children would be boy-girl-girl.]

96. A couple plan to have three children. What is the fractional probability that they will have one boy and two girls in any order? [In other words, they could have boy-girl-girl, girl-girl-boy, or girl-boy-girl.]

Questions 97 - 99:

In a hypothetical population, 49 percent of the people have type O blood and four percent have homozygous type A blood. The following percent choices refer to questions 97 - 99:

(a) 2%	**(f) 25%**
(b) 4%	**(g) 28%**
(c) 10%	**(h) 32%**
(d) 12%	**(i) 42%**
(e) 15%	**(j) 51%**

97. What percentage of the population have type B blood?

98. What percentage of the population have type AB blood?

99. What percentage of the population have type A blood?

Questions 100 - 109:

A pea plant that is heterozygous round-seeded and heterozygous tall is crossed with a plant that is wrinkle-seeded and short. Assume that Tall (T) and Round (R) are dominant, while the homologous alleles short (t) and wrinkled (r) are recessive. Also assume that all of the genes occur on separate chromosomes and there are no different chromosomal combinations produced by crossing over.

The following genotypic choices refer to questions 100 - 102:

(a) RRTT	**(f) Rrtt**
(b) RRTt	**(g) rrTT**
(c) RRtt	**(h) rrTt**
(d) RrTT	**(i) rrtt**
(e) RrTt	**(j) none of the above**

100. What is the genotype of the round-seeded tall parent?

101. What is the genotype of the wrinkle-seeded short parent?

102. What is the exact genotype of their wrinkle-seeded tall offspring?

The following numerical choices refer to questions 103 - 107:

(a) 1 (b) 2 (c) 4 (d) 8 (e) 16

103. How many different gametes can the round-seeded tall parent produce?

104. How many different gametes can the wrinkle-seeded short parent produce?

105. How many different genotypic progeny can these two parents produce?

106. How many different phenotypic progeny can these two parents produce?

107. How many different gametes can the wrinkle-seeded tall offspring from the above cross produce?

The following fractional choices refer to questions 108 - 109:

(a) 1/2 (b) 1/4 (c) 3/4 (d) 3/16 (e) 9/16

108. What is the fractional chance of these original parents producing a wrinkle-seeded tall offspring?

109. In a cross between two wrinkle-seeded tall offspring (produced from the original parents in the above cross), what fractional ratio of their offspring would be wrinkle-seeded and tall?

Questions 110 - 119:

For questions 110 - 119 indicate whether the following blood transfusions are compatible. Use (a) for compatibility (no agglutination) and (b) for incompatibility (agglutination). Incompatible means that the recipient has antagonistic antibodies that will clump the donor's blood. In these questions, only consider the antibodies of the recipient's blood (ignore the antibodies of the donor's blood). Use the following table to answer the donor-recipient questions 110 - 119:

RECIPIENT

	Alleles & Antibodies	O anti-A anti-B	A anti-B	B anti-A	AB None
DO	O	?	?	?	?

N
O
R

A	?	?	?	?
B	?	?	?	?
AB	?	?	?	?

(a) = NO CLUMPING **(b) = CLUMPING**

110. type A Donor and type AB Recipient?

111. type A Donor and type O Recipient?

112. type B Donor and type O Recipient?

113. type B Donor and type A Recipient?

114. type B Donor and type AB Recipient?

115. type AB Donor and type B Recipient?

116. type AB Donor and type O Recipient?

117. type AB Donor and type AB Recipient?

118. type O Donor and type A Recipient?

119. type O Donor and type AB Recipient?

Questions 120 - 123:

Use the following choices for questions 120 - 123:

(a) A Positive

(b) A Negative

(c) B Positive

(d) B Negative

(e) AB Positive

(f) AB Negative

(g) O Positive

(h) O Negative

(i) all of the above

(j) none of the above

120. With regard to the A-B-O blood groups <u>and</u> the Rh factor, which blood type is often called the "universal recipient?"

121. **With regard to the A-B-O blood groups and the Rh factor, which blood type is often called the "universal donor?"**

122. **With regard to the A-B-O blood groups and the Rh factor, which blood type is the most common in the United States?**

123. **With regard to the A-B-O blood groups and the Rh factor, which blood type is the least common in the United States?**

Questions 124 - 126:

Use the following blood genotypes for questions 124 - 126:

(a) AB	**(d) BB**
(b) AO	**(e) BO**
(c) AA	**(f) OO**

All four blood phenotypes (A, B, AB & O) are represented in a family of six children. Assume that all children are from the same father and mother. Also assume that the father has no B allele in his genotype.

124. **What is the father's blood genotype?**

125. **What is the mother's blood genotype?**

Question 126:

126. **A sister and brother both have type B blood. Another sister has type A. If their mother has type O, what is the father's blood genotype? [We are assuming here that all three children were fathered by the same man.]**

Questions 127 - 133:

Questions 127 - 133 refer to the following F_1 data chart, the results of 25 random draws from a container of 25 red and 25 white beads. The beads represent red genes (dominant) and white genes (recessive). For each draw, only two beads are selected and recorded, without discriminating on the basis of color. These 25 draws represent 25 random matings in which a red or white-bearing egg and a red or white-bearing sperm come together.

Genotype	RR	Rr	rr
Tabulation	||||	||||| |||||	||||| ||||| |
Genotype			

Frequency	**122?**	**123?**	**124?**
Phenotype Frequency	**RED 125?**		**WHITE 126?**

Determine the percent or numerical value for each question using the following choices:

(a) 16 (b) 18 (c) 32 (d) 40 (e) 44 (f) 56

127. Genotypic percent of RR?

128. Genotypic percent of Rr?

129. Genotypic percent of rr?

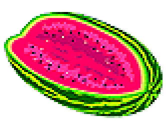
130. Phenotypic percent of RED?

131. Phenotypic percent of WHITE?

132. Number of red beads to be used in the next (F_2) generation?

133. Number of white beads to be used in the next (F_2) generation?

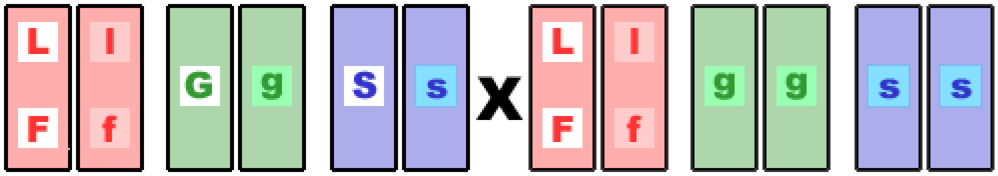
Questions 134 - 139:



A Genetic Cross Between Watermelons

In watermelons the gene for green rind (G) is dominant over the gene for striped rind (g), and the gene for short fruit (S) is dominant over the gene for long fruit (s). The alleles for rind color and fruit length occur on two different pairs of homologous chromosomes. For this question, assume that a gene for large melons (L) and and gene for many seeds (F) occur at opposite ends of another chromosome (linkage). The alleles for size and seed number, i.e. the genes for small melons (l) and few seeds (f), occur on a third homologous chromosome. A watermelon plant bearing large, green, short fruits containing many seeds was crossed with a plant bearing large, striped, long fruits containing many seeds. Some of the offspring from this cross produced small, striped, long fruits with few seeds.

Assuming no crossing over between homologous chromosomes, what is the fractional chance of producing the following offspring? Remember that there are three pairs of homologous chromosomes in this problem, and one of the homologous pairs exhibits autosomal linkage. The chromosomes of each parent are shown in the following illustration:



Answer choices for questions 134 - 135:

(a) 2 (b) 4 (c) 6 (d) 8 (e) 10 (f) 12 (g) 16 (h) 20 (i) 32 (j) 64 (k) 128

134. How many different possible gametes can the green, short-fruit parent produce?

135. How many different possible gametes can the striped, long-fruit parent produce?

Answer choices for questions 136 - 139:

(a) 1/16 (b) 2/16 (c) 3/16 (d) 4/16 (e) 5/16 (f) 1/32 (g) 5/32

(h) 14/32 (i) 18/32 (j) 21/64 (k) 32/64 (l) 48/64 (m) No Chance

136. Large, striped, long watermelon containing few seeds.

137. Large, green, short watermelon containing many seeds.

138. Small, striped, short watermelon containing few seeds.

139. Small, striped, long watermelon containing many seeds.

Part V. Multiple Choice Questions 140 - 176:

140. One gene masks or inhibits the expression of other non-allelic genes located on different gene loci of non-homologous chromosomes:
(a) polygenic inheritance
(b) incomplete dominance
(c) multiple alleles
(d) epistasis
(e) pleiotropy

141. An example of the above type of inheritance (previous question) in human populations:
(a) skin color
(b) albinism
(c) eye color
(d) hemophilia
(e) color blindness

142. In a family of three children, two children are Rh positive and one is Rh negative. One child suffered from severe erythroblastosis fetalis. Is the father (a) homozygous, (b) heterozygous, <u>or</u> (c) unable to

determine from the given information?
Choose (a), (b) or (c).

143. Which of the following parents can have boys and girls with normal color vision <u>and</u> girls and boys who are colorblind? [Assume that "o" represents the recessive x-linked allele for colorblindness.]
- **(a) $X^{+}Y$ and $X^{o}X^{o}$**
- **(b) $X^{+}Y$ and $X^{+}X^{o}$**
- **(c) $X^{o}Y$ and $X^{+}X^{o}$**
- **(d) $X^{o}Y$ and $X^{+}X^{+}$**
- **(e) $X^{o}Y$ and $X^{o}X^{o}$**

144. If a lethal recessive mutant gene occurs in a large haploid population, will this mutation tend to spread throughout the population?
(a) yes (b) no

145. Plumage coloration in parakeets involves interaction of the following alleles: B = blue and C = green. Codominant alleles B & C together = Green (neither gene is completely dominant over the other). Homozygous or heterozygous dominant B alleles with recessive c alleles = Blue. Homozygous or heterozygous dominant C alleles with recessive b alleles = yellow. All recessive alleles (bbcc) = white. What is the fractional probability of getting green offspring in a cross between two heterozygous green parakeets (BbCc X BbCc)?

(a) 9/16	**(b) 3/16**	**(c) 1/16**
(d) 3/4	**(e) 1/2**	**(f) 1/4**
(g) 2/3	**(h) 1/3**	**(i) no chance**

146. A plausible explanation of how racial differences may have first emerged in small populations when the earth was sparsely inhabited by hunting and gathering tribes of people?
- **(a) natural selection**
- **(b) differential migration**
- **(c) random selection**
- **(d) mutation pressure**
- **(e) continental drift**
- **(f) genetic drift**

147. A plausible explanation for the lack of genetic variability in isolated populations of Torrey pines and elephant seals?
- **(a) natural selection**
- **(b) differential migration**
- **(c) random selection**
- **(d) mutation pressure**
- **(e) continental drift**
- **(f) genetic bottleneck**

148. Which of the following animals cannot carry a lethal recessive gene?
- **(a) grasshopper**
- **(b) butterfly**
- **(c) drone honeybee**
- **(d) calico cat**
- **(e) siamese cat**
- **(f) mule**

149. Suppose that in cocker spaniel dogs there is a dominant gene (S) for solid color dogs and a recessive gene (s) for spotted dogs. How would you determine if a solid color bitch is heterozygous or homozygous?
(a) breed her with another solid color male
(b) breed her with a spotted male
(c) get her spayed and forget it
(d) breed her with an albino male
(e) count the number of Barr bodies per cell
(f) ask your neighborhood veterinarian

150. How many Barr bodies would you expect inside the nucleus of a somatic cell from a calico cat?
(a) one
(b) two
(c) three
(d) four
(e) none
(f) many

151. Which of the following crosses results in a tangelo?
(a) orange X grapefruit
(b) tangerine X orange
(c) tangerine X grapefruit
(d) shaddock (pomelo) X orange
(e) grapefruit X lemon
(f) choices (c) and (d)

152. Which of the following crosses results in a mule?
(a) stallion X jennyass
(b) stallion X hinny
(c) mare X hinny
(d) mare X jackass
(e) stallion X pony
(f) choices (c) and (d)

153. Which of the following crosses is typically impossible?
(a) pheasant X chicken
(b) zebra X horse
(c) male lion X female tiger
(d) calico cat X female siamese cat
(e) female bison X domestic steer
(f) all of the above

154. How many Barr bodies would expect to find inside the nucleus of a cell from a super female or trisomy X (XXX) during interphase of the cell cycle?
(a) 2 (b) 3 (c) 4 (d) 23 (e) 44 (f) 46

155. Assuming three alleles in the A-B-O human blood groups, how many different genotypes are possible?
(a) 4 (b) 6 (c) 8 (d) 12 (e) 16 (f) 32

156. Where is the location of the A, B and Rh positive antigens in human red blood cells (RBCs)?
(a) cytoplasm
(b) cell membrane

(c) nuclear membrane
(d) endoplasmic reticulum
(e) cell wall
(f) vacuolar membranes

157. Where is the location of the anti-A, anti-B and anti-Rh antibodies in the human circulatory system?
(a) RBC membrane
(b) RBC cytoplasm
(c) cytoplasm of phagocytes
(d) lymph nodes
(e) blood plasma
(f) membrane of lymphocytes

158. A potentially serious anemia of the human fetus may result if the:
(a) mother is Rh positive and the father is Rh positive
(b) mother is Rh negative and the father is Rh negative
(c) mother is Rh negative and the father is Rh positive
(d) mother is Rh positive and the father is Rh negative
(e) mother is Rh positive <u>or</u> Rh negative and father is Rh positive

159. Which of the following mothers would NOT usually produce anti-Rh antibodies against her A positive fetus?
(a) A negative
(b) B negative
(c) O negative
(d) AB positive
(e) AB negative
(f) choices (b) and (c)
(g) choices (b), (c) and (d)

160. Which of the following six types of white blood cells (WBCs) divide into antibody-producing plasma cells and "memory cells?"
(a) B-lymphocytes
(b) T-lymphocytes
(c) monocytes
(d) neutrophils
(e) eosinophils
(f) basophils

161. Which of the following results in active immunity?
(a) RhoGam
(b) gamma globulin
(c) antivenin
(d) tetanus toxoid
(e) tetanus antiserum
(f) immunotoxins

162. Persons of blood type AB can receive a blood transfusion from other A, B and O blood donors because:
(a) AB blood contains no anti-A or anti-B antibodies
(b) AB blood contains no anti-Rh antibodies
(c) the Rh factor is always absent from AB blood
(d) AB blood contains no clumping factor
(e) AB blood contains no A or B antigens

(f) AB blood contains no Rh antigens

163. In relation to A-B-O maternal-fetal blood incompatibility, which of the following types of babies are always compatible with their mother's blood type?
(a) type A
(b) type B
(c) type AB
(d) type O
(e) choices (a) and (b)
(f) none of the above

164. It has been suggested that Queen Victoria of England was the carrier of a recessive, X-linked gene for hemophilia. Assuming that she was indeed heterozygous for this trait, which of the following statements are true?
(a) Queen Victoria's father must have had hemophilia
(b) hemophilia will occur in more of her male than female descendants
(c) all of her daughters would have been carriers of hemophilia
(d) all of her sons would have had hemophilia
(e) the queen must have died from hemophilia
(f) none of the above statements are true
(g) all of the above statements are true

165. Which of the following cells are involved in the antibody-mediated immune response by actually producing the immune antibodies?
(a) T-lymphocyte
(b) B-lymphocyte
(c) plasma cell
(d) effector T-cell
(e) helper T-cell
(f) killer T-cell
(g) choices (b) and (c)

166. There are 64 chromosomes in the diploid cells of a horse (2n = 62), and 62 chromosomes in the diploid cells of a donkey (2n = 62). What is the diploid chromosome number of a mule?
(a) 23 (b) 60 (c) 63 (d) 66 (e) 96 (f) 126

167. All the genes of a haploid or diploid organism, including viruses and unicellular and multicellular organisms?
(a) genome
(b) genotype
(c) karyotype
(d) chromosome complement
(e) nucleosome
(f) chromatin
(g) lectotype

168. Which of the following statements are true regarding complete selection against recessive genes in a large diploid population?
(a) lethal recessive genes are difficult to remove from diploid populations
(b) lethal recessive genes are quickly removed from haploid populations
(c) lethal recessive genes are passed on by heterozygous carriers
(d) lethal recessive genes completely disappear after 99 generations
(e) the ratio between dominant and recessive genes remains constant
(f) all of the above statements are true

(g) all of the above statements are true except choice (b)
(h) all of the above statements are true except choices (d) and (e)

169. A normally pigmented couple have an albino child. What is the fractional probability that their next two children will be normally pigmented but carriers of albinism?
(a) 1/4 (b) 1/2 (c) 1/8 (d) 3/8 (e) 1/16 (f) 3/16 (g) 1/30 (h) 1/70

170. The frequency of albinism in the U.S population is approximately one in 20,000 births. What is the fractional probability that a person with normal skin pigmentation carries the recessive gene for albinism?
(a) 1/4 (b) 1/2 (c) 1/8 (d) 3/8 (e) 1/16 (f) 3/16 (g) 1/30 (h) 1/70

171. Which of the following biological principles states that the relative frequencies of genotypes and phenotypes in large, randomly mating populations tend to remain constant from generation to generation. This of course excludes selection against certain genes, mutations, and interbreeding with different populations or races:
(a) Mendel's Laws of Genetics
(b) Hardy-Weinberg Law
(c) Law of Differential Migration
(d) Immigration is Inversely Proportional to Emigration
(e) Jacob-Monod Theory
(f) Law of Independent Assortment
(g) Theory of Acquired Characteristics

Questions 172 - 173:

The following fractional choices refer to questions 172 - 173:

(a) 2^2 (b) 2^3 (c) 2^4 (d) 2^6 (e) 2^{20} (f) 2^{40} (g) 2^{60}

(h) 20^2 (i) 20^3 (j) 20^4 (k) 20^6 (l) 20^{20} (m) 20^{40} (n) 20^{60}

172. How many squares in a genetic checkerboard (Punnet square) would be needed for a cross between parents each with 20 pairs of heterozygous genes. Assume that all the genes occur on separate chromosomes, there is no crossing over, and there are only two possible alleles per locus?

173. How many squares in a genetic checkerboard (punnet square) would be needed for a cross between parents each with 20 pairs of heterozygous genes. Assume that all the genes occur on three pairs of homologous chromosomes, there is no crossing over, and there are only two possible alleles per locus?

Questions 174 - 176:

The following questions refer to a cross between a diploid radish and a diploid cabbage, each with a haploid number of nine chromosomes.

(a) 1	**(b) 2**	**(c) 4**
(d) 8	**(e) 12**	**(f) 16**

(g) 32 **(h) 36** **(i) 64**

174. How many haploid sets of chromosomes are contained in a cell from a sterile bigeneric rabbage (the offspring from this cross)?

175. How many sets of chromosomes are contained in a cell from a fertile bigeneric rabbage. (the offspring from this cross)?

176. What is the chromosome number of a tetraploid rabbage (i.e. how many chromosomes are contained in a cell from a tetraploid rabbage)?
