Name: _____ Block: _____

Chapter 3 – Genetics: The Science of Heredity

Lesson 1: What is Heredity?

What Did Mendel Observe?

Gregor Mendel (1800s): European priest that studied pea plants and the way characteristics are passed from one generation to the next.

- HEREDITY: the passing of physical characteristics from parents to offspring.
- TRAIT: a specific characteristic an organism can pass to its offspring through its genes.
    - Examples: seed color, height, flower color

Mendel's Experiments

- GENETICS: the scientific study of heredity
- FERTILIZATION: when egg and sperm cells join together
- Pea plants typically self-pollinate
    - Pollen from a flower lands on the pistil of the same flower.
- Mendel developed a technique to cross-pollinate pea plants "crossed"
    - Crossed plants with contrasting forms of a trait – like tall and short
- PUREBRED: organism is the offspring of many generations that have the same form of a trait.
    - Example: purebred tall plants always come from tall parent plants

The F1 & F2 Offspring

P generation: the purebred parents that are crossed.

- F1 generation: first filial, offspring from P generation
    - In Mendel's cross of tall plants with short plants, all short plants "disappeared"
- F2 generation: second filial, offspring of F1 generation
    - Mendel allowed to self-pollinate – ¾ tall, ¼ short

Experiments With Other Traits

- In all of his crosses, Mendel found that only one form of the trait appeared in the F1 generation. However, in the F2 generation, the "lost" form of the trait always reappeared in about ¼ of the plants.

How Do Alleles Affect Inheritance?

- Mendel concluded that individual factors, sets of genetic information, control the inheritance of traits in peas.
    - Factors exist in pairs – one from female parent, one from male parent
        - One factor can hide the other
- GENE: term used to describe the factors that control a trait
- ALLELES: the different forms of a gene
    - Traits are controlled by alleles it inherits from parents
    - DOMINANT ALLELE: one whose trait always shows up in the organism when the allele is present.
    - RECESSIVE ALLELE: one whose trait is always hidden whenever the dominant allele is present.

Alleles in Mendel's Crosses

- HYBRID: organism that has two different alleles for a trait

Symbols for Alleles

Name: _____ Block: _____

- Geneticists use letters to represent alleles
  - Dominant allele = capital letter (T)
  - Recessive allele = lower case letter (t)
  - Two dominant alleles = (TT)
  - Two recessive alleles (tt)
  - A hybrid (Tt)

Significance of Mendel's Contribution

- Before Mendel, people thought the traits of an individual organism were a blend of the parents.
  - Mendel showed that offspring traits are determined by individual, separate alleles inherited from each parent.
  - Mendel = Father of Genetics

Lesson 2: Probability and Heredity

What is Probability?

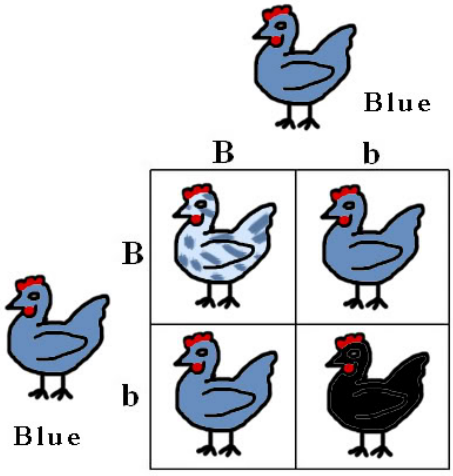
- PROBABILITY: a number that describes how likely it is that an event will occur.
  - Example: Toss a coin – 50/50 odds of heads/tails, ½, 1:2
- Laws of probability predict what is likely to occur – not what will occur.
- Each event occurs independently from each other
  - First coin toss does not impact second coin toss

Probability and Genetics

- Mendel observed very predictable results in each of his crosses.
  - Used principles of probability to predict the results of genetic crosses

Punnett Squares

- PUNNETT SQUARE: a chart that shows all the possible ways alleles can combine in a genetic cross.
  - Geneticists use them to see all combinations of alleles and to determine the probability of a particular outcome.
  - In a genetic cross, the combination of alleles that parents can pass to an offspring is based on probability



What Are Phenotype and Genotype?

- PHENOTYPE: physical appearance or visible traits
  - Example: Smooth pea pod
- GENOTYPE: genetic makeup, or alleles
  - Example: TT
- HOMOZYGOUS: an organism that has two identical alleles for a trait (TT)
- HETEROZYGOUS: an organism that has two different alleles for a trait (Tt) (hybrid)

Lesson 3: Patterns of Inheritance

How Are Most Traits Inherited?

- Most traits are the result of complex patterns inheritance – there are 4 complex patterns

1) INCOMPLETE DOMINANCE: occurs when one allele is only partially dominant
   - Example: Crossing a red flower with a white flower results in a pink flower
     - RR (red) X WW (white) → pink
2) CODOMINANCE: occurs when both alleles for a gene are expressed equally.

Name: _____ Block: _____

- Example: In chickens, neither white nor black is dominant
  - All offspring of black hen and white rooster will have both colors of feathers

3) MULTIPLE ALLELES: three or more possible alleles determine the trait
   ** Remember – an organism can only inherit two alleles for a gene – one from each parent
   - Example: 4 alleles control fur color in rabbits, but they can only inherit two which leads to a variety of coat colors
4) POLYGENIC INHERITANCE: occurs when more than one gene affects a trait.
   a. Alleles of different genes work together to produce these traits
   b. Results in a broad range of phenotypes
      - Example: Human height or time it takes a plant to flower

How Do Genes and the Environment Interact?

- Traits can be inherited OR learned (acquired).
  - Acquired traits are not carried by genes and are not passed onto offspring.
    - The language a person speaks, haircut
  - Inherited traits carried by genes but can also be affected by factors in the environment.
    - Vocal cords and tongues, height, freckles
  - Phenotypes in organisms result from both genes and environmental interactions

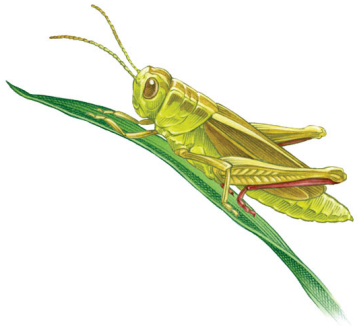
Genes and the Environment

- Environmental factors can influence the way genes are expressed.
  - Environmental factors can change an organism's genes.
    - Smoking can cause body cells to change causing cancer
    - These changes are not passed on to offspring.

Lesson 4: Chromosomes and Inheritance

How Are Chromosomes, Genes and Inheritance Related?

- Mendel showed that genes exist (called them factors), but scientists in the 20th century did not now what cell structures contained genes.
  - Walter Sutton (1900s) studied cells of grasshoppers – wanted to understand how sex cells form.
    - Hypothesized that chromosomes are key to learning how offspring have traits similar to those of their parents.



Chromosomes and Inheritance

- Sutton came to the following conclusions:
  - Grasshopper body cells have 24 chromosomes
  - Grasshopper sex cells have 12 chromosomes
  - When egg & sperm unite (fertilization), fertilized egg has 24 chromosomes
  - 24 chromosomes exist as 24 pairs
    - 1 chromosome in each pair from female parent, 1 chromosome from male parent
  - Sutton knew alleles existed in pairs in organisms – 1 from each parent
    - Realized paired alleles are carried on paired chromosomes
    - Chromosome theory of inheritance: genes pass from parents to their offspring on chromosomes

A Lineup of Genes

- Human body cells contain 46 chromosomes in 23 pairs.
  - Chromosomes made up of many genes joined like beads on a string.
  - Body cells contain 20-25,000 genes that control traits.

Name: _____ Block: _____

What Happens During Meiosis

- MEIOSIS: the process by which the number of chromosomes is reduced by half as sex cells form.
  - Chromosome pairs separate into two different cells.
  - Sex cells that form later have only half as many chromosomes as the other cells in the organism.

Steps of Meiosis:

- Before Meiosis: every chromosome in the parent cell is copied. Centromeres hold the two chromatids together.
  1) Chromosome pairs line up in the center of the cell.
  2) Pairs separate and move to the ends of the cell.
  3) Two cells form. Each cell has half the original number of chromosomes. Each chromosome is still made of paired chromatids.
  4) In each cell, the chromosome pairs move to the center.
  5) The centromeres split, and the chromosomes separate. They become single chromosomes and move to opposite ends of the cell.
- After Meiosis: Four sex cells are produced. Each cell has half the number of chromosomes of the parent cell. Each sex cell has only 1 chromosome from an original pair.