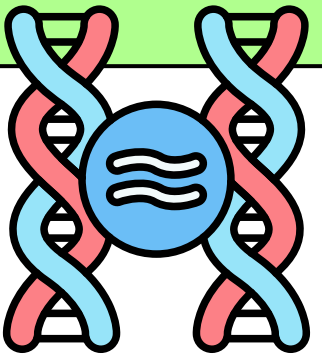
HEREDITY

Introduction

- **Heredity** refers to the transmission of characters from parents to offsprings.
- **An inherited trait** is a particular genetically determined feature that distinguishes a person from the others for example; attached or free ear lobes in human beings.

Accumulation of Variation during Reproduction



Variation occurs during reproduction whether organisms multiply sexually or asexually.

- **Variations in Asexual Reproduction**
  - Variations are fewer.
  - Occurs due to small inaccuracies in DNA copying. (Mutation)
- **Variations in Sexual Reproduction**
  - Variations are large.
  - Occurs due to crossing over, separation of chromosomes, mutation.
- **Importance of Variation**
  - Depending upon the nature of variations different individuals would have different kinds of advantage.
  - Example, Bacteria that can withstand heat will survive better in a heat wave.
  - Main advantage of variation to species is that it increases the chances of its survival in a changing environment.
- Free ear lobes and attached ear lobes are two variants found in human populations.

Mendel and His Work on Inheritance

- Gregor Johann Mendel (1822 & 1884) started his experiments on plant breeding and hybridisation. He proposed the laws of inheritance in living organisms.
- Mendel was known as Father of Genetics.
- Plant selected by Mendel: Pisum sativum (garden pea). He used a number of contrasting characters for garden pea.

Some important terms

Gene	• It is the part of a chromosome which controls a specific biological function.
Contrasting characters	• A pair of visible charactes such as tall and dwarf, white and violet flowers, round and wrinkled seeds, green and yellow seeds etc.
Dominant trait	• The character which expresses itself in a (Ft) generation is dominant trait. Example : Tallness is a dominant character in pea plant.
Recessive trait	• The character which does not express itself but is present in a generation is recessive trait. Ex. dwarfism in the pea plant.
Homozygous	• A condition in which both the genes of same type are present for example; an organism has both the genes for tallness it is expressed as TT and genes for dwarfness are written as tt.
Heterozygous	• A condition in which both the genes are of different types for example; an organism has genes Tt it means it has a gene for tallness and the other for dwarfness only tall character is expressed.
Genotype	• It is genetic make up of an individual for example; A pure tall plant is expressed as TT and hybrid tall as Tt.
Phenotype	• It is external appearance of the organism for example; a plant having Tt composition will appear tall although it has gene for dwarfness.
Homologous pair of characters	• These are those in which one member is contributed by the father and the other member by the mother and both have genes for the same character at the same position.

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Monohybrid Cross

- The cross in which Mendel showed inheritance of dominant and recessive characters is monohybrid cross to observe inheritance of single pair of contrasting characters
- eg - cross between two pea plants with one pair of contrasting characters

Pure Tall Plants TT → T

Pure Small Plants tt → T

Parents

Gametes

Cross Pollination

(Genotype) Tt

F_1 Generation

All tall plants (phenotype)

Self Pollination

Gametes	T	t
T	TT	Tt
t	Tt	tt

- First-generation or F_1 progeny are no 'medium-height' plants. All plants were tall.
- Second-generation or F_2 are progeny (descendant) of the F_1 tall plants are not all tall.
- Both the tallness and shortness traits were inherited in the F_1 plants, but only the tallness trait was expressed. Thus, two copies of the trait are inherited in each sexually reproducing organism.
- These two may be identical or may be different depending on the parentage.
- **Conclusion:**
  - Phenotypic ratio- Tall : Dwarf 3 : 1
  - Genotype ratio- Pure Tall : Hybrid Tall : Pure Dwarf 1 : 2 : 1
  - A single copy of T is enough to make the plant tall, while both copies have to be 't' for the plant to be short.
  - **Characters/traits like 'T' are called dominant trait (because it express itself) and 't' are recessive trait (because it remains suppressed).**

Dihybrid Cross

- A cross between two plants having two pairs of contrasting characters is called dihybrid cross.
- Mendel Cross breed pea plants bearing round green seed with plants bearing wrinkled and yellow seeds.
- In the F_1 generation he obtained all round and yellow seeds it means round and yellow traits of seeds are dominant features while wrinkled and green are recessive.
- He self-pollinated the plants of F_1 generation to obtain F_2 generation, he obtained four different types of seeds round yellow, round green, wrinkled yellow and wrinkled green in the ratio of **9 : 3 : 3 : 1**. He concluded that traits are independently inherited

Round and Green
RRyy

Wrinkled and Yellow
rrYY

Parents

Ry

Cross Pollination

rY

Gametes

RrYy

F₁ Generation

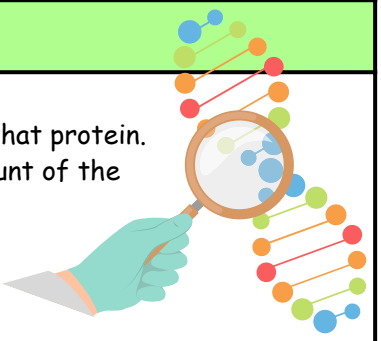
All Round Yellow seeds

Self Pollination

Gametes	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

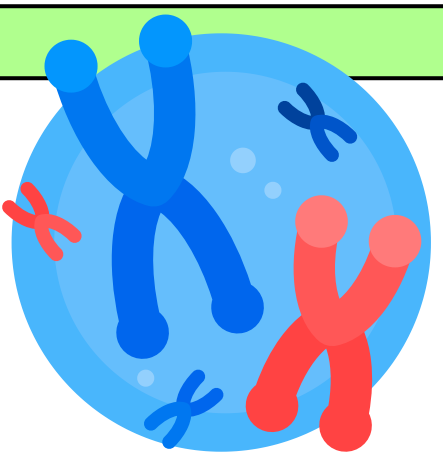
- **Conclusions**
  - Round and yellow seeds are Dominant characters.
  - Occurrence of new phenotype combinations show that genes for round and yellow seeds are inherited independently of each other.

How do these traits get expressed?



- Cellular DNA is the information source for making proteins in the cell.
- A section of DNA that provides information for one protein is called the gene for that protein.
- Plant height can thus depend on the amount of a particular plant hormone. The amount of the plant hormone made will depend on the efficiency of the process for making it.
- Cellular DNA (Information source) → For synthesis of Proteins (Enzyme) → Works efficiently → More Hormone → produced Tallness of plant
- Therefore, genes control characteristics/traits.

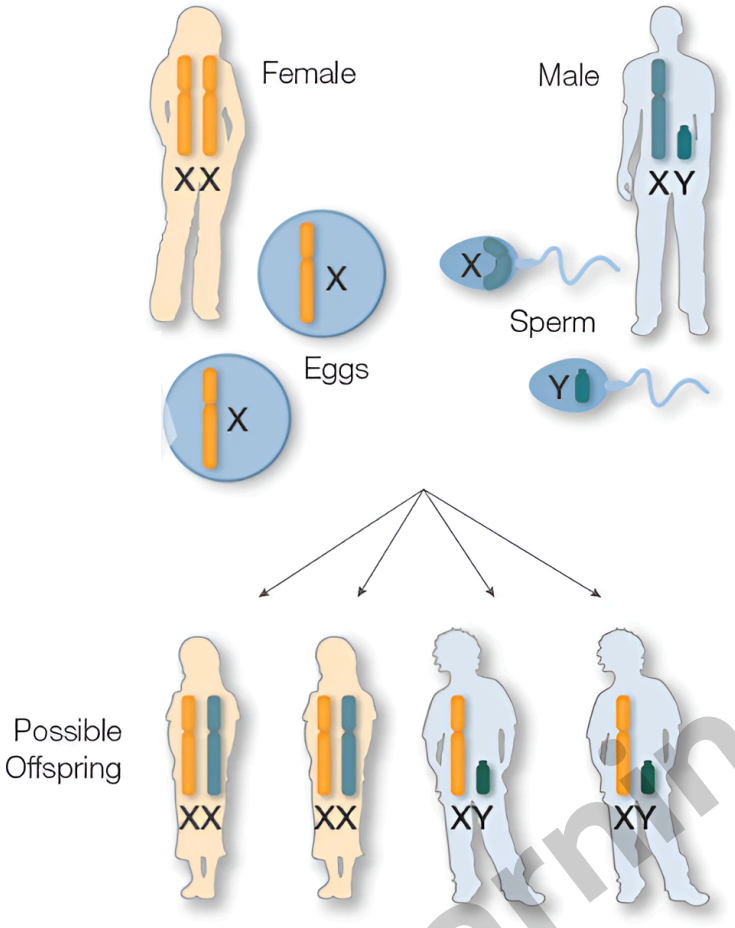
Sex Determination



- Determination of sex of an offspring is known as Sex Determination.
- Factors responsible for Sex Determination
  - Environmental
    - In some animals, the temperature at which the fertilized eggs are kept decides the gender. Example: Turtle
  - Genetic
    - In some animals like humans gender or individual is determined by a pair of chromosomes called sexchromosome.
      - XX – Female
      - XY – Male

Sex Chromosomes

- In human beings, there are 23 pairs of chromosome.
- Out of these 22 chromosomes pairs are called autosomes and the last pair of chromosome that help in deciding gender of that individual is called sex chromosome.
  - XX – Female
  - XY – Male



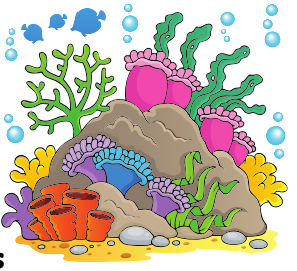
- This shows that half the children will be boys and half will be girls. All children will inherit an X chromosome from their mother regardless whether they are boys or girls.
- Thus, sex of children will be determined by what they inherit from their father, and not from their mother.

Our Environment

Ecosystem

All the interacting organisms in an area together with the non-living constituents of the environment form an ecosystem. E.g., forest, pond etc.

- Types of Ecosystem
  - **Natural ecosystem:** The ecosystem which exist in nature on its own. Example: forest, lake, ocean.
  - **Artifical ecosystem:** Man-made ecosystems are called artificial ecosystem. Example: crop field, aquarium, garden.
- Components of ecosystem



Components of Ecosystem

Abiotic Components (Air, water, land)

Biotic Components (Plant, animals)

Producers

Consumers

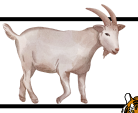
Herbivore → **Carnivore**

Omnivore → **Parasites**

Decomposers

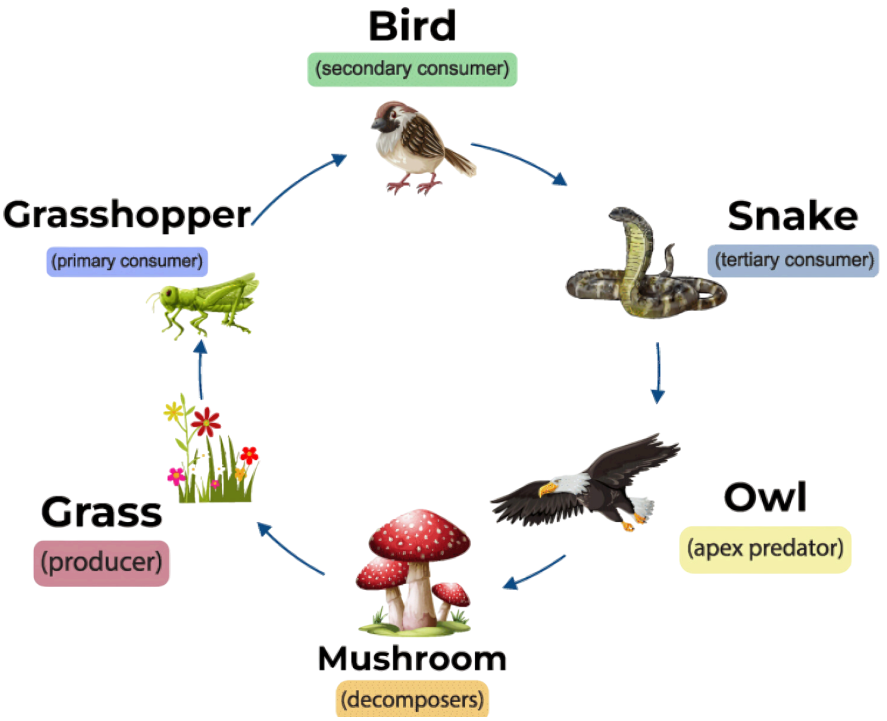
  - **Abiotic Components:** All the non-living components such as air, water, land, light, temperature etc. form the abiotic components.
  - **Biotic Components:** All the living components such as plants, animals, bacteria, fungi etc. form the biotic components.
- On the basis of nutrition biotic components are further divided into:
  - **Producers:** All green plants and blue-green algae can produce their own food using abiotic components (photosynthesis), hence called producers.
  - **Decomposers:** Include organisms which decompose the dead plants and animals. Example: bacteria, fungi. These help in the replenishment of natural resources.
  - **Consumers:** Include all animals which depend on producers directly or indirectly for their food. These are -

Herbivores	Plant eaters. Example: goat, deer.
Carnivores	Flash eaters. Example: tiger, crocodile.
Omnivores	Eats both plants and animals. Example: human.
Parasites	Live on the body of host and take food from it. Example: lice, cascuta.



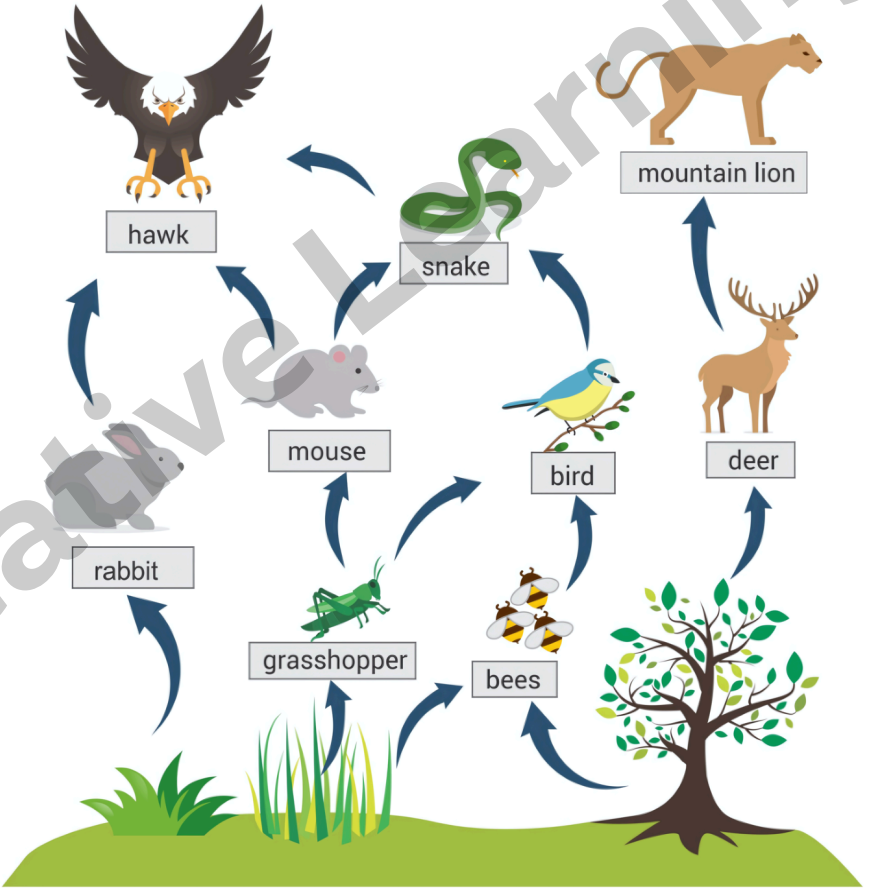
Food Chain

- *The sequence of living organisms in a community in which one organism consumes another organism to transfer food energy, is called a food chain.*
  - A food chain is unidirection where transfer of energy takes place in only one direction.
  - Food chain is sequential process which represents "who eats whom".
  - Food chain refers to an arrangement of different biotic groups in a sequence of energy transfer. These biotic groups are producer herbivores, carnivores.
- Example -
  - Grass → Deer → Lion



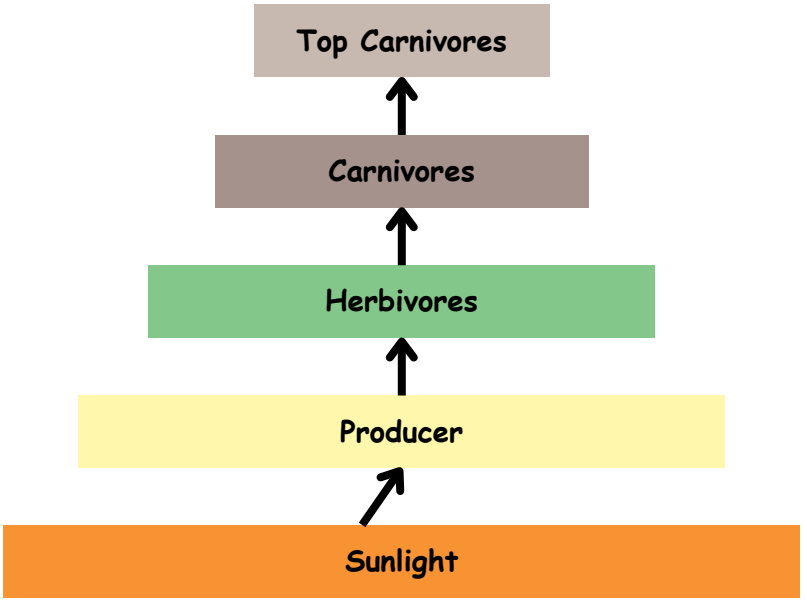
Food Web

- The inter-connected food chains operating in an ecosystem which establish a network of relationship between various species, are called a food web.
- In a food web, one organism may occupy a position in more than one food chain. An organism can obtain its food from different sources and in turn, may be eaten up by different types of organisms.



Flow of energy between trophic levels

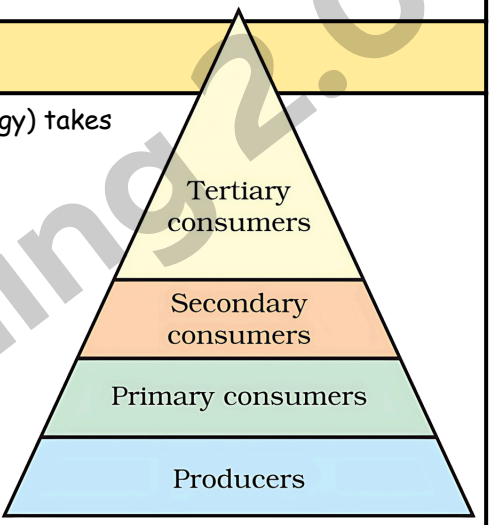
- Flow of energy in a food chain is unidirectional.
- Green plants capture 1% of sunlight and convert it into food energy.



- **10 percent law:** Only 10% of energy is transferred to the next trophic level. The remaining 90% energy is used in life processes (digestion, growth, reproduction etc.) by present trophic level.
- Due to this gradual decrease in energy, food chains contain 3-4 trophic levels.

Trophic Levels

- The various steps in the food chain at which the transfer of food (or energy) takes place is called trophic levels.
- The various trophic levels are given below :
  - The plant or the producers constitute the first trophic level.
  - The herbivores or primary consumers form the second trophic level.
  - Carnivores or secondary consumers make up the third trophic level.
  - Large carnivores or the tertiary consumers which feed upon the small carnivores constitute the fourth trophic level.
- **Biomagnification -** The concentration of harmful chemicals increases with every next trophic level in a food chain.
- Maximum concentration of such chemicals get accumulated in human bodies as human occupy the top level in any food chain.



Ozone layer

- Ozone layer is a protective blanket around the earth which absorbs most of the harmful UV (ultraviolet) radiations of the sunlight, thus protecting living beings from many health hazards such as skin cancer, cataract, destruction of plants etc.
- Ozone (O_3) layer is present at higher levels of atmosphere (i.e. stratosphere). It is a deadly poison at ground level.

Formation of Ozone molecule

- The high energy UV radiations break down the O2 molecules into free oxygen (O) atoms.

$$O \xrightarrow{(UV)} O + O \text{ (atoms)}$$

- These oxygen atoms then combine with oxygen (O2) molecule to form the ozone molecule.

$$O_2 + O \rightarrow O_3 \text{ (ozone)}$$

Depletion of ozone layer

- The decrease in the thickness of ozone layer over Antarctica was first observed in 1985 and was termed as ozone hole.
- This decrease was linked to excessive use of synthetic chemicals like chlorofluorocarbons (CFCs) which are used in refrigerators, ACs, fire-extinguishers, aerosols sprays etc.
- United Nations Environment Programme (UNEP) succeeded in forging an agreement to stop CFC production at 1986 levels (KYOTO PROTOCOL) by all countries.

Garbage Disposal

- Improvements in lifestyle have resulted in accumulation of large amounts of waste materials.
- Types of materials in Garbage
  - Biodegradable: Substances which can be decomposed by the action of micro-organisms are called biodegradable wastes.
    - Example: fruit and vegetable peels, cotton, jute, dung, paper, etc.
  - Non-biodegradable wastes: Substances which cannot be decomposed by the action of micro-organisms are called non-biodegradable wastes.
    - Example: plastic, polythenes, metals, synthetic fibres, radioactive wastes, pesticides etc.
- Micro-organisms release enzymes which decompose the materials but these enzymes are specific in their action that's why enzymes cannot decompose all the materials.

Methods of waste disposal

Biogas plant	• Biodegradable waste can be used in biogas plant to produce biogas and manure.
Sewage treatment plant	• The drain water can be cleaned in sewage treatment plant before adding it to rivers.
Land fillings	• The wastes are buried in low lying areas and are compacted by rolling with bulldozers.
Composting	• Organic wastes are filled in a compost pit and covered with a layer of soil, after about three months garbage changes to manure.
Recycling	• Non-biodegradable wastes are recycled to make new items.
Reuse:	• It is a conventional technique to use an item again. Example: newspaper for making envelops.