Key: If a Q has *, see last page

HEREDITY (B) Key

GENETIC CROSSES

In minks, a single gene controls coat color. The allele for a brown (B) coat is dominant to the allele for silver-blue (b) coats.

1. A homozygous brown mink was crossed with a silverblue mink. There were 9 offspring in the F1 generation. What color were they? Brown
2. Two of the offspring from the F1 generation above were mated. What would the ratio of brown to silverblue offspring be in the F2 generation? 3:1
3. What is the genotypic ratio of the F2 generation? 1 BB:2 Bb:1 bb

In domestic cats, the gene for Tabby stripes (T) is dominant over the gene for no stripes (t)

4. If a breeder crossed a heterozygous Tabby cat with a stripeless cat, what percent of the F1 generation would have tabby stripes? 50 %

OOmpas generally have gray faces, which is caused by a dominant gene. The recessive condition results in an orange face.

5. Two heterozygous OOmpahs are crossed. What proportion of the offspring will have orange faces? 25%

Colorblindness is a sex-linked trait. A woman, whose mother is colorblind and whose father has normal vision marries a normal visioned man.

6. What is the woman's genotype? X^C X^c
7. What is the woman's phenotype? Normal
8. What is the chance that her first offspring will be colorblind if male? 50%
9. What is the chance that her first offspring will be colorblind if female? 0%

GENETIC CROSSES (cont'd)

In humans, there are four types of blood; type A, type B, type AB, and type O.

10. What possible genotypes will produce B type blood? I^B I^B / I^B i
11. What is the only genotype that will produce O type blood? ii
12. What is the only genotype that will produce AB type blood? I^A I^B

You are blood type O, and your partner is blood type AB.

13. Complete a Punnett square for the cross. **
14. List the possible phenotypes of the offspring. **

In the 1950's, a young woman sued film star/director Charlie Chaplin for parental support of her illegitimate child. Charlie Chaplin's blood type was already on record as type AB. The mother of the child had type A and her son had type O blood.

15. Complete the Punnett square for the cross between the mother of the child and Charlie Chaplin. **
16. The judge ruled in favor of the mother and ordered Charlie Chaplin to pay child support costs of the child. Was the judge correct in his decision based on blood typing evidence? Explain why or why not. Refer to any Punnett squares to support your answer **

HEREDITY (B)

Suppose a newborn baby was accidentally mixed up in the hospital. In an effort to determine the parents of the baby, the blood types of the baby and two sets of parents were determined. Baby 1 had type O Mrs. Brown had type B Mr. Brown had type AB. Mrs. Smith had type B Mr.Smith had type B.

17. Draw the Punnett squares for each couple. **
18. To which parents does the baby belong? Refer to the Punnett squares in your justification. **

A man with type B blood marries a woman with type A blood. They have the first child with blood type O.

19. What are the genotypes of the mother and the father? **
20. Draw the Punnett square of the cross of the couple **
21. What is the genotype and phenotype of the baby? **

A cross between red-flowered snapdragons and white-flowered snapdragons produces offspring with pink flowers. Let R = red flowers and W = white flowers.

22. What is the genotype of a plant with a phenotype of red flowers? RR
23. What is the phenotype of a plant with a genotype of RW? Pink

Suppose a pink-flowered plant is crossed with a pink-flowered plant.

24. Draw the Punnett Square. **
25. What are the possible genotypes and phenotypes of the offspring? RR (Red) / RW (Pink) / WW (White)
26. What ratio of the offspring will have pink flowers? 50%
27. What ratio of the offspring will have red flowers? 25%

DNA REPLICATION AND STRUCTURE

28. DNA molecules are part of what class of macromolecule? Nucleic Acids
29. DNA molecules are made of monomers, termed Nucleotides ?
30. The monomer is made of what parts? Nitrogenous Base, Phosphate(PO4 (3-)), Sugar(2'-deoxyribose)
31. DNA replication is crucial to the advancement of a cell in the cell cycle. In what stage does a cells **chromosomal** DNA go through replication? S - phase
32. What is the principal enzyme that is responsible for DNA replication? DNA Polymerase (III)
33. DNA replication is directional. In what direction does it occur? How does this differ for the two strands? 5' -> 3' The 3' strand is leading because it is continuous, 5' lagging, discontinuous.
34. What enzyme is responsible for unwinding the supercoil? Topoisomerase
35. What enzyme is responsible for unzipping the double helix? Helicase
36. What is the name of the shape created after DNA is unzipped? Replication Fork
37. The leading strand has simple replication. The lagging strand has a more complicated set of reactions that replicate it. It is synthesized in pieces. What are these pieces called? Okazaki fragments
38. The template strand is 5'ATTGATCCTAGTCA3'. What will the replicated strand be? 3' T A A C T A G G A T C A G T 5'

MITOSIS AND MEIOSIS

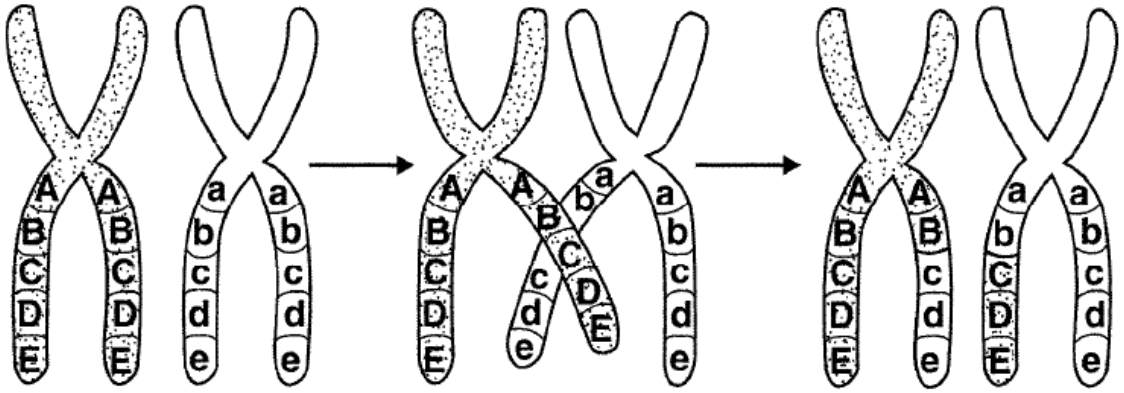
39. Mitosis occurs in what kinds of cells? Somatic cells; non-germ line cells.
40. Mitosis is split into many stages. Name the 5 major stages (exclude prometaphase in all answers). Prophase, Metaphase, Anaphase, Telophase, Cytokinesis*
41. How many times does DNA replicate during the cell cycle and mitosis? Twice; once in S phase, once during mitosis

* Cytokinesis is not technically part of mitosis. However, if a note regarding this is written, it will be awarded credit. In addition, if the student specifies that G2 of interphase is part of mitosis, full credit should still be awarded.

HEREDITY (B)

42. How many times do the cells divide in mitosis? Once
43. What is the ploidy of a human's parent cell? 2n
44. What will the ploidy be of the daughter cells? 2n
45. What is the main purpose of mitosis? Cell replication; growth etc.
46. Which of the following happens when a cell divides?
    a) The cell's volume increases.
    b) It becomes more difficult for the cell to get enough oxygen and nutrients.
    c) The cell has DNA overload.
    d) Each daughter cell receives its own copy of the parent cell's DNA.

47. Which pair is correct?
    a) G1 phase, DNA replication
    b) G2 phase, preparation for mitosis
    c) S phase, cell division
    d) M phase, cell growth
48. When during the cell cycle is a cell's DNA replicated?
    a) G1 phase
    b) G2 phase
    c) S phase
    d) M phase
49. Which event occurs during interphase?
    a) The cell grows.
    b) Centrioles appear.
    c) Spindle fibers begin to form.
    d) Centromeres divide.

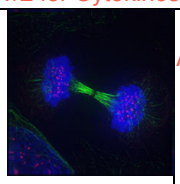


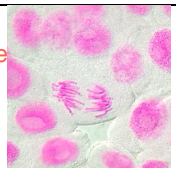
50. (**Refer to previous diagram**) What is shown in the figure?
    a) Independent assortment
    b) Anaphase I of meiosis
    c) Crossing-over
    d) Replication

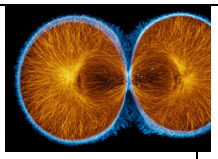
HEREDITY (B)

For the following images, write down the stage of mitosis the cell is in.

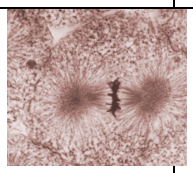
Telophase; 1/2 for Cytokinesis

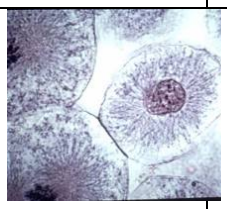
51. 

52. 
Anaphase

53. 
Cytokinesis

54. 
Metaphase

55. 
Metaphase

56. 
Prophase

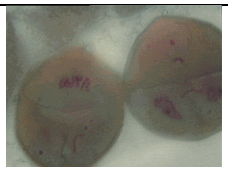
57. During what phases are there chromatids?
Prophase, Metaphase

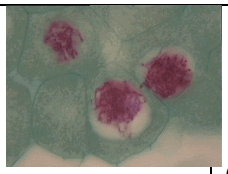
58. During what phases are there chromosomes?
Anaphase until Prophase

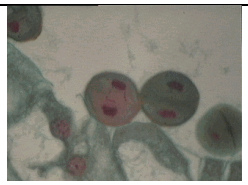
59. **Short Answer:** Distinguish and Explain the following terms briefly
   a) Chromatin The DNA/histone complex of DNA found in the nucleolus.
   b) Chromosomes Condensed chromatin in the X pattern
   c) Chromatid Half of a chromosome
   d) Sister vs nonsister chromatid Sister = part of same chromosome. Non-sister = homologous chromosome
   e) Homologous Chromosomes Chromosomes at the same position (ie: Chromosome 10 in humans)
   f) Asters Center from which spindles extend
   g) Telophase vs Cytokinesis Telophase = nuclear division, Cytokinesis = cytosolic/cytoplasmic division
   h) Histone proteins Proteins around which the DNA of chromosomes attaches

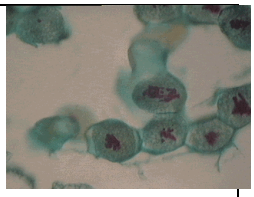
For the following images, state what phase of meiosis the cell is in.

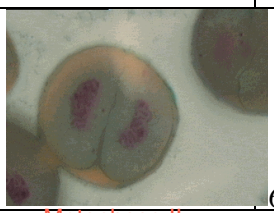
Only questions 61, 62, 63, and 65 counted for credit; the rest are hard to determine

60. 
Metaphase I

61. 
Prophase II

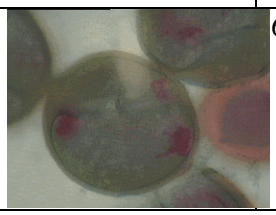
62. 
Anaphase II

63. 
Telophase II

64. 
Metaphase II

Interkinesis

65. 

66. 

67. List which question numbers have images from meiosis II.

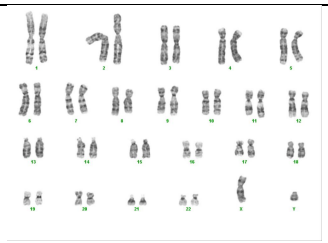
68. Explain the following terms briefly
   a) Meiosis I vs II Meiosis 1 is reduction (2 haploid cells); Meiosis 2 is replication (4 haploid cells)
   b) Ploidy before and after 2n X 1 -> 1n X 4
   c) Meiosis purpose and Mitosis purpose

Purpose of Meiosis = gamete formation
Purpose of Mitosis = growth; differentiation

HEREDITY (B)

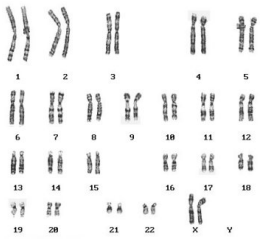
For Questions 51 and 52, write the gender on your answer sheet. For Questions 53-58, label the nondisjunction disorder on your answer sheet.

69.



Male

70.

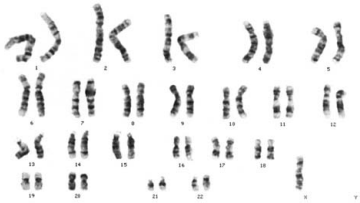


Female

71.

Trisomy 18

72.

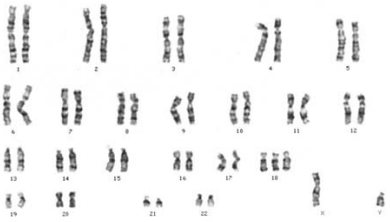


XO/Turner's Syndrome

73.

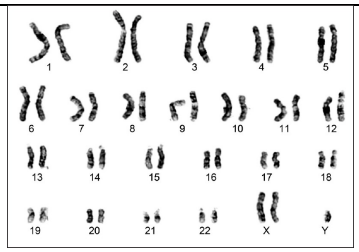
Trisomy 21

74.



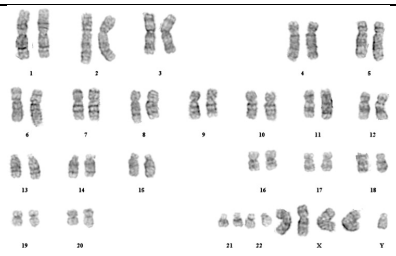
Trisomy 18

75.



XXY/Klinefelters

76.

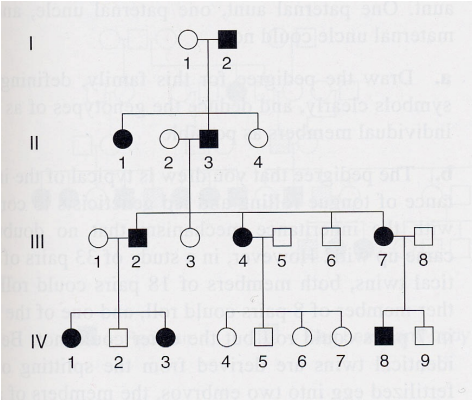


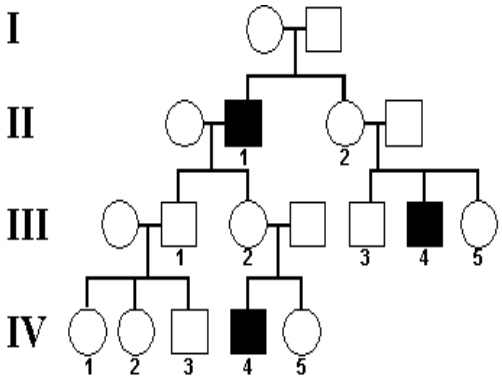
Trisomy 21 + XXXXY (Poly X)

77. What is the apparent gender of the karyotype in Question 34?

HEREDITY (B)

Pedigree Analysis





78. Referring to the above pedigree (left), the inheritance of the disease by II-3 rules out what type of inheritance? Why? X-linked b/c received disease from father, and X from mother
79. Referring to the above pedigree (right), what is the type of inheritance imaged?

X-linked recessive

Essay Questions (tie breakers)

62. Discuss Mendel's laws of segregation and independent assortment. Explain how the events of meiosis I account for the observations that led Mendel to formulate these laws. (10 pts)

63. Meiosis reduces chromosome number and rearranges genetic information. (10 pts)
    a) Explain how the reduction and rearrangement are accomplished in meiosis.
    b) Several human disorders occur as a result of defects in the meiotic process. Identify ONE such chromosomal abnormality; what effects does it have on the phenotype of people with the disorder? Describe how this abnormality could result from a defect in meiosis.

Question 62: Scoring Rubric

A. MENDEL'S LAWS

FACTORS (genes or alleles) in pairs / 2 alleles per trait (1)
FACTORS (alleles, genes)
dominant or recessive; or (1)
maternal + paternal origin; or (1)
heterozygote has 2 types. (1)
EXAMPLES (A, a; green, yellow, Punnett square) or monohybrid cross (1)
FIRST LAW EXPLAINED: segregation of alleles into gametes (1)
SECOND LAW EXPLAINED: independent assortment;
each pair assorts independently of other pairs (1)
EXAMPLE of dihybrid cross (or Punnett square) (1)
ONLY OCCURS WITH UNLINKED GENES; CROSSOVER EXCEPTIONS (1)
(max 6)

B. MEIOSIS I

GAMETES FORMATION (reduction division for purpose of maintaining chromosome #) (1)
GENES (traits, alleles) are on chromosomes (1)
HOMOLOGOUS CHROMOSOMES PAIR (dyad, bivalent, tetrad used in context) (1)
PAIRING OCCURS DURING PROPHASE I (1)
SYNAPSIS (synaptonemal complex, chiasmata) (1)
may related chiasma to crossover
INDEPENDENT ASSORTMENT due to independent alignment at metaphase I (1)
PAIRS SEGREGATE AT ANAPHASE I (1)
DAUGHTER NUCLEI AFTER MEIOSIS I have one of each chromosome type (each 2 chromatids) (1)
(may relate to Punnett square)
PHASES OF MEIOSIS I: prophase, metaphase, anaphase, telophase - in correct order
some description of each, for example:
prophase : organization
metaphase : line up at equator
anaphase : segregation
telophase : 2 "nuclei" (1)
(max 6)

Question 63: AP Biology released 2004 question:

for key, refer to link: http://apcentral.collegeboard.com/apc/members/repository/ap04_sg_biology_37082.pdf

Punnett Squares

13. $ii \times I^A I^B$

	I^A	I^B
i	$I^A i$	$I^B i$
i	$I^A i$	$I^B i$

14. Type A or B blood.

15. ~~A B × A O~~

$I^A I^B \times I^A i$

	I^A	I^B
I^A	$I^A I^A$	$I^A I^B$
i	$I^A i$	$I^B i$

16. No possibility of an ii genotype

17. Brown I^B I^B/i × Smith I^B I^B/i (i)

	I^B	I^B/i
I^A	$I^A I^B$	$I^A I^B$ / $I^A i$
I^B	$I^B I^B$	$I^B I^B$ / $I^B i$

	I^B	I^B/i
I^B	$I^B I^B$	$I^B i$ / $I^B I^B$
I^B/i	$I^B I^B$ / $I^B i$	$I^B I^B$ / $I^B i$ / $i I^B$ / ii

18. The Baby Belongs to Smiths.

19. Mom: $I^A i$ Dad: $I^B i$

20.

	I^B	i
I^A	$I^A I^B$	$I^A i$
i	$I^B i$	ii

21. Type O; ii

24.

	R	W
R	RR	RW
W	RW	WW