Ministry of Higher Education

& Scientific Research

Al Muthanna University

College of Veterinary Medicine

Division of Public Health

Subject: Genetics

Grade: 2

Lecture : 3

Mendelian inheritance

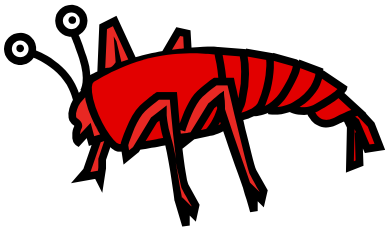
Variation

Mechanisms of Evolution: Mendelian Genetics in Populations

1- Genetic variation is the raw material of evolutionary change
2- Evolution can be defined as a change in gene frequencies through time.
3- Population genetics tracks the fate, across generations, of Mendelian genes in populations.
4- Population genetics is concerned with whether a particular allele or genotype will become more or less common over time
5- The traits an organism inherits is determined during the life process of reproduction.
6- More **variation** (differences) are found in sexual reproduction than by asexual reproduction.
7- In sexual reproduction, the offspring resembles its parents but is also different from them.

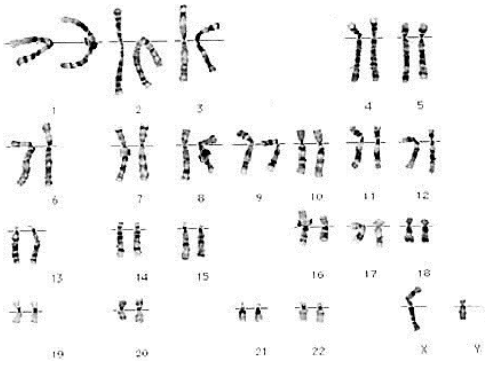
Species and Chromosome Number

- The chromosome number (species chromosome number) is the same from generation to generation within an organism or species.
- Every species will have a different chromosome number.
  - Human = 46
  - Crayfish = 100
  - Dog = 48
  - Cat = 38
  - Pea = 14
  - Fruit fly = 8



Chromosome Arrangement

- In a cell, chromosomes are arranged in pairs.
- A photograph or chart of chromosomes arranged in pairs is called a **karyotype**.

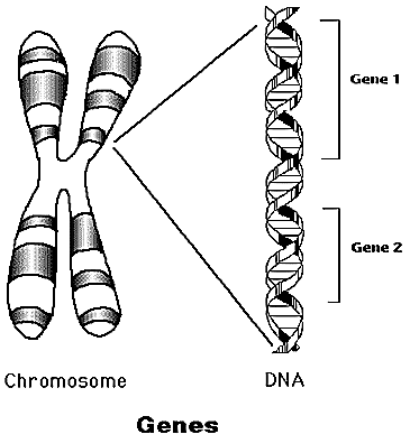


Gregor Mendel

- Today's knowledge about genetics is a result of genetic studies started by Gregor Mendel in the middle 1800's.
- Because of his work, he is called the "father of genetics."
- Mendel did not know about genes, but thought that certain "factors" were responsible for traits passed from parents to offspring.

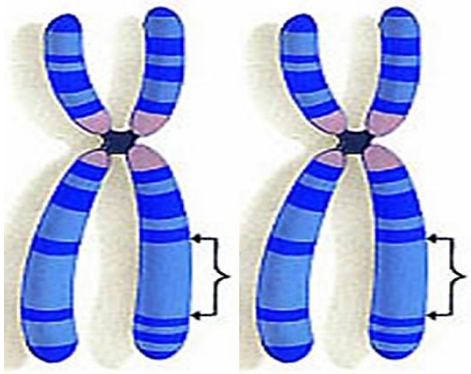
The Gene-Chromosome Theory

- This theory states that chromosomes (found in the nucleus of the cell) are made of small units called genes.
- Genes carry hereditary information and are found at specific locations along chromosomes.



Genes

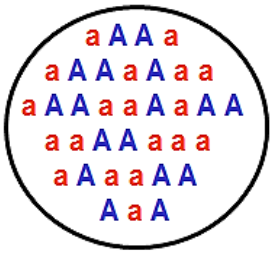
Alleles: are pairs of genes that carry the same traits and are found at the same locations on pairs of chromosomes. Each chromosome may contain several hundred genes.



Assumptions:

1) **Diploid, autosomal locus with 2 alleles: A and a**
2) **Simple life cycle:**

PARENTS	GAMETES	ZYGOTES
(DIPLIOD)	(HAPLOID)	(DIPLOID)



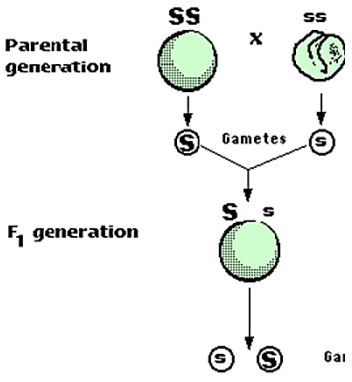
These parents produce a large gamete pool (Gene Pool) containing alleles A and a.

Inheritance of Traits

During fertilization, the male and female parents each contribute genetic information (traits) to the zygote (fertilized egg). One half of its genetic information from its male parent and the other half from its female parent. Genetic traits are carried in chromosomes.

Mendel's Experiments

Gregor Mendel conducted heredity experiments using common garden pea plants. Mendel crossed (mated) large numbers of plants. Mendel concluded that there were traits that always appeared (were expressed) when they were present in an organism.



The purebred plants are called the **parent (P) generation**. The offspring of a cross between two parent (P) generation plants are called the **first filial (F_1) generation**.

- The trait that always appears when it is present is called the **dominant** trait.
- The trait that is hidden by the dominant trait is called the **recessive** trait.

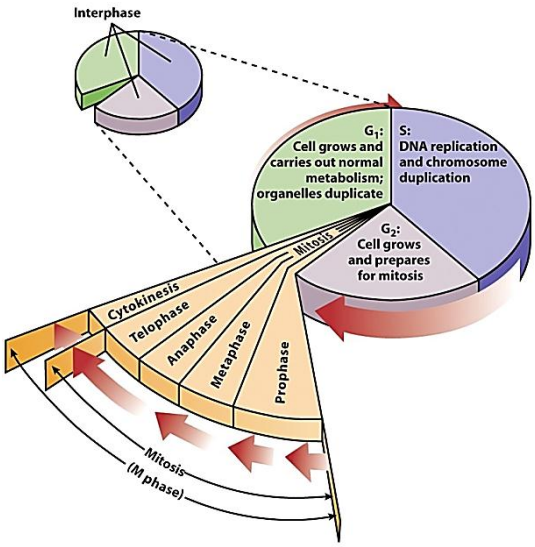
Genetic Terms

- **Homozygous Trait** - Both genes for that trait are the same.
  Ex: A pea plant with two genes for tallness.
- **Heterozygous Trait** - Both genes for that trait are not the same.
  Ex: A pea plant with one gene for tallness and one for shortness.

- **Genotype - The genetic makeup of an organism.**
- **Phenotype - The external appearance of an organism.**
  - For example, an organism that looks tall can have a genotype that is pure tall or hybrid tall. This is because whenever the dominant trait is present, the organism expresses (shows) the dominant trait**.**

Cell Cycle

- **Repetitive sequence of events that characterizes life of cell.**
- **Consists of two main phases:**
  - Interphase: Period that cells are in when not dividing., 90% of cell cycle
  - M phase: Includes mitosis and cytokinesis



- **Interphase has three sub-phases**
  - G_1 (first gap): Cell makes copies of organelles and grows larger
  - S (synthesis) : - Genetic material is copied, End of this phase, cells chromosomes are doubled, Copies are attached; thus total number of chromosomes remains the same
  - G_2 (second gap): Cell prepares upcoming M phase

Regulation of Cell Cycle

- Cell cycle must be regulated or can result in cancer which is Uncontrolled cell growth
- Metastasize: cell breaks free from original cancerous mass and resides in new area in the body

Two checkpoints during

  - First between G_1 and S
  - Second between G_2 and M

- **To pass checkpoints, cell must possess appropriate amount of protein in cytoplasm.**

- These proteins activate other proteins necessary for production of genetic material and mitosis
- When regulator concentration is high, cell cycle progresses.
- When low, cell cycle is suspended at that stage.

External and internal regulatory agents also influence passage through checkpoints.

EVOLUTIONARY THOUGHT AFTER DARWIN

- By the 1870s, most scientists accepted the historical reality of evolution (and this has been true ever since).
- It would be at least 60 years after the publication of *The Origin of Species* before natural selection would come to be widely accepted.
- People wanted life itself to be purposeful and creative, and consequently did not find natural selection appealing.

- Neo-Lamarckism -- inheritance of acquired characteristics.
- Orthogenesis -- variation that arises is directed toward a goal.
- Mutationism -- discrete variations are all that matter.

Mendelian genetics disproved Lamarckian and blending inheritance theories. However, the emphasis on discrete variation caused a rift between mutation and natural selection that was initially damaging to the field.

THE MODERN SYNTHESIS OF EVOLUTIONARY BIOLOGY

- The rift between genetics and natural selection was resolved in the 1930s and 1940s.
- This synthesis was forged from the contributions of geneticists, systematists, and paleontologists.

Outcomes of the "MODERN SYNTHESIS"

- Populations contain genetic variation that arises by random mutation.
- Populations evolve by changes in gene frequency.
- Gene frequencies change through random genetic drift, gene flow, and natural selection.
- Most adaptive variants have small effects on the phenotype so changes are typically gradual.
- Diversification comes about through speciation.

Some Definitions:

- **Population:** A freely interbreeding group of individuals.
- **Gene Pool:** The sum total of genetic information present in a population at any given point in time.
- **Phenotype:** A morphological, physiological, biochemical, or behavioral characteristic of an individual organism.
- **Genotype:** The genetic constitution of an individual organism.
- **Locus:** A site on a chromosome, or the gene that occupies the site.
- **Gene:** A nucleic acid sequence that encodes a product with a distinct function in the organism.
- **Allele:** A particular form of a gene.
- **Gene (Allele) Frequency:** The relative proportion of a particular allele at a single locus in a population (a number between 0 and 1).
- **Genotype Frequency:** The relative proportion of a particular genotype in a population (a number between 0 and 1).

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