Name: _____ ID#: _____

NORTH CENTRAL HIGH SCHOOL
NOTE & STUDY GUIDE

X Biology I

Unit 1-7: Genetics

Additional resources available at
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REQUIRED READING FROM BIOLOGY: CONCEPTS & CONNECTION (CAMPBELL, ET. AL.):
CHAPTER 9, PATTERNS OF INHERITANCE (PG. 152 - 179)
CHAPTER 11, HOW GENES ARE CONTROLLED (PG. 208 – 229)
CHAPTER 12, DNA TECHNOLOGY AND GENOMICS (PG. 230 – 253)

Grade Chart: (For Teacher Use Only)

Section	Assignment	Score (✓ or ☒)	Points (Out of)
1	LECTURE 1-6-1: Meiosis		10
2	Study Guide Part I, Meiosis		10
3	LECTURE 1-6-2: Intro to Genetics		10
4	Study Guide Part II, Intro to Genetics		10
5	Bikini Bottom Genetics Activity, Part I		20
6	Bikini Bottom Genetics Activity, Part II		
7	LECTURE 1-6-3: Genetic Crosses		10
8	Study Guide Part III, Genetics Crosses		10
9	Bikini Bottom Genetics Activity, Part III (Incomplete/Codominance)		20
10	Bikini Bottom Genetics Activity REDUX (Dihybrid Crosses)		
11	LECTURE 1-6-4: Heredity & Modern Genetics		10
12	Study Guide Part III, Heredity & Modern Genetics		10
	TOTAL *5/6 and 9/10 are separate grades (not included)*		80

NOTES: Meiosis & Gamete Formation

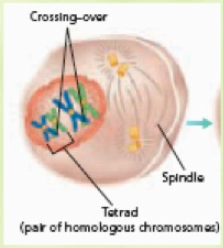
Objectives

Homologous Chromosomes

- _____ are 2 copies of a chromosome that contain the genetic information for the same traits.
- One half of a homologous pair is called an _____.
- During sexual reproduction, the offspring receives one autosome from each parent, creating a homologous pair.
- This means that the offspring gets _____the material from each parent.

The Phases of Meiosis

- Meiosis, like mitosis, occurs in distinct phases.
- _____ : The chromosomes coil and the nuclear membrane breaks down. Chromosomes pair up into _____ trough the process of **synapsis.**
- During prophase I parts of one chromosome can switch places with its sister chromosome. This is called _____.
- Crossing over leads to new genetic variations.

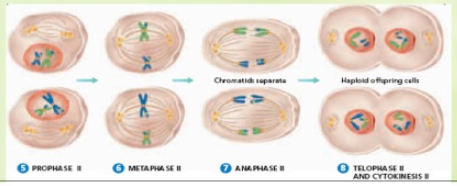


The Phases of Meiosis (Cont…)

- **Metaphase I**: The tetrads line up _____ at the center of the cell.
- **Anaphase I**: The chromosome pairs split and begin to move the the poles. The randomization of this process is called _____.
- **Telophase I**: Here, the chromosomes reach the poles and cytokinesis begins.

Meiosis II

- The meiotic process continues is the same phases a second time.
- The resulting cells are _____ because they have half the number of chromosomes as they started with.
- When a haploid cell fuses with another haploid cell, the resulting _____ is diploid.

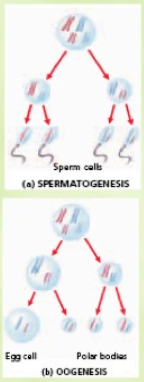


Gamete Production

- Meiosis is important for the production of **gametes**, or sexually reproductive cells like _____.
- If gametes were to be produced by mitosis then the following generation would have _____ the chromosomes of the preceding generation.
- Female gametes and male gametes are produced differently from each other.

Sperm & Egg Production

- _____ is the production of new sperms cells where one diploid cell gives rise to _____.
- _____ is the production of a new egg cell where one diploid cell gives rise to _____ haploid egg and 3 **polar bodies** (which are eventually destroyed.)



Similarities b/w Mitosis & Meiosis

- Mitosis and Meiosis are similar in the following ways:
  - They are both forms of _____.
  - The use roughly the same phases.
  - The main purpose of both is to create new cells that contain the _____ from the parent cell.
  - Both processes are asexual.

Differences b/w Mitosis & Meiosis

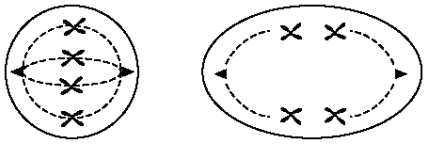
- Mitosis and Meiosis are different in the following ways:
  - Mitosis ends with 2 diploid copies (_____) of the parent cells and meiosis ends with 4 haploid cells (that are _____ from the parent cell with only half the chromosomes.)
  - The cells in mitosis copy their DNA before mitosis begins, but cells undergoing meiosis do not.
  - Mitosis occurs in one stage consisting of _____ phases and meiosis occurs in _____ stages of the same 4 phases.

Part II: Meiosis

____ 1. Separation of homologues occurs during

a. mitosis.
b. meiosis I.
c. meiosis II.
d. fertilization.

Diagrams 1 and 2 show cells from an organism with a diploid chromosome number of 4.



1 2

____ 2. Refer to the illustration above. Which of the cells will be a diploid cell at the completion of division?

a. 1
b. 2
c. Both
d. Neither

____ 3. Refer to the illustration above. Which of these cells is in the process of dividing to form gametes?

a. 1
b. 2
c. Both
d. Neither

____ 4. When crossing-over takes place, chromosomes

a. mutate in the first division.
b. produce new genes.
c. decrease in number.
d. exchange corresponding segments of DNA.

5. The stage of meiosis during which homologues line up along the equator of the cell is called _____.

6. After a new nuclear membrane forms during telophase of mitosis or meiosis, the _____ divides, resulting in two cells.

7. The process called _____ guarantees that the number of chromosomes in gametes is half the number of chromosomes in body cells.

8. A reciprocal exchange of corresponding segments of DNA is called _____.

9. The cells resulting from meiosis in either males or females are called _____.

10. As a result of spermatogenesis, four cells are produced that can all develop into sperm cells. As a result of oogenesis, only _____ cell(s) develop(s) into (an) egg cell(s).

11. Control of the cell cycle occurs at three main _____.

12. What would happen if the chromosome number were not reduced before sexual reproduction?

13. Compare the features of mitotic metaphase, meiotic metaphase I, and meiotic metaphase II. Write your answer in the space below.

14. Explain how offspring resulting from sexual reproduction differ from offspring resulting from asexual reproduction.

NOTES: Intro to Genetics

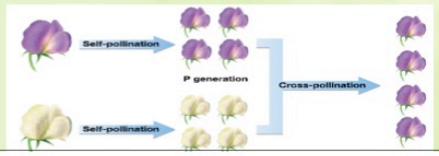
Objectives

Once Upon a Time…

- In 1843, a monk named _____ was in charge of the garden at his monastery.
- He began to make observations about the different _____ of pea plants (seed color, shape, height, etc…)
- Then he wondered what would happen if pollen from a pea plant with one trait would **cross-pollinate** a plant with a different trait.

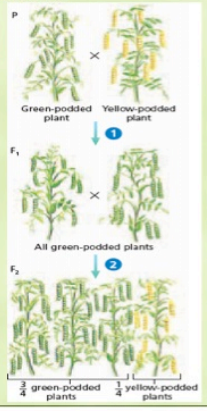
How Did He Do That?

- Mendel started with true-breeding, or purebred plants that, when self-pollinated, always produce offspring with the same trait.
- He then cross-pollinated plants with opposite purebred traits (purple flowers with white flowers.)
- The result was that the _____ all produced purple flowers.
- This indicated that the genetic code for purple was _____ because it overpowered the genetic code for white.



What Happened Next?

- Mendel then cross-pollinated the plants from the F_1 generation to for the F_2 generation and something changed.
- He got 75% purple flowers and 25% white flowers.
- The same thing happened with other traits, like pod color.
- This indicated that the _____ trait could resurface.
- It also indicated that all plants must have a pair of _____ for each trait.



Law of Segregation

- Mendel concluded that each parent must pass one gene for each trait to each of its offspring.
- This meant the genes for those traits must split during gamete production (_____) to give only one gene to each gamete.
- When 2 gametes fuse, the offspring would have one gene from the _____ parent and one from the _____ parent.
- This is known as the _____.

Law of Independent Assortment

- Mendel also crossed plants that had more than one trait different (EXAMPLE: purple flowers, with yellow pods and white flowers with green pods.)
- He discovered that while some plants expressed the dominant trait for one characteristic, they could express the recessive trait for another.
- This meant that the traits _____ _____ _____
- This is know as the **Law of Independent Assortment**.

What We Know Now

- Molecular genetics have supported Mendel's findings and has cleared up some of the confusion.
- We have learned that a code, or **genes**, for each trait can be found on the chromosomes.
- The alternative forms of a gene are called _____ (EXAMPLE: One allele is white flowers, the other allele is purple flowers.)
- We also know that some alleles are dominant and others are recessive, which means that when the dominant allele is present then that trait is always _____.

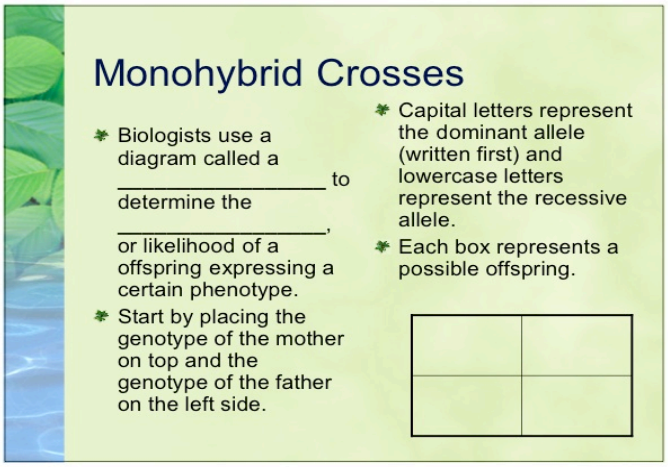
Genotypes

- A _____ is an organisms genetic make up (which alleles it has.)
- If an organism has 2 alleles that are the same (EXAMPLE: Purple Flowers & Purple Flowers), then they are called _____, or _____.
  - If the organism has 2 alleles for the dominant trait then they are _____ .
  - If the organism has 2 alleles for the recessive trait then they are _____ .
- If an organism has 2 different alleles (one dominant and one recessive), then it is called _____, or _____.

Phenotypes

- The genotype will determine which physical characteristic is expressed.
- The physical trait that is expressed by a specific genotype is called the _____.
- It is possible to predict the genotypes, and therefore the phenotypes of offspring if we know the genotype of both parents.

Genotype [Alleles]	Phenotype [Trait]
Heterozygous (Hybrid) [EX: Purple/White]	_____ [_____]
Homozygous Dominant (Purebred) [EX: Purple/Purple]	_____ [_____]
Homozygous Recessive (Purebred) [EX: White/White]	_____ [_____]



Part I: Fundamentals of Genetics

____ 1. The "father" of genetics was
a. T. A. Knight.
b. Hans Krebs.
c. Gregor Mendel.
d. None of the above

____ 2. Mendel obtained his P generation by allowing the plants to
a. self-pollinate.
b. cross-pollinate.
c. assort independently.
d. segregate.

____ 3. What is the probability that the offspring of a homozygous dominant individual and a homozygous recessive individual will exhibit the dominant phenotype?
a. 0.25
b. 0.5
c. 0.66
d. 1.0

____ 4. True-breeding pea plants always
a. are pollinated by hand.
b. produce offspring each of which can have multiple forms of a trait.
c. produce offspring each of which can have only one form of a trait.
d. are heterozygous.

____ 5. The first filial (F_1) generation is the result of
a. cross-pollination among parents and the next generation.
b. crosses between individuals of the parental generation.
c. crosses between the offspring of a parental cross.
d. self-fertilization between parental stock.

____ 6. Which of the following is the designation for Mendel's original pure strains of plants?
a. P
b. P_1
c. F_1
d. F_2

____ 7. The passing of traits from parents to offspring is called
a. genetics.
b. heredity.
c. development.
d. maturation.

____ 8. A genetic trait that appears in every generation of offspring is called
a. dominant.
b. phenotypic.
c. recessive.
d. superior.

____ 9. homozygous : heterozygous ::
a. heterozygous : Bb
b. probability : predicting chances
c. BB : Bb
d. homozygous : BB

____ 10. Mendel's finding that the inheritance of one trait had no effect on the inheritance of another became known as the
a. law of dominance.
b. law of universal inheritance.
c. law of separate convenience.
d. law of independent assortment.

____ 11. The law of segregation explains that
a. alleles of a gene separate from each other during meiosis.
b. different alleles of a gene can never be found in the same organism.
c. each gene of an organism ends up in a different gamete.
d. each gene is found on a different molecule of DNA.

____ 12. When Mendel crossed pea plants that differed in two characteristics, such as flower color and plant height,
a. these experiments led to his law of segregation.
b. he found that the inheritance of one trait did not influence the inheritance of the other trait.
c. he found that the inheritance of one trait influenced the inheritance of the other trait.
d. these experiments were considered failures because the importance of his work was not recognized.

____ 13. The phenotype of an organism
a. represents its genetic composition.
b. reflects all the traits that are actually expressed.
c. occurs only in dominant pure organisms.
d. cannot be seen.

____ 14. If an individual has two recessive alleles for the same trait, the individual is said to be
a. homozygous for the trait.
b. haploid for the trait.
c. heterozygous for the trait.
d. mutated.

____ 15. An individual heterozygous for a trait and an individual homozygous recessive for the trait are crossed and produce many offspring. These offspring are likely to be
a. all the same genotype.
b. of two different phenotypes.
c. of three different phenotypes.
d. all the same phenotype.

16. In heterozygous individuals, only the _____ allele achieves expression.

17. The principle that states that one factor may mask the effect of another factor is the principle of _____.

18. In Mendel's experiments, a trait that disappeared in the F_1 generation but reappeared in the F_2 generation was always a _____.

19. The cellular process that results in the segregation of Mendel's factors is _____.

20. The portion of a DNA molecule containing the coded instructions that result in a particular characteristic of an organism is called a(n) _____.

21. An organism that has two identical alleles for a trait is called _____.

22. An organism's _____ refers to the set of alleles it has inherited.

23. The appearance of an organism as a result of its genotype is its _____.

25. Describe Mendel's observation regarding independent assortment. Write your answer in the space below.

26. Describe how genotype and phenotype are related, and give an example. Write your answer in the space below.

NOTES: Genetic Crosses

Objectives

Get'cha Some Vocab! (Review)

- A _____ is an organisms genetic make up (which alleles it has.)
- If an organism has 2 alleles that are the same (EXAMPLE: Purple Flowers & Purple Flowers), then they are called _____, or _____.
  - If the organism has 2 alleles for the dominant trait then they are _____ .
  - If the organism has 2 alleles for the recessive trait then they are _____ .
- If an organism has 2 different alleles (one dominant and one recessive), then it is called _____, or _____.
- The genotype will determine the _____, which is the physical characteristic expressed.

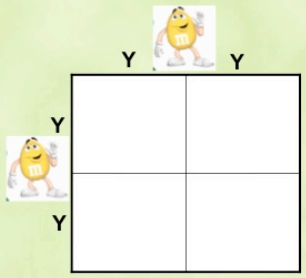
Predicting Traits

- Geneticists can predict the **probability** of genotypes and phenotypes of the offspring of specific parents using a **Punnett square**.
- This cross can show what traits are most likely to be expressed based on which trait is _____ and which trait is _____.
- To calculate probability: Take the number of offspring with the desired genotype or phenotype divided by the total number of offspring and multiple by 100%.

Probability = $\frac{\text{\_\_\_\_\_}}{\text{\_\_\_\_\_}}$ X 100%

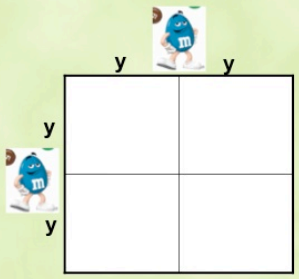
Homozygous X Homozygous (D)

- In this example, a homozygous dominant female mates with a homozygous dominant male.
- The offspring have a _____% chance of having a homozygous dominant genotype.
- The offspring will have a _____% chance of expressing the dominant phenotype.



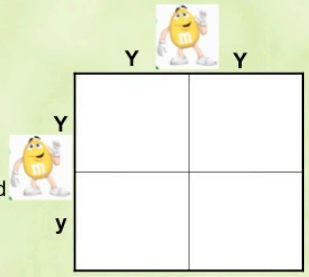
Homozygous X Homozygous (r)

- In this example, a homozygous recessive female mates with a homozygous recessive male.
- The offspring have a _____% chance of having a homozygous recessive genotype.
- The offspring will have a _____% chance of expressing the recessive phenotype.



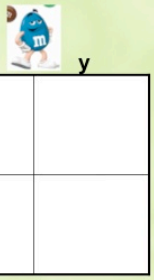
Homozygous (D) X Heterozygous

- In this example, a homozygous dominant female mates with a heterozygous male.
- The offspring have a _____% chance of having a homozygous dominant genotype and a _____% chance of having a heterozygous genotype.
- The offspring will have a _____% chance of expressing the dominant phenotype.



Homozygous (r) X Heterozygous

- In this example, a homozygous recessive female mates with a heterozygous male.
- The offspring have a _____% chance of having a heterozygous genotype and a _____% chance of having a homozygous recessive genotype.
- The offspring will have a _____% chance of expressing the dominant phenotype and a _____% chance of expressing the recessive phenotype.

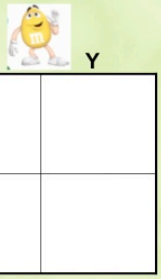


Heterozygous X Heterozygous

- In this example, a heterozygous female mates with a heterozygous male.
- The offspring have a _____% chance of having a homozygous dominant genotype, a _____% chance of having the homozygous recessive genotype, and a _____ % chance of having the heterozygous genotype..
- The offspring will have a _____% chance of expressing the dominant phenotype and a _____% chance of expressing the recessive phenotype.

Incomplete Dominance

- There are some instances when a heterozygote expresses a phenotype that is between multiple dominant traits.
- This is called _____.
- The result of incomplete dominance is a new trait that is a mix between the two possible traits.
- EXAMPLE:
  - YY = Yellow
  - BB = Blue
  - YB = Green



Codominance

- There are also times when there can 2 traits that are both dominant.
- In this case, both traits will be expressed and are _____.
- EXAMPLE:
  - YY = Yellow
  - GG = Green
  - YG = Reg & Green

	Y	Y
G		
G		

Dihybrid Crosses

- In a dihybrid cross, you are able to look at the probabilities of 2 traits appearing together in the offspring.
- Instead of the Punnett square consisting of 4 boxes (2 X 2), it consists of 16 boxes (4 X 4).
- Each box will contain 2 genotypes (one for each trait.)
- This illustrates the **Law of Independent Assortment**.
- Independent assortment happens as a result of meiosis (gamete production).
- All the possible gametes are listed on the sides of the punnett square and are carried through.

Practice With Dihybrid Crosses

- Y: Yellow
- y: Blue
- N: Peanut
- n: Plain
- Female:

YyNn
- Male:

YyNn

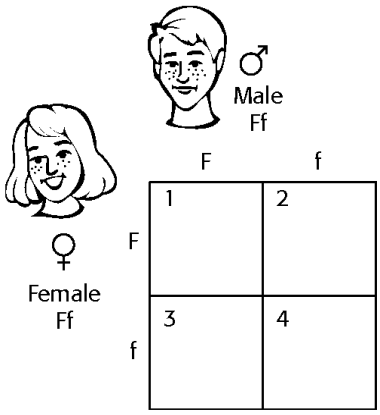
	YN	Yn	yN	yn
YN				
Yn				
yN				
yn				

Part II: Genetic Crosses

____ 1. Tallness (T) is dominant over shortness (t) in pea plants. Which of the following represents the genotype of a pea plant that is heterozygous for tallness?

a. T
b. TT
c. Tt
d. tt

In humans, having freckles (F) is dominant over not having freckles (f). The inheritance of these traits can be studied using a Punnett square similar to the one shown below.



____ 2. Refer to the illustration above. The genotype represented in box 1 in the Punnett square would

a. be homozygous for freckles.
b. have an extra freckles chromosome.
c. be heterozygous for freckles.
d. have freckles chromosomes.

____ 3. Refer to the illustration above. The genotype in box 3 of the Punnett square is

a. FF.
b. Ff.
c. ff.
d. None of the above

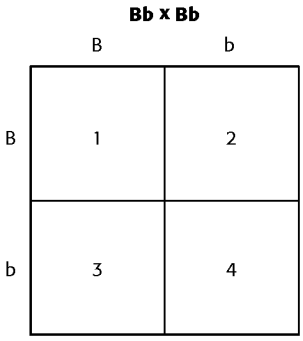
____ 4. A trait that occurs in 450 individuals out of a total of 1,800 individuals occurs with a probability of

a. 0.04.
b. 0.25.
c. 0.50.
d. 0.75.

____ 5. How many different phenotypes can be produced by a pair of codominant alleles?

a. 1
b. 2
c. 3
d. 4

In rabbits, black fur (B) is dominant over brown fur (b). Consider the following cross between two rabbits.



____ 6. Refer to the illustration to the right. The device shown, which is used to determine the probable outcome of genetic crosses, is called a

a. Mendelian box.
b. Punnett square.
c. genetic graph.
d. phenotypic paradox.

____ 7. Refer to the illustration to the right. Both of the parents in the cross are

a. black.
b. brown.
c. homozygous dominant.
d. homozygous recessive.

____ 8. Refer to the illustration above. The phenotype of the offspring indicated by box 3 would be

a. brown.
b. black.
c. a mixture of brown and black.
d. The phenotype cannot be determined.

____ 9. Refer to the illustration above. The genotypic ratio of the F_1 generation would be

a. 1:1.
b. 3:1.
c. 1:3.
d. 1:2:1.

____ 10. What is the expected genotypic ratio resulting from a homozygous dominant ´ heterozygous monohybrid cross?

a. 1:0
b. 1:1
c. 1:2:1
d. 1:3:1

____ 11. What is the expected genotypic ratio resulting from a heterozygous X heterozygous monohybrid cross?

a. 1:2:1
b. 1:3:1
c. 1:2
d. 1:0

____ 12. What is the expected phenotypic ratio resulting from a homozygous dominant X heterozygous monohybrid cross?

a. 1:3:1
b. 1:2:1
c. 2:1
d. 1:0

____ 13. An organism that has inherited two of the same alleles of a gene from its parents is called
a. hereditary.
b. heterozygous.
c. homozygous.
d. a mutation.

____ 14. In pea plants, yellow seeds are dominant over green seeds. What would be the expected genotype ratio in a cross between a plant with green seeds and a plant that is heterozygous for seed color?
a. 1:3
b. 1:2:1
c. 4:1
d. 1:1

____ 15. codominance : both traits are displayed ::
a. probability : crosses
b. heterozygous : alleles are the same
c. homozygous : alleles are the same
d. Punnett square : chromosomes combine

____ 16. The difference between a monohybrid cross and a dihybrid cross is that
a. monohybrid crosses involve traits for which only one allele exists, while dihybrid traits involve two alleles.
b. monohybrid crosses involve self-pollination, while dihybrid crosses involve cross-pollination.
c. monohybrid crosses involve one trait; dihybrid crosses involve two traits.
d. dihybrid crosses require two Punnett squares; monohybrid crosses need only one.

____ 17. A cross of two individuals for a single contrasting trait is called
a. monohybrid.
b. dihybrid.
c. dominant.
d. codominant.

____ 18. Refer to the illustration to the right. The phenotype represented by box 1 is
a. round, yellow.
b. round, green.
c. wrinkled, yellow.
d. wrinkled, green.

____ 19. Refer to the illustration to the right. The genotype represented by box 2 is
a. RRYY.
b. RrYY.
c. RrYy.
d. rrYy.

____ 20. Refer to the illustration above. Which of the following boxes represents the same phenotype as box 7?
a. 3
b. 4
c. 5
d. 6

	RY	Ry	rY	ry
RY	7		6	
Ry			1	3
rY		2	5	4
ry				

Pea plants

R = round seed
r = wrinkled seed
Y = yellow seed
y = green seed

21. The likelihood that a specific event will occur is called _____.

22. A fractional probability of 1/2 is the same as a decimal probability of _____.

23. A situation in which both alleles for a trait are expressed in a heterozygous offspring is called _____.

24. A table used to determine and diagram the results of a genetic cross is called a _____.

25. In genetics, lowercase letters are usually used to indicate _____.

26. A cross involving two pairs of contrasting traits is a(n) _____

27. Explain what is meant by homozygous and heterozygous, and give an example of each. Write your answer in the space below.

28. All of the offspring resulting from a cross between a red snapdragon and a white snapdragon are pink. What is a possible explanation for this? Write your answer in the space below.

NOTES: Heredity & Modern Genetics

Objectives

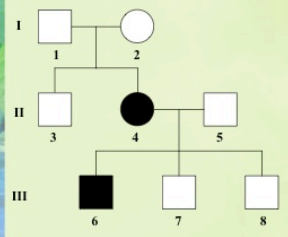
Heredity

- _____ explains how genetic material, and thus physical traits are passed on from parents to offspring.
- Parents give each offspring one-half of their homologous chromosomes.
- When the 2 parental gametes combine, the combination of the traits of the parents appear in the offspring following the _____
- It is possible to track the genotypes through multiple generations to see what inheritance patterns emerge.

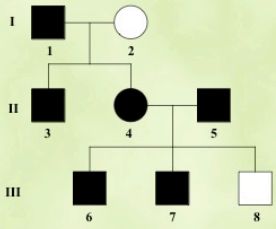
Pedigrees

- A _____ is a chart used to map out how a specific trait is inherited through multiple generations.
- There are simple rules on how to read a pedigree.
- On a pedigree chart there will be roman numerals at each row to represent generations.
- Numbers under each individual are used for reference.

Practice with Pedigrees



- What are the genotypes of each individual?



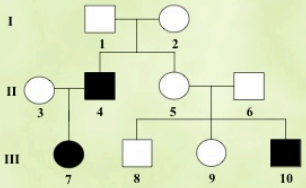
- What are the genotypes of each individual?

The Humble Fruit Fly

- In the early 1900's, Thomas Hunt Morgan was studying *Drosophila melanogaster*, the common fruit fly and noted a specific trend. (Male flies had a higher occurrence of white vs. red eyes.)
- He noticed that fruit flies had 3 pairs of chromosomes and in females they all looked similar, but in males one of the pairs differed.
- He had discovered "_____".
- In females, the last set of chromosomes were the same, meaning they had two _____ chromosomes.
- In males, the last set had one long chromosome ("_____") and one short chromosome ("_____")

Sex-Linked Traits

- Because of the difference in size, the X chromosome can contain instructions for certain traits that do not exist on the Y chromosome.
- Sex-Linked traits have a different inheritance pattern than traits on other chromosomes because _____ _____
- The genotypes for sex-linked traits are represented with X or Y and the letter that represents the trait as a superscript. (EX: _____ _____



- What are the genotypes of each individual?

Polygenic Traits

- Some traits are not simply expressed as either present or absent, but are expressed with _____ because there are multiple genes that code for the trait (EXAMPLE: Skin tone, hair color, height, etc.)
- In these traits, the more often the dominant trait appears in the series of genes that code for it, the closer the trait appears to the dominant trait.
- _____ often play a role in the expression of these traits (more sun=darker skin.)

Genes for Skin Tone		
Gene 1	B	B
Gene 2	B	b
Gene 3	B	b
Gene 4	B	B

Genes for Skin Tone		
Gene 1	B	B
Gene 2	b	b
Gene 3	b	b
Gene 4	B	b

Multiple Allele Traits

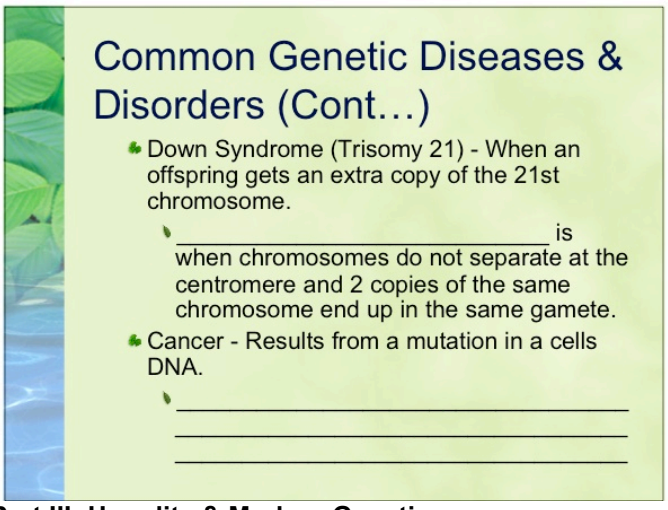
- Some genes have multiple alleles that can result from different genetic combinations (EXAMPLE: Blood type.)
- In this case, _____ _____
- We use a similar form of notation as sex-linked traits to display how these traits are expressed. (EX: I^AI^B or I^Ai).
- In the case of blood, the gene codes for which antigen in on the outside of the red blood cell, thus determining what blood can be transfused.

Possible Gametes from Dad	Possible Gametes from Mom: I^A	I^B	i
I^A			
I^B			
i			

- A Blood type
- B Blood type
- AB Blood type
- O Blood type

Common Genetic Diseases & Disorders

- There are many different diseases and disorders that result from variations in one's genetic code.
- There are different types of genetic diseases based on where they are and how they are expressed:
  - Color-blindness & Hemophilia - _____ _____
  - Huntington's Disease - _____ _____
  - Sickle-Cell Anemia - _____ _____



Part III: Heredity & Modern Genetics

____ 1. Down syndrome : nondisjunction ::
a. chromatids : centromere
b. male : XY chromosomes
c. haploid : mitosis
d. meiosis : diploid

____ 2. female : XX ::
a. female : gametes
b. female : eggs
c. male : YY
d. male : XY

____ 3. Which of the following is the best explanation for the observation that females rarely get the disease hemophilia?
a. Large quantities of male hormones are necessary in order for the allele carrying the disease to be expressed.
b. Female fetuses that carry the allele for the disease die before birth.
c. A female could get the disease only by having a mother who is a carrier and a father who has the disease. Since most males with the disease do not survive to reproductive age, this is an extremely unlikely event.
d. A female could get the disease only by having parents who are both carriers of the disease. Because females cannot be carriers, this is an impossible event.

____ 4. A change in a gene due to damage or incorrect copying is called
a. evolution.
b. meiosis.
c. segregation.
d. a mutation.

____ 5. A diagram in which several generations of a family and the occurrence of certain genetic characteristics are shown is called a
a. Punnett square.
b. monohybrid cross.
c. pedigree.
d. family karyotype.

____ 6. Which of the following traits is controlled by multiple alleles in humans?
a. sickle cell anemia
b. blood type
c. hemophilia
d. pattern baldness

____ 7. What would be the blood type of a person who inherited an A allele from one parent and an O allele from the other?
a. type A
b. type B
c. type AB
d. type O

____ 8. While studying several generations of a particular family, a geneticist observed that a certain disease was found equally in males and females and that all children who had the disease had parents who also had the disease. The gene coding for this disease is probably
a. sex-linked recessive.
b. sex-linked dominant.
c. autosomal recessive.
d. autosomal dominant.

____ 9. If a characteristic is sex-linked, it
a. occurs most commonly in males.
b. occurs only in females.
c. can never occur in females.

d. is always fatal.

____ 10. Since the allele for colorblindness is located on the X chromosome, colorblindness
a. cannot be inherited.
b. occurs only in adults.
c. is sex-linked.
d. None of the above

____ 11. People with Down syndrome have
a. 45 chromosomes.
b. 46 chromosomes.
c. 47 chromosomes.
d. no X chromosomes.

____ 12. The sex of an offspring is determined by
a. the mother.
b. the father.
c. both parents.
d. the offspring.

____ 13. If nondisjunction occurs,
a. there will be too many gametes produced.
b. no gametes will be produced.
c. a gamete will receive too many or too few copies of a chromosome.
d. mitosis cannot take place.

____ 14. Consider a cross between a homozygous white-eyed female *Drosophila* and a red-eyed male *Drosophila*. What proportion of the female offspring would be expected to be white-eyed? What proportion of the male offspring would be expected to be white-eyed?
a. none; all
b. 50%; 50%
c. all; none
d. none; 25%

15. The X and Y chromosomes are called the _____ chromosomes.

16. Spontaneous changes in genetic material are called _____.

17. A person who is heterozygous for a recessive disorder is called a(n) _____.

18. A genetic disorder resulting in defective blood clotting is _____.

19. A trait that is determined by a gene found only on the X chromosome is said to be _____.

20. The failure of replicated chromosomes to separate is called _____.

21. In humans, cystic fibrosis is caused by a recessive gene that is not sex-linked. A man and a woman, neither of whom has cystic fibrosis, have two children with the disease. What is the probability that their third child will have the disease?

22. What are the possible genotypes of children born to a man who has the genotype I^Ai for blood type and a woman who has the genotype I^AI^B? What are the possible phenotypes?

23. In humans, colorblindness is a recessive, sex-linked trait. What is the probability that the children of a woman heterozygous for colorblindness and a man with normal color vision will be colorblind? Explain your answer.