SAWA UNIVERSITY

الوراثة الطبية 1 / الكورس الاول

Pattern of Inheritances: Mendel's Laws and Dominant Inheritance

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Theoretical : Medical Genetics

محاضرة رقم 9 و 10

Lecture No. 9 +10

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Learning Objectives

By the end of this lecture, you will be able to:

1. Define key genetic concepts including gene, allele, genotype, and phenotype.
2. Explain Mendel's Laws (Law of Segregation and Law of Independent Assortment) and their significance in classical genetics.
3. Differentiate between dominant and recessive alleles and describe how each contributes to trait expression.
4. Interpret and construct Punnett squares to predict genotypic and phenotypic ratios.

Introduction

- The laws of inheritance were derived by Gregor Mendel, who conducted hybridization experiments in garden peas. Between 1856 and 1863, he cultivated and tested some 5,000 pea plants. From these experiments, he induced two generalizations which later became known as Mendel's Principles of Heredity or Mendelian inheritance.
- Inheritance characteristics are determined by `factors' called (alleles), these factors occur in pairs (gene on mother and father homologous chromosomes).

Mendel reasons for choosing pea plant for genetic experiments

1- Short life cycle

2- Produce large numbers of offspring

3- The possibility of genetic mutations when exposed to radiation or chemicals

4- The possibility of controlling pollination in this plant

5- Ease of upbringing

Mendel studied seven pairs of characters in pea, Shown in the following picture

	Height	Seed Shape	Seed Color	Seed Coat Color	Pod Shape	Pod Color	Flower Position
Dominant	 Tall	 Round	 Yellow	 Green	 Inflated (full)	 Green	 Axial
Recessive Trait	 Short	 Wrinkled	 Green	 White	 Constricted (flat)	 Yellow	 Terminal

Hereditary terminology

- **Gene** is unit of heredity on a chromosome. gene has an alternative state called allele
- **Allele:** An allele is an alternative form of a gene located at a specific site on a chromosome that controls a particular hereditary trait.
- **Dominant trait** is a trait that appears in an individual even if they carry only one copy of the allele responsible for it.
- **Recessive trait** is a trait that only appears in the external appearance when an individual possesses two recessive alleles.
- **Homozygous:** Having identical alleles for one or more genes called pure

Hereditary terminology

- **Heterozygous:** Carrying two different alleles for one or more genes also called hybrid.
- **Genotype**: The set of alleles an organism has for a particular trait.
- **Phenotype**: is the physical appearance of an individual **(e.g. red, white)** .
- **Monohybrid cross :** Cross involving a single trait e.g. flower color.
- **Dihybrid cross :**Cross involving two traits e.g. flower color & plant height

Mendel's laws

❖ **1st Mendel law (law of Segregation):**

- **Each organism contains two factors for each trait, and the factors segregate during the formation of gametes so that each gamete contains only one factor for each trait, one from each parent.**
- For example, flower color: R = red (dominant) , *r* = white (recessive) .If cross a homozygous red (RR) with a homozygous white (*rr*):

RR X rr

Rr

F1 monohybrids are allowed to self-pollinate

Rr x Rr

Genotypes: RR: Rr: Rr: rr

Phenotypes: 3 red : 1 White

Mendel's 2nd law (law of Independent Assortment)

- **Members of one pair of factors segregate independently from other pair of factors during gamete formation.**
- Mendel performed a second series of experiments in which he crossed plants that differed in 2 traits; such crosses are called dihybrid crosses.
- For example, flower color: R = red (dominant) and *r* = white (recessive)
- and stem length: T = tall and *t* = short

TT RR x *tt rr*

(tall, red) (short, white)

F1 Generation: (T*t* Rr) All tall, red flowers

If F1 generation is allowed to self-pollinate, Mendel observed 4 phenotypes:

Tt Rr x Tt Rr

(tall, red) (tall, red)

TR Tr Rt rt X TR Tr Rt rt

Punnett Square

- Punnett Sqaure – A square diagram used to predict the genotypes of a particular cross. TR Tr Rt rt X TR Tr Rt rt

	TR	Tr	**tR**	**tr**
TR	TTRR	TTRr	TtRR	TtRr
Tr	TTRr	TTrr	TtRr	Ttrr
tR	TtRR	TtRr	ttRR	ttRr
tr	TtRr	Ttrr	ttRr	ttrr

Genotype ratios (9): 1 TTRR :2TTRr : 2Tt RR: 4Tt Rr:1TTrr: 2Tt rr: 1 tt RR: 2 tt Rr: 1tt rr
phenotype ratios (4): (9)Tall, red : (3)Tall, white : (3) Short, red , (1)Short, white

The Third Law (Law of Dominance)

- **states that recessive alleles will always be masked by dominant alleles.**
- **Therefore, a cross between a homozygous dominant and a homozygous recessive will always express the dominant phenotype, while still having a heterozygous genotype.**
- P1 Monohybrid cross
- *For seed shape, a pure monohybrid cross can be understand as follows:*

Trait: Seed shape
Alleles: R – Round r – Wrinkled
Cross: Round seeds X Wrinkled seeds
RR X rr
Genotype: Rr (Heterozygous)
Phenotype: Round

Dominant Inheritance

- Dominant inheritance occurs when a single dominant allele is sufficient to express a trait.

1. Genotypes that show the dominant trait:

- **AA** → dominant
- **Aa** → dominant

2.Genotypes that show the recessive trait:

- **aa** → recessive (dominant trait absent)

3. Characteristics of Dominant Inheritance

- The trait typically appears in every generation.
- Only one affected parent is needed to pass on the trait.
- Two recessive individuals cannot produce a dominant offspring.
- Affected individuals have at least one dominant allele.

- **Questions**

1. What is the difference between genotype and phenotype?
2. Describe the Law of Segregation.
3. Predict the offspring ratios for **Aa × aa**.

Any questions?