HEREDITY

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Heredity - The transmission of characters from the parents to their offsprings

Inheritence - The process of passing characters or traits

Types of traits

Inherited traits	Acquired traits
Received from parents	Obtained during lifetime
Examples: • Shape of nose • eyes • hair colour etc.	Examples: • learned language • football skills • muscular body • ear piercings etc.
Passed on from one generation to another	Cannot be passed on to the next generation
Occur due to change in DNA	No change in DNA is involved
Lead to evolution.	Don't result in evolution

Genetics - Branch of science which deals with heredity and variation

Variations - The difference between traits/characters among the individuals of a species

ACCUMULATION OF VARIATION

I. Environmental Factors

As compared to first generation, the second generation organisms show variation in dealing with environmental conditions.

Example:

In a bacterial colony, various individuals show variation in heat resistence capacity

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If temperature increases, most bacteria die. Only few survivors are left (who were able to withstand high temperature)

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This varidtion will be accumulated by bacteria of next generation

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Ultimately, highly heat resistant trait will be developed to allow survival at high temperatures

II. Reproduction

Asexual	Sexual
• individuals are similar to parents	• Variations are generated because of:
• No/minor variations due to small inaccuracies in DNA copying	(a) Exchange of DNA segments in gamete forms
	(b) Unions of traits between 2 different parents during fertilization

Free ear lobes VS Attached ear lobes

Gregor Johann Mandel (1822-1884)

» Gave the law of inheritance (1866)

» His findings were unknown until 3 scientists republished his work in 1901.

» He was then credited as 'Father of Genetics'

» Conducted experiments for 8 years on common garden pea (Pisum Sativum).

↳ • Diploid
• consists 14 chromosomes (7 pairs)

Why only PEA plant?

(a) Short life cycle
- Makes it possible to study several generations ~~which~~ within short time period
- They grow to maturity in a single season

(b) Produces large no. of seeds in one generation
- Allows him to perform several crosses like monohybrid, dihybrid and trihybrid

(c) Bisexual flowers
- Self-pollination and cross-pollination can be performed easily

(d) Simple physical characteristics
- Easy to recognise and study
- Large number of offsprings

Seven Pairs of Contrasting Traits

	Characters	Dominant	Recessive
1	Flower colour	Purple	White
2	Seed colour	Yellow	Green
3	Seed shape	Round	Wrinkled
4	Pod colour	Green	Yellow
5	Pod shape	Inflated	Constricted
6	Flower position	(nodes) Axillary	(tip) Terminal
7	Plant height	Tall	Dwarf

Genotype – The specific genetic constitution of an organism

Phenotype – The observable characters or physical appearance of an organism that are genetically controlled

MONOHYBRID CROSS

Parents : Homozygous – Pure tall (T), Pure short (dwarf) (t)

Trait : Plant height

F_1 (homozygous)

$TT \times tt$

	T	T
t	Tt	Tt
t	Tt	Tt

(T – dominant, t – recessive)

F_1 gen. – Tt, Tt, Tt, Tt

∴ All plants are tall (heterozygous) (Tt)

$Tt \times Tt$ F_2

♀ \ ♂	T	t
T	TT	Tt
t	Tt	tt

F_2 gen :

Phenotype – 3 : 1

Genotype – 1 : 2 : 1

(mono-hybrid ratio)

* F_1 = First Filial generation

In F_2 generation, there is a 25% chance that the plant is dwarf (phenotypic ratio).

DIHYBRID CROSS

» Breeding results in 2 pairs of contrasting characters

Character:

~~Trait~~ : Seed colour and seed shape

Parents: RRYY x rryy

Traits: Round and yellow x wrinkled and green

Gametes: RY , ry

F_1

	RY	RY
ry	RrYy	RrYy
ry	RrYy	RrYy

Phenotype - All seeds are Round and Yellow

Genotype - RrYy , RrYy , RrYy , RrYy

[when both dominant and recessive genes are present together, only the dominant alleles are expressed]

F_2

Gametes: RY , Ry , rY , ry

♀ \ ♂	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

round, yellow | round, green | wrinkled, yellow | wrinkled, green

Phenotype — 9:3:3:1

Genotype - very complex

(1:2:1:2:4:2:1:2:1)

Mandel's Law of Inheritance

Mandels breeding experiments are summarized under 3 laws

1. Law of Dominance

- Out of a pair of contrasting characters present together, only one is able to express itself while the other remains suppressed. The expressed character is DOMINANT and the suppressed one is recessive.
- The recessive character can only be expressed when the pair consists of both recessives (i.e. Homozygous recessive)

2. Law of Segregation (Law of purity of gametes)

- The two members of a pair of factor do not blend, but separate/segregate into different gametes during gamete formation.
- The gametes combine together by random fusion at the time of zygote formation.

3. Law of Independent Assortment

- When there are two pairs of contrasting characters, the distribution of the members of one pair into the gametes is independent of the distribution of other pair.

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Locus – The location of a gene on a chromosome
Genome – The total no. of genes in haploid gametes

Mutation – A sudden change in:
- one or more genes
OR - number or structure of chromosomes

Example: Radioactive radiations alter the gene structure and their effects can be seen generation after generation

An atomic explosion which had occurred during WW2 (1945) in Japan (Hiroshima, Nagasaki) had led to a number of deformities in the body of plants and animals which are still persisting.

Gene (Factor) – Basic unit of heredity which controls the expression of a character
(thousands of them are present in a chromosome to control various characteristics.)
They work in pairs

Allele – The alternative form of a gene occupying the same position on a chromosome and affecting the same characteristic, but in 2 different ways
- Example – Free and attached ear lobe are alleles of ear lobe character

Homozygous – Same type of allele
Heterozygous – Different types of alleles present

Why to study genetics?

(i) Animal husbandary – Improvement of domestic animals

(ii) Legal applications – Analysis of blood group is used to solve court cases of disputed percentage, baby mix in the hospital, etc.

(iii) Agriculture – Plant breeders have successfully produced several varieties of different food crops by hybridisation

How do traits get expressed?

Cellular DNA is the information source for making proteins in the cell.
A segment of DNA that provides information for one protein is known as the gene for that protein.

Proteins control the characteristics like tallness of a plant due to growth hormone.

The growth hormone depends on the efficiency of enzyme.
If the gene for enzyme is efficient, lot of hormone will be made and thus, the plant becomes tall.

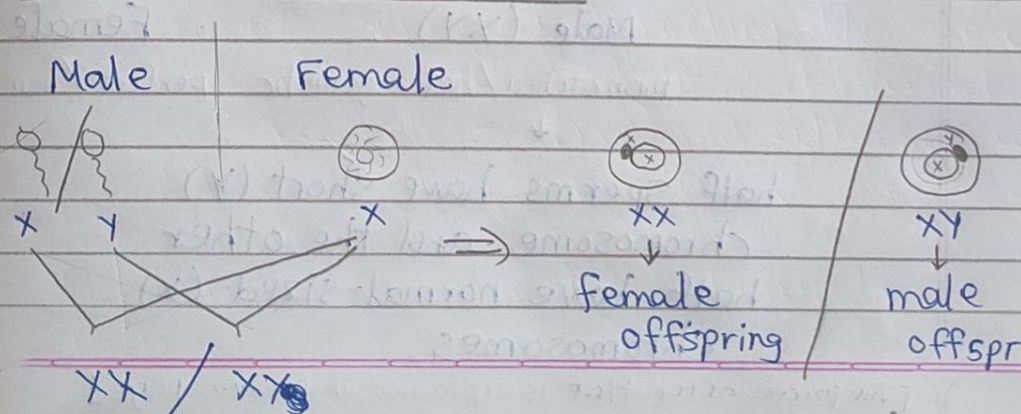
[and if the gene of enzyme is inefficient, amount of hormone will be less and the plant becomes short]

Chromosome pairing

♀ (mom) 50% DNA ♂ (dad) 50% DNA

- Both parents contribute equally to the DNA of the offspring during sexual reproduction.
- Each parent contributes a copy of the same gene, so the offspring gets one gene from each parent.
- Germ cells (sperm / egg) have one set of genes (half of the total). [haploid]
- These gene sets are present as chromosomes, so each cell has two copies of each chromosome (one from each parent). [diploid]
- When germ cells combine (fertilization), they restore the normal number of chromosomes in the offspring.
  [Eg- pea plant has 2 sets of genes from both parents and same with humans]

SEX DETERMINATION



I. Environmental factors

In Reptiles, the temperature at which the fertilised egg is kept determines the sex of the offspring.

Turtles
- Lower temp. (below 28°c) : Males
- Higher temp. (above 31°c) : Females

Snails
Sex is not genetically determined, so they can change it in different conditions

Crocodiles
- Lower temp. (below 30°) : Females
- Higher temp. (32°-34°c) : Males

II. Genetic control

In Humans,

23 pairs of chromosomes
- 22 pairs – autosomes
- 23rd pair (last) – sex chromosomes

⇓

Male (XY)	Female (XX)
mismatched / heterogametic	perfect / homogametic

↓

half sperms have short (Y) chromosome and the other half have normal-sized (X) chromosomes.

[The process after that is explained in previous page]