GHSGT Review: Biology (Day 5)

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OBJECTIVE: Explains and uses the basic Mendelian genetic principles.

GENETICS

The study of heredity is called genetics. Modern genetics is based on the knowledge that traits are transmitted by means of chromosomes. Offspring resemble their parents because they carry their parent's genetic material in units called genes.

Gregor Mendel studied the inherited traits in pea plants. He knew nothing about chromosomes and yet he was able to discover the basic principles of heredity. Mendel had logical experimental methods and he had careful record keeping. From his study, we can predict the percent of characteristic traits that will be passed off to offspring.

Some words you should know:

1. Heredity - the passing of traits from parents to offspring.
2. Genetics - scientific study of heredity.
3. Chromosomes - transmits traits through the egg and sperm (in their nuclei).
4. Genes – located on the chromosome, they are the units of heredity.
5. Gregor Mendel – Father of genetics. He studied the pea plant because it was readily available. The plants grew quickly, had a large number of offspring, and Mendel could control plant reproduction and contrasting traits. His theory was not accepted at the time because there was no cell theory and no one had seen a chromosome.
6. Dominant – traits that express themselves.
7. Recessive – traits that are hidden.
8. Allele – two copies of a gene for every trait. They may be the same (homozygous) or they may be different (heterozygous).
9. Genotype – the set of alleles an individual receives.
10. Phenotype – The appearance of the trait or allele that is expressed.
11. Cross Pollination – Taking the pollen from one plant and using it to fertilize another plant.
12. Self-Pollination – A plant uses its own pollen to pollinate (fertilize) itself.
13. Heterozygous– offspring from parents with different characteristics (hybrid).
14. Homozygous – offspring from parents with identical characteristics (purebreed).
15. Principle of Dominance – one gene in a pair may prevent the other gene from being expressed. A dominant gene masks another. A recessive gene is masked by dominant. Dominant traits are given capital letter and recessive genes are given lower case letters.

THE PUNNET SQUARE

The Punnett Square is a grid to help scientists show all the possible gene combinations for a cross. Dominant traits are symbolized by capital letters and lower case letters symbolize recessive traits.

Looking at the Punnett Square below, see if you can verify the following information:

	T	**t**
T	TT	Tt
t	Tt	tt

a. There are four offspring produced.
b. One will be homozygous tall phenotype and genotype.
c. Two will be heterozygous phenotypes, but tall genotypes.
d. One will be homozygous short phenotypes and genotypes.
e. Genotype: 25% TT, 50% Tt, 25% tt
f. Phenotype: 75% tall, 25% short

Summary of Mendel's Laws:

LAW	PARENT CROSS	OFFSPRING
DOMINANCE	**TT x tt tall x short**	**100% Tt tall**
SEGREGATION	**Tt x Tt tall x tall**	**75% tall 25% short**
INDEPENDENT ASSORTMENT	**RrGg x RrGg round & green x round & green**	**9/16 round seeds & green pods 3/16 round seeds & yellow pods 3/16 wrinkled seeds & green pods 1/16 wrinkled seeds & yellow pods**

CHROMOSOMES AND GENETICS

Walter Sutton, in 1903, proposed the Chromosome Theory. This theory stated that the hereditary factors, or genes, are carried on the chromosomes. The major points that supported his hypothesis were:

1. The egg and sperm cells are the only physical link between one generation to the next. Genes must be carried in these cells.
2. Hereditary material is probably located in the nucleus instead of in the cytoplasm.
3. During meiosis, each pair of homologous chromosomes separates independently of one another. Each gamete receives just one of the genes from each allelic pair.

The chromosomes determine sex in an organism. Females have two 'X' chromosomes and males have an 'X' and a 'Y' chromosome. In most organisms, including humans, the male parent determines the sex. The female parent always carried the 'X' chromosome. The male gamete may carry an 'X' or a 'Y'.

OBJECTIVE: Describes patterns of inheritance and genetic engineering.

GENETIC DISORDERS

Abnormal chromosomes determine some human genetic disorders. Abnormalities can occur due to nondisjunction. Nondisjunction is the failure of a chromosome pair to separate during meiosis. When nondisjunction occurs during the first division of meiosis, half of the gametes produced lack one chromosome and the other half have an extra chromosome.

Several serious problems result from cells with the wrong number of chromosomes (too many or too few). Down syndrome children can have an extra chromosome 21. These children have almond-shaped eyes, short limbs, and thick tongues, as well as varying degrees of mental retardation. Klinefelter's syndrome results in males with an extra 'X' chromosome. These males are sterile and show some degree of mental retardation. If females inherit an extra 'X', they develop normally but are usually sterile. Turner's syndrome individuals only have one 'X' chromosome and no other sex chromosome. These individuals are female and do not develop normally. They have short, thick webbed necks and are sterile.

Colorblindness and hemophilia are sex-linked traits. These traits are carried on the 'X' chromosome. Colorblindness occurs when an individual receives recessive alleles (X^c). These individuals cannot distinguish between red and green. A female can be color blind ($X^c X^c$), carry the trait ($X^C X^c$), or have both dominant alleles($X^C X^C$). A male, because they only have one 'X' chromosome are either color blind (X^cY) or have normal color vision (X^CY).

Hemophilia is a disorder that is caused by a recessive gene on the 'X' chromosome. People with hemophilia cannot produce a protein needed for blood clotting. Small cuts can lead to severe bleeding. A female can get hemophilia if she has two recessive genes. A male can get hemophilia if he has just one.

GENETIC ENGINEERING

In the last thirty years, biologists have found new ways to change the genetic makeup of an organism or its offspring by artificial means. Among these techniques is a process of transferring genes from one organism to another.

Cloning is the duplication of an organism. You can either cut off part of a plant and root it, or you can take a somatic cell (non-sex cell) from an organism and grow a complete organism from this one cell.

Recombinant DNA means changing the DNA in an organism. Part of the DNA of one organism is transferred into the DNA of another organism. The new DNA in the organism is called recombinant DNA. Bacteria containing recombinant DNA have already produced medicines to combat certain human diseases.

Practice:

1. Which of the following is a possible abbreviation for a genotype?

A. BC
B. Pp
C. Ty
D. fg

2. What is the best way to determine the phenotype of the feathers on a bird?

A. analyze the bird's DNA (genes)
B. look at the bird's feathers
C. look at the bird's beak
d. examine the bird's droppings

3. Which of the following pairs is not correct?

A. kk = hybrid
B. hybrid = heterozygous
C. heterozygous = Hh
D. homozygous = RR

4. The genes present in an organism represent the organism's _____.

A. genotype
B. phenotype
C. physical traits

5. Which choice represents a possible pair of alleles?

A. k & t
B. K & T
C. K & k
D. K & t

6. How many alleles for one trait are normally found in the genotype of an organism?

A. 1
B. 2
C. 3
D. 4

7. Which statement is not true?

A. genotype determines phenotype
B. phenotype determines genotype
C. a phenotype is the physical appearance of a trait in an organism
D. alleles are different forms of the same gene

Answers: 1. B, 2. B, 3. A, 4. A, 5. C, 6. B, 7. B