Biology 10 - Introduction to Biology
West Valley College - Norris

Inheritance

I. Definitions

A. Inheritance (heredity)
B. Gene

E. Phenotype

II. History - Gregor Mendel

III. Mendelian Genetics - How it All Works (the distribution and function of genes)
A. Monohybrid Cross (simplest, only one trait (one gene) is of interest)
1. What Mendel Observed

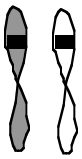
Law of Segregation - Mendel observed that traits are determined by paired particles that are separated during gamete formation and later recombined during fertilization

2. Mendels Observations are explained by Chromosome Movements

a. The Chromosome:

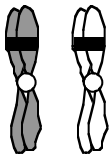
gene location ----------> on chromosome

unreplicated homologous chromosomes



replication

replicated homologous chromosomes



Note: Different forms of the gene (called alleles) may exist on homologous chromosomes (however, alleles on sister chromatids are identical)

- Homozygous - homologous chromosomes carry the same form (allele) of the gene
- Heterozygous - homologous chromosomes carry different forms (alleles) of the gene

b. Movement of a Gene Through Two Generations (use space below to draw)

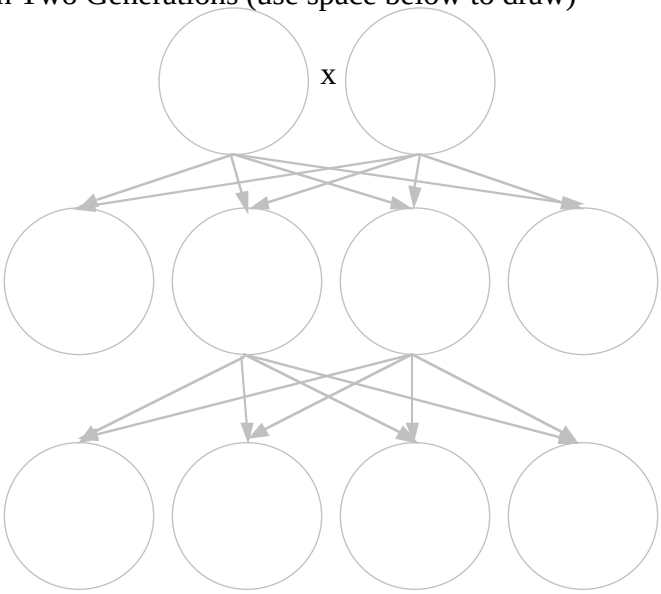
Parental Generation
"pure or true breeding"

x

(F1) First Generation

mate any two to produce the next generation

(F2) Second Generation



3. The Punnett Square
(1) define the parental genotype (allele form on each homologous chromosome)
(2) from parental genotype determine the possible gamete types
(3) determine the possible combinations of gametes

4. Some Human Traits determined by a Single Gene
- tongue rolling (dom), widows peak (dom), middigital hair (dom), dimples (dom)

B. Dihybrid Cross - two traits (genes) are of interest

1. Law of Independent Assortment - Mendel observed that in a dihybrid cross particles that determine different traits move independently of each other

2. Linkage - genes on the same chromosome do not sort independently

C. Other Variations on Mendels Theme

1. Incomplete Dominance - neither allele masks the other, the heterozygous condition is unique

2. Codominance - neither allele is masked, both alleles are expressed
example: Blood Types

3. Sex Linked Traits (carried on the sex chromosomes)
"autosome" - chromosomes found in both males and females
"sex chromosomes" - 1 pair, different in males and females (determine gender)

IV. Complications

A. Environmentally Sensitive Genes

B. Interactions Between Genes

C. Genetic Disorders

1. Inheritable Genetic Diseases
- recessive
- dominant

2. Mutations
a. Changes in Chromosome Structure
- deletion
- duplication
- inversion
- translocation

b. Changes in Chromosome Number
- non-disjunction (i.e. Down's Syndrome)

V. Additional Selected Key Terms

allele	autosome	centromere	chromosome	chromatid	codominance
gene	genotype	heterozygous	homozygous	incomplete dominance	
phenotype	sex chromosome	true breeding			

General Biology (Bio 10 - Intro to Biology / Bio 11 - Human Biology)
West Valley College - Norris

Terminology: Inheritance

I. DEFINITIONS

allele - general term for the alternative forms of a gene. The vast majority of genes come in one of two forms specifying the production of different versions of a specific protein.

autosomes - all chromosomes except the sex chromosomes (22 of the 23 pairs in humans)

codominance - dominant alleles are equally potent (both will be expressed individually in the heterozygous condition)

deletion - loss of part of a chromosome (may be caused by many factors)

dihybrid cross - genetic cross in which two different genes are of interest

dominant allele - the alternative form of a gene that is expressed preferentially

fertilization - fusion of haploid gametes (specifically nuclei) forming a diploid zygote

gene - discrete portion of a chromosome (specifically the DNA) that contains the instructions for synthesis of one protein

genotype - the genetic composition of an individual

heterozygous - term describing the situation where the two homologous chromosomes carry different alleles for the gene of interest (usually one carries the dominant allele and the other the recessive allele)

homozygous - term describing the situation where the two homologous chromosomes carry the same allele for the gene of interest (either both carry the dominant allele or the recessive allele, called homozygous dominant or homozygous recessive respectively)

incomplete dominance - the dominant allele does not completely mask the recessive allele (the heterozygous condition is distinctly different from either the homozygous dominant or recessive conditions)

monohybrid cross - genetic cross in which only one gene is of interest

nondisjunction - failure of one or more homologous pairs of chromosomes to separate during meiosis

phenotype - the expression of the genotype, often this is a visible characteristic

probability - likelihood that a chance event will occur

recessive - the alternative form of a gene that is masked by the dominant allele

sex chromosomes - homologous pair of chromosomes responsible for gender determination (1 of the 23 pairs in humans)

sex linked - traits that are determined by genes located on the sex chromosomes (usually meaning the X chromosome)

trait - a distinguishing feature determined by a single gene (i.e. ability or lack of ability to roll the tongue)

translocation - exchange of DNA fragments between non-homologous chromosomes

Study Questions – Inheritance:

1. Define “inheritance”.
2. What is a “gene”? What is the significance of a gene?.
3. What is an “allele”? What does it mean when an allele is described as dominant? As recessive?
4. What is a “genotype”?
5. Define “homozygous” and “heterozygous”.
6. What is a “phenotype”?
7. What is a “trait”?
8. What organism did Mendel study during his studies of inheritance? What were some of the advantages of this organism?
9. What did Mendel observe during his studies (i.e. what could he see)?
10. Describe Mendel’s “law of segregation”. What does this mean?
11. Describe Mendel’s “law of independent assortment”. What does this mean? Does it always hold true?
12. What is gene “linkage”? How can genes be unlinked?
13. Define and describe ”incomplete dominance”. What is an example of incomplete dominance?
14. Define and describe “codominance”. What is an example of codominance?
15. Define and describe “sex linkage”. What is an example of a sex linked trait?
16. What is an “autosome”? A “sex chromosome”?
17. What is an environmentallly sensitive gene?
18. Are all traits of an individual determined simply by one gene each?
19. Describe the different ways in which chromosome structure might be altered.
20. Describe how chromosome number might be altered.
21. Complete the sample genetics problems in the laboratory manual and the problems included below. Practrice, practicve, practice.

“*It has yet to be proven that intelligence has any survival value.*”
Arthur C. Clarke

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Genetics Practice Problems

I. Complete Dominance

1. What type of offspring would be expected from the mating of a female with attached earlobes (recessive trait) with a male with attached earlobes? What is expected from the mating of a female heterozygous for this condition with a male with attached earlobes?
2. A woman with hanging lobes who married a man with hanging earlobes gave birth to a son with attached lobes. What are the genotypes of these three people? If they have additional children, what would be the expected genotypic and phenotypic ratios?
3. A woman with hanging earlobes married a man with hanging earlobes and has four children with hanging earlobes. Her second marriage was to a man with attached earlobes, with whom she had two children with hanging earlobes and two children with attached earlobes. What are the possible genotypes for the woman, her husbands, and all of her children? What are the likely genotypic and phenotypic ratios of her children from each marriage?
4. A woman with attached earlobes, whose father had hanging earlobes, married a man with hanging earlobes. All of their children have hanging earlobes? What are the likely genotypes of all these people? What is the expected genotypic and phenotypic ratios of their offspring?
5. Normal pigmentation is due to a dominant allele (P) while albinism (absence of pigmentation) is due to a recessive allele (p).
   a. A normal man marries an albino woman. Their first child is an albino. What are the genotypes of these three people? If they have more children what will they look like?
   b. An albino man marries a normal woman and all of their children are normal. What are the genotypes of these people (parents and children)?
   c. A normal man whose father was an albino, marries an albino woman whose parents were both normal. They have three children, two normal and one albino. What are the genotypes of these people?

II. Dihybrid Cross

6. An albino woman heterozygous for hanging earlobes marries a man heterozygous for both albinism and hanging earlobes. What is the probability of their having an albino child with attached earlobes? A normally pigmented child with hanging earlobes?

7. An albino man with attached earlobes marries a normally pigmented woman with hanging earlobes. They have a normally pigmented child with attached earlobes. What are the genotypes for these three individuals? What must the womans genotype be if their second child is albino?

II. Incomplete Dominance

8. In shorthorn cattle a roan color results when one parent is white and the other is red - a case of incomplete dominance. A breeder of shorthorn cattle has cows which are white and a bull which is roan. What proportion of the calves produced by this herd will be white? roan? red? Which of these will be heterozygous? Homozygous? Starting with white cows and a roan bull, could he eventually establish a true breeding red heard? How?

III. Codominance

9. There are three different alleles possible for the blood type gene the A and B alleles are both dominant (codominant) and the O allele is recessive. For the six possible genotypes (AA, AO, BB, BO, AB, OO) four phenotypes may be expressed (blood types A, B, AB, O). A man with blood type A marries a woman with blood type B. They have a son with blood type O. What are the genotypes of these three people? The mans second wife is a woman with blood type AB what are the possible blood types of their children?

IV. Sex-Linked Factors

10. The gene for the ability to smell cyanide (C) is dominant over the gene for the lack of such smelling ability (c). This gene is located on the X chromosome. A woman who cannot smell cyanide marries a man who can. What are their genotypes? What are the possible genotypes of their children? Will their offspring be good candidates as safety inspectors at a cyanide factory?

Answers:

1. All children from parents with attached lobes will have attached lobes (*ee* x *ee* = all *ee*). 2nd question: Ee x *ee* = 2/4 Ee (hanging) and 2/4 *ee* (attached)

2. Male Ee x female Ee = 1/4 EE (hanging), 2/4 Ee (hanging), 1/4 *ee*(attached). The 1st son was *ee*. Genotypic ratio: 1:2:1, phenotypic ratio: 3:1 (3/4 of offspring would be expected to have hanging lobes, 1/4 attached).

3. Female Ee. 1st marriage: female Ee x husband probably EE (Ee is possible). Children all have hanging earlobes, E_ (probably 2/4 EE, 2/4 Ee). 2nd marriage: husband *ee*, children 1:1 hanging to attached earlobes (2/4 Ee, 2/4 *ee*).

4. Female *ee* with father Ee and mother Ee (or *ee*). Husband probably EE (Ee also possible). All children would be Ee.

5. a. Male Pp (normal pigment) x female pp (albino) produce 2/4 Pp (pigmented), 2/4 pp (albino).
   b. Male pp (albino) x female probably PP (pigmented) = all Pp (pigmented)
   c. Male Pp (pigmented), from father pp (albino) and mother PP or Pp (pigmented). Female pp (albino) from parents who were both Pp (pigmented). Children: 2/4 Pp (pigmented), 2/4 pp (albino)

6. Mother ppEe, father PpEe.
   Albino child with attached earlobes (ppee): 1/8,
   normally pigmented with hanging earlobes (P_E_): 3/8

7. Father (ppee), mother - cannot completely deduce genotype (P_Ee), first child (Ppee), after second child (pp) can deduce mothers full genotype as PpEe.

8. Let R stand for the allele for red, and r for the allele for white. The cows are rr (white), the bull is Rr (roan). Calves: 2/4 rr (white), 2/4 Rr (roan). If only roan (Rr) calves were mated with each other 1/4 2nd generation calves would be red (RR). If then only red calves were mated with each other a true breeding herd of red (RR) cattle would be produced.

9. Male AO (type A), Female BO (type B), child OO (type O). Second marriage children may be: 2/4 type A (1/4 AA, 1/4 AO), 1/4 type AB (AB), 1/4 type B (BO)

10. Mother cc, father CY. All female children Cc (can smell cyanide), all male children cY (cannot smell cyanide). Only the female children could be safety inspec