NAME_____

DATE_____PERIOD_____

CHROMOSOMAL THEORY OF INHERITANCE

The Theory:

Genes are located on chromosomes

Chromosomes segregate and independently assort during meiosis

Evidence:

Cytologists:	**Geneticists:**
1879 - Mitosis worked out 1890 - Meiosis worked out	1860 - Mendel proposed laws of segregation & independent assortment 1900 - Mendel's work rediscovered

Sutton & Boveri:

1902

Identified parallels b/w Mendel's factors & behavior of chromosomes

Work led to chromosomal theory of inheritance

Linkage:

- Genes located on same chromosome are inherited together
- Do NOT assort independently

Genetic Recombination:

Production of offspring with different traits that parents

Recombination of Unlinked Genes

YyRr x yyrr (yellow round x green wrinkled)

1/4 yellow round
1/4 green wrinkled — Parent types (50%)
1/4 yellow wrinkled
1/4 green round — Recombinants (50%)

Recombination of Linked Genes

Gray normal winged fly x Black vestigial winged fly
(b+bvg+vg) (bbvgvg)

b+ = gray
= black

vg+ = normal wings b
vg = vestigial wings

Phenotype	Expected if Unlinked	Expected if Linked	Actual
Black normal	575		206
Gray normal	575	1150	965
Black vestigial	575	1150	944
Gray vestigial	575		185
Total	2300	2300	2300

Recombination Frequency

$$\frac{\text{\# of recombinants}}{\text{Total}} = \frac{206 + 185}{2300} = 17\%$$

Conclusion

- Genes are linked, but not totally
- Incomplete linkage is due to crossing over during meiosis

Genetic Maps

Use recombination freq. to develop chromosome map

Data	
Loci	Recombination Frequency
b – vg	17%
cn – b	9%
cn – vg	9.5%

1st b----------17----------vg

2nd cn----------9----------b

3rd Possibility #1 cn----------9----------b----------17----------vg

Possibility #2 b----------9----------cn----------9.5----------vg

Conclusion – rule out possibility #2 because distance between b and vg is 17…cannot be 18.5; no double cross overs

Sex Linkage Or X-linkage

Males:	Females:
XY	XX

Sry Gene:

- Sex determination region
- On Y chromosome
- Triggers events that lead to testicular formation

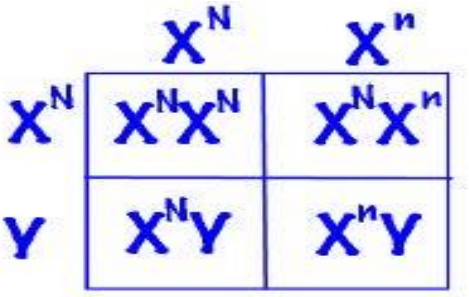
Sex Linked Disorders

Ex. Colorblindness

X^N = normal vision

X^n = colorblind

X^NX^n x X^NY



- Colorblind son the X^n came from Mom
- Affected males get X^n from Mom

Affected females get one X^n from Mom and 1 from Dad • More males affected than females

Females XX

- 1 of X inactive (forms barr body)
- Inactivation happens during embryonic development
- Inactivation random • Females mosaics of 2 cell types
  - ▶ Parental X inactive
  - ▶ Maternal X inactive

QUESTIONS:

15.1

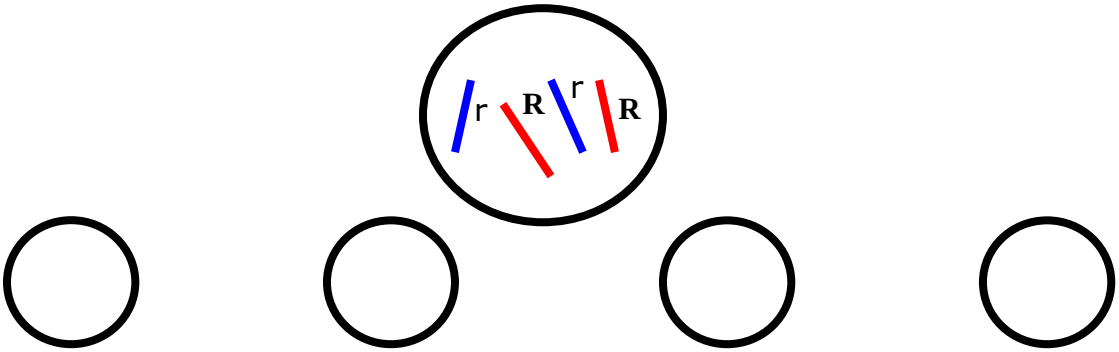
1. What is the *chromosome theory of inheritance?*

_____

_____

2. Explain the *law of segregation*. Use two different colored pencils to illustrate the segregation of alleles. You may want to consult Figure 15.2 in your text, and model your sketches on this.

F_1 Parent Cell



Haploid Gametes

3. Explain the *law of independent assortment*. To demonstrate that you understand this concept, consider a cell with two pairs of chromosomes. Sketch the two different ways these chromosomes might be arranged during metaphase I.

4. Give three reasons fruit flies are great subjects for genetic studies.

1. _____

2. _____

3. _____

5. The notation for *wild type* and *mutant* traits follows some accepted conventions. Notate the following genotypes for a female fruit fly:

   a. a fly homozygous for red eyes _____

   b. a fly heterozygous for red eyes _____

   c. a fly homozygous for white eyes _____

6. When Thomas Hunt Morgan mated a white-eyed male fly with a red-eyed female, he came to the startling conclusion that the trait for eye color was located on the chromosome that determines sex. Show this cross. Begin with the parental generation, and go through the F_2.

parental generation

F_1 generation

F_2 generation

7. What unusual result suggested that the eye-color trait is located on the X chromosome?

_____

15.2

8. Why is the human male considered to be the heterogametic sex?

_____

Why is the human female the homogametic sex?

_____

9. What is the function of the *SRY* gene?

_____

_____

Where is it found?_____

10. Define sex-linked disorders and give examples of those found in humans.

Definition:_____

_____

Examples:_____

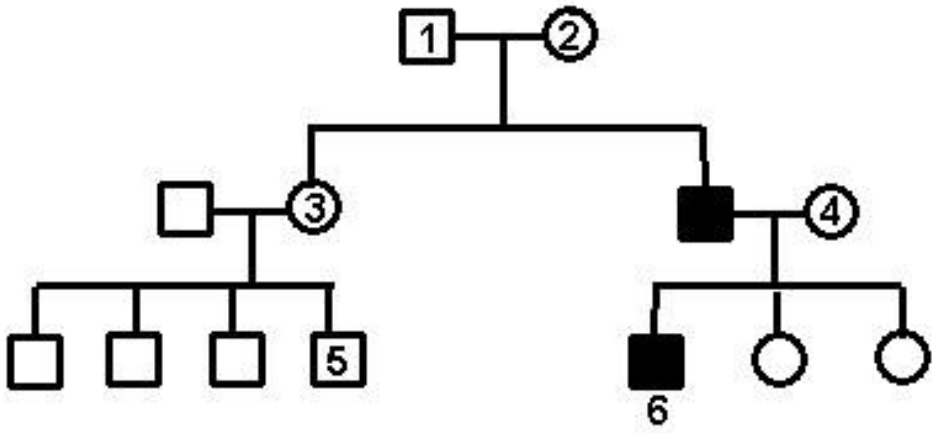
11. From which parent do sons get their sex-linked alleles?_____

From which parent do daughters get their sex-linked alleles?_____

12. Why do sex-linked disorders appear more often males than in females?

_____

13. Two normal color-sighted individuals produce the following children and grandchildren. Determine the probable genotype for the indicated individuals. Remember colorblindness is a sex-linked trait. X^N = normal allele; X^n = colorblind allele; XX = female; XY = male.



1._____ 2._____ 3._____

4._____ 5._____ 6._____

14. A woman is a carrier for a sex-linked lethal gene that causes spontaneous abortions. She has nine children. How many of these children do you expect to be boys?

_____

15. The normal daughter of a man with hemophilia marries a man who is normal for the trait.

a. What is the probability that a daughter will be a hemophiliac?

_____

b. What is the probability that a son will be a hemophiliac?

_____

d. If the couple has four sons, what is the probability that all four sons will be born with hemophilia?

_____

16. Red-green color blindness is caused by a sex-linked recessive allele. A colorblind man marries a woman with normal vision whose father was color-blind.

a. What is the probability that they will have a color-blind daughter?

_____

b. What is the probability that their first son will be color-blind. NOTE: This question is worded slightly different from the first.

_____

17. What are Barr bodies?

_____

_____

18. Explain what it means when females are referred to a mosaic of two cell types?

_____

_____

_____

What are two examples of this mosaicism in females?

_____

15.3

19. What are *linked genes?* Do linked genes sort independently? Explain

_____

_____

20. If two genes are linked on the same chromosome, we call this combination the *parental combination*. These genes will be transmitted as a unit and will not sort independently. However, during meiosis, *crossing over* occurs between homologous chromosomes, and the linked genes can become "unlinked." In general, the farther two genes are from each other along the chromosome, the more often they will come "unlinked." *Genetic recombination* is the process during which linked genes become unlinked. What do geneticists call the offspring that show these new combinations?

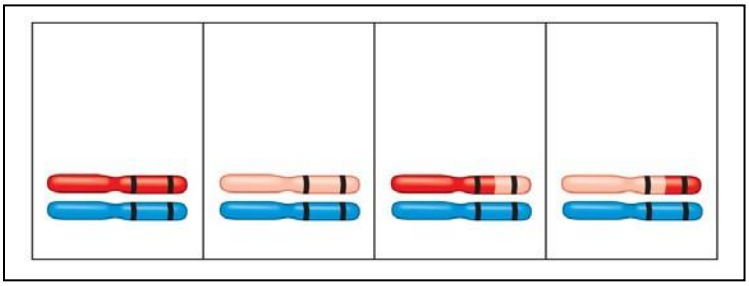
_____

21. *Alfred H. Sturtevant*, a student of Thomas Hunt Morgan, used assumptions from observations of crossovers to map genes. What is a *linkage map*?

_____

22. What is a *map unit*? _____

23. Use the figure below, which is from Figure 15.10. It shows the results of a cross between a fruit fly that is heterozygous for gray body with normal wings, and a fruit fly that has a black body with vestigial wings. Because these genes are linked, the results are not what might have been predicted. Show the phenotypes and number of each type of offspring. Indicate which offspring are the recombinants and which are the parental type. Finally, calculate the map distance between the two genes. Show all your work here.



24. A wild-type fruit fly (heterozygous for gray body color and normal wings) was mated with a black fly with vestigial wings. The offspring gave the following distribution: wild type, 778; black-vestigial, 785; black-normal, 158; gray vestigial, 162.

    a. What are the genotypes of the recombinants?

    _____

    b. What is the recombination frequency between the genes for body color and wing type? Show your work.

25. In guinea pigs, black (B) is dominant to brown (b), and solid color (S) is dominant to spotted (s). A heterozygous black, solid-colored pig is mated with a brown, spotted pig. The total offspring for several litters is:

Black solid	16	Black spotted	5
Brown solid	5	Brown spotted	14

    a. Calculate the recombination frequency for the cross. Show your work.

b. Are these genes linked or nonlinked?_____

c. How do you know?_____

26. The following recombination frequencies were found. Determine the order of these genes on the chromosome.

a—c 10% b—c 4% c—d 20% a—d 30% b—d16%
a—e 6% b—e 20%

---

27. Spottedness, coloredness, antennae length, and fur type are traits found in tribbles. The key below represents the alleles for these traits:

S = spotted	s = solid color
C = colored	c = white
L = long antennae	l = short antennae
F = fuzzy fur	f = curly fur

The chart below shows the results of crosses performed by a team of geneticists on the starship Enterprise C.

Cross #	Parents	Offspring
1	Heterozygous spotted long antennae X Solid short antennae	753 spotted long 748 solid short 151 spotted short 150 solid long
2	Heterozygous colored fuzzy fur X White curly fur	853 colored fuzzy 848 white curly 861 colored curly 840 white fuzzy
3	Heterozygous colored long antennae X White short antennae	500 colored long 503 white short 56 colored short 60 white long
4	Heterozygous colored spotted X White (solid colored)	1069 colored spotted 1074 white (solid colored) 85 colored solid 76 white spotted (spots appear as light gray patches)

a. Calculate the recombination frequency for each cross. Show your work.

Cross #1 Calculations	Cross #2 Calculations

Cross #3 Calculations	Cross #4 Calculations

b. Are all four genes found on the same chromosome? Explain.

_____

_____

_____

c. For the genes that are found on the same chromosome, in what sequence are they found on the chromosome?

_____

15.4

28. Define nondisjunction.

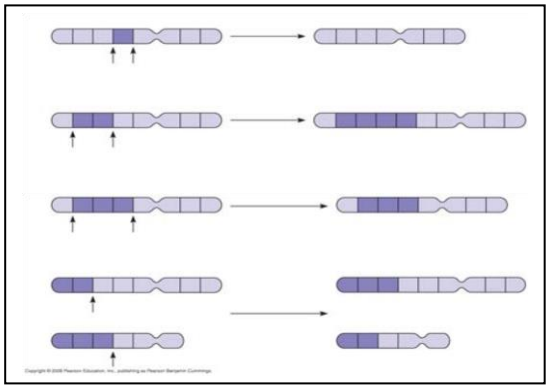
_____

29. Identify the type of chromosomal alteration being described in each of the following statements. Use the key below to indication your answers.

A.	Aneuploidy	B.	Deletion
C.	Duplication	D.	Inversion
E.	Polyploidy	F.	Translocation

_____ A piece of a chromosome breaks off and is lost
_____ A piece of a chromosome breaks off and reattaches to the same chromosome, but in a reversed orientation.
_____ An extra chromosome
_____ An extra complete set of chromosomes
_____ A piece of chromosome 5 breaks off and attaches to chromosome 7
_____ A piece of a chromosome breaks off and attaches to the end of its sister chromatid.
_____ An individual with a 2n+1 chromosome number
_____ An individual with a 4n chromosome number
_____ The gene sequence on chromosome is ABCDEFG before the alteration and a sequence of ADCBEFG after.
_____The gene sequence on a chromosome is ABCDEFG before the alteration and ABCDABCDEFG after.
_____ The gene sequence on a chromosome is ABCDEFG before the alteration and ABCDEF after.

18. Chromosome structure can be altered in several ways. Label each type of alteration (deletion, duplication, inversion, translocation) shown in this figure, and explain what occurs.



18. What is the relationship between maternal age and the incidence of Down's syndrome? What are the four characteristics of this syndrome?

_____
_____

19. Complete the following chart comparing the types of human disorders or syndromes related to chromosomal abnormalities.

Name of Disorder or Syndrome	Chromosomal Alternation Involved	Symptoms or Associated Traits
	Trisomy 21	
		Sterility, small testes, feminine body contours, normal intelligence or mental retardation
Turner Syndrome		
	Deletion in Chromosome 5	
Metafemales		
CML		

15.5

20. Define genomic imprinting

_____

_____

21. What evidence is used to support genomic imprinting occurs?

_____

_____

_____

_____

_____

28. Although you inherited one chromosome of each pair from your mother and your father, you have inherited a group of genes from your mother only. What genes are these? _____

29. You should have identified mitochondrial DNA as the correct response to question 28 above. What other organelle has its own genes? These are *extranuclear genes*. _____

22. Is the following statement true or false? "All the genes that are found in your cells are located in the nucleus on the chromosomes." Provide evidence to support your answer.

_____

_____

_____

End of Chapter Synthesis and Evaluation Problems

1. Answer question 18 on page 304.

***Question #18 should be typed out, then answered in no more and no less than 100 to 150 words. Turn in separately to the tray. This is worth **20 points**! Do not plagiarize. Use your own words and thoughts…but, use vocabulary terms and ideas taught in this chapter!

Study Guide/ISN (20 points)

1. In your study guide book, review pages 110 to 113. . In your ISN, title a page as follows: **Chapter 15 Chromosomal Basis of Inheritance Must Know!** In one color, copy down the must know items listed on page 110 in study guide leaving space underneath to include in an different color a brief description, diagram, model, or pneumonic device that will help you study for the unit test and more importantly the AP Test in May.
2. **TEST PREP (covers chapters 13-15):** Answer Topic 4 questions on page 114-118 in study guide. Then, correct your answers. Pay special attention to any questions you missed and write a short explanation next to your wrong answer that explains the correct answer. This will really help you in seeing what you do and don't know, as well as, help you with retention of material.

Level 1

	Answers	Corrections	Notes
1.	_____	_____	
2.	_____	_____	
3.	_____	_____	
4.	_____	_____	
5.	_____	_____	
6.	_____	_____	
7.	_____	_____	
8.	_____	_____	
9.	_____	_____	
10.	_____	_____	
11.	_____	_____	
12.	_____	_____	
13.	_____	_____	
14.	_____	_____	
15.	_____	_____	
16.	_____	_____	
17.	_____	_____	
18.	_____	_____	
19.	_____	_____	
20.	_____	_____	
21.	_____	_____	
22.	_____	_____	

Level 2---show your work—use a different color to make corrections and notes

1.

2.

3.

	Answers	Corrections	Notes
4.	_____	_____	
5.	_____	_____	
6.	_____	_____	
7.	_____	_____	

Bozeman Science/ AP Biology/ISN (See Syllabus for format) **(20 points each)**

1. Chromosomal Inheritance (Big Idea 3)