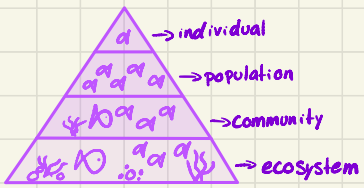
Ecosystem => A group of organisms interacting with each other and with the non-living parts of the environment

↳ biotic => living components

↳ abiotic => non-living components

a) Salinity
b) pH
c) temperature
d) light intensity
e) mineral availability

} influences a community of organisms.



-> ecosystems = **Open systems** -> but largely self-contained!

↳ both energy and matter can enter and exit the system

- Energy => as sunlight (stored chemical energy)
  => stored in the tissues of any organisms that migrate into system (or out)
- Matter => when an organism arrives / leaves the system

Usually, organisms stay within their ecosystem until they die. Then, the matter & energy stored in their tissues is recycled within the ecosystem.

*Closed systems -> like Earth!

- Matter can only be recycled
  ↳ **cannot** enter/ leave
- Energy **can** enter/ leave

Sunlight as a source of energy:

- Sun - initial source of energy in food chains

a) Light energy => Chemical energy
   via producers

b) Chemical energy => primary consumers
   Stored in plants ↳ as they eat plants

c) Chemical energy => secondary consumers
   in primary consumers ↳ as they eat 1st consumers

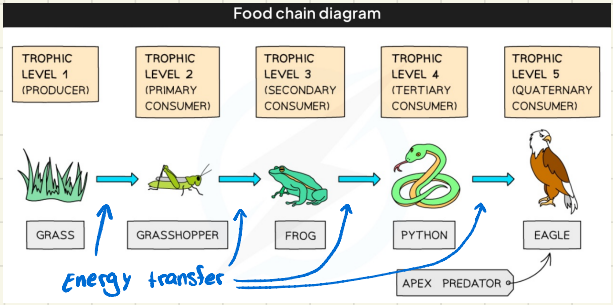
} Exceptions:
- deep sea volcanic vents
- Underground caves

} energy from chemical process as initial source.

Food chains/webs

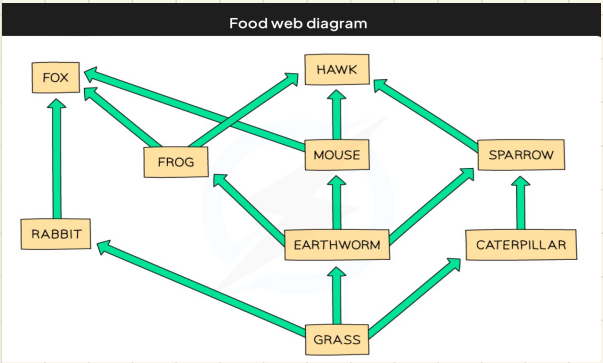
Food chains

- Feeding relationship (shows)
- Arrows = energy transfer
  - ↳ From 1 trophic level to the next
- Transfer of biomass



Food webs

- Show how several food chains are connected
  - ↳ There are multiple food sources for individual organisms



Decomposers ! carbon compounds

- Inorganic nutrients are converted into carbon compounds
  - ↳ carbs ! proteins => inside tissues of living plants ! animals
  - ↳ supply of these is finite
    - when organisms die, they have to be released
      - => carbon compounds => back to inorganic nutrients (used by producers)
- **decomposition** => process of breaking down the bodies of dead organisms
  - ↳ enables cycling of nutrients
    - Breakdown of molecules in the bodies of dead organisms
  - ↳ carried out by **decomposers**
    - a) Detritivores => initiate by breaking apart tissue
    - b) Saprotrophs => release enzymes that break down organic molecules
      - ✗ Releasing inorganic nutrients
      - ✗ These absorb some nutrients and leave some in soil for producers

Organic
"contains carbon"

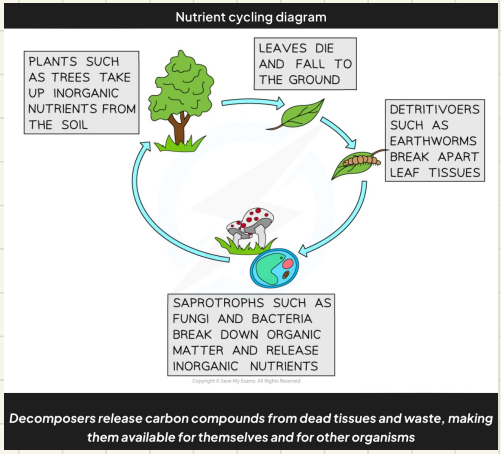
1. Carbs
2. Lipids
3. proteins

} energy building nutrients

4. Vitamins
   - ↳ speed up metabolism/ energy convertion

inorganic
"does not contain carbon"

1. H_2O
2. Minerals (Ca, P, Mg, Fe, I, Na, K)
   - a) Ca, P, Mg => bone health
   - b) Fe => O_2 transfer in blood (heam group)
   - c) I => thyroid health
   - d) Na, K => Pump + movement



Autotrophs ∴ Carbon Compounds

- ATP comes from CC
- Mode of nutrition => how an organism aquires the CC (Carbon Compounds) to make energy
  1. Heterotrophy
  2. Autotrophy
     - ↳ Autotrophs produce their own organic molecules from simple inorganic substances
       - a) Photosynthesis => ligh E ~~> organic molecules [Photoautotrophs]
       - b) E from oxidation of inorganic compounds [Chemoautotrophs]
     - ↳ Organic molecules produced => built into macromolecules
       - anabolic process
     - ↳ Producers (like)
       - i) green plants
       - ii) cyanobacteria
       - iii) algae
  1. Photoautotrophs
     - ↳ Light energy => release e^- => light independent (Krebbs cycle) => $C_6H_{12}O_6$
  2. Chemoautotrophs
     - ↳ Oxidise inorganic chemicals to get e^-
       - Some bacteria
         => Fe^{2+} into Fe^{3+}
     - ↳ Producers where light is unavailable

Heterotrophs ∴ Carbon compounds

- Gain their CC by ingesting the tissues of other organisms
- Ingest biological material, digest it, build it back up
  - ↳ May happen inside or outside body
- Dif. types:
  - a) Consumers
  - b) detrivores
  - c) Saprotrophs

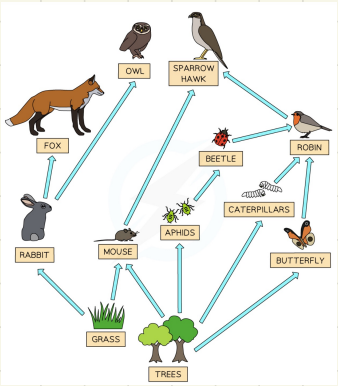
Trophic Levels

- Trophic levels = position of an organism in a food chain
- Indicate how many organisms energy has passed through

E from Apex Predator = passed on to decomposers when they die.

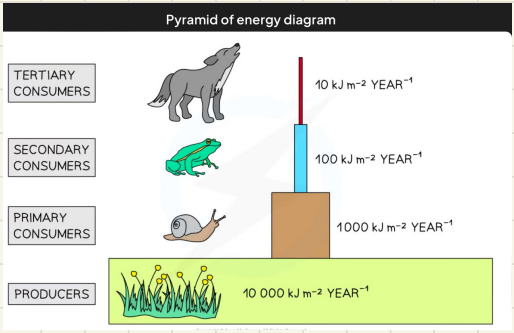
Some organisms have a varied diet => might be a part of multiple trophic levels.

Trophic levels table		
Trophic level	Name of trophic level	Description of trophic level
1	Producers	Organisms that produce their own carbon compounds using, e.g. light energy
2	Primary consumers	Herbivores that feed on plant tissue
3	Secondary consumers	Carnivores that are predators of primary consumers
4	Tertiary consumers	Carnivores that are predators of secondary consumers
5	Quaternary consumers	Carnivores that are predators of tertiary consumers



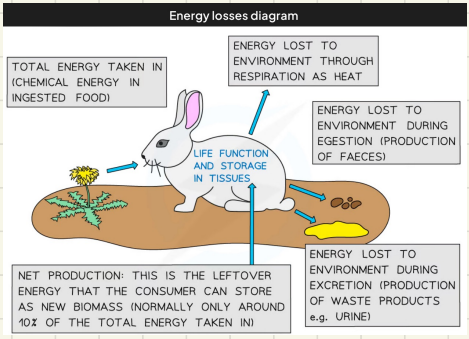
Pyramid of Energy

- illustrate energy contained within organisms biomass
  - ↳ total mass of living material
- Length of each box represents E present
  - ↳ Should be drawn to scale so length = proportional to E represented
- Always => widest @ base => decrease
  - ↳ There is + E contained within biomass of producers
- Show stepped decrease in E contained
  - ↳ E availabe decreases => not all E transferred to next biomass
    - Around 10% (due to)
      - i) Incomplete consumption — Not all the organism is eaten (wood, sticks, bones)
      - ii) Incomplete digestion — cellulose or fur cannot be digested
      - iii) Heat E loss => respiration
      - iv) Excretion of waste products — Excretion => urea in urine
      - v) Not all organisms are consumed



Units => E, per unit area, per year

$kJ\ m^{-2}\ year^{-1}$

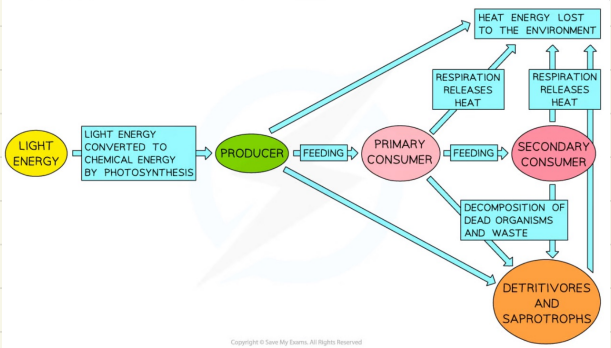


Heat loss to environment

- Heat is lost (during cellular respiration) to environment
  a) Producers
  b) Consumers
  c) detritivores
  d) Saprotrophs
- By process of radiation

Role of decay organisms:
→detritivores & saprotrophs are not part of food chains but they do allow energy loss to occur.
↳decompose animal parts that were uneaten
↳break down waste material

Energy lost as heat diagram



Number of Trophic levels & energy loss

- Food chains usually don't have more than 4/5 trophic levels
  ↳ After this, too difficult for predators to hunt enough
- Biomass decreases w/ each trophic level
  a) Fewer individuals
  b) Smaller individuals

} each next consumer has to intake more of the previous trophic level to gain enough E to survive!

Primary production

- light E into chemical E = producers
- Accumulation of CC in autotroph's biomass = Primary production
  - ↳ Biomass accumulates as organisms grow + reproduce
  - ↳ Occurs more quickly in some biomes than in others
    - a) More sunlight
    - b) Optimum temp.
    - c) High rainfall

    } Photosynthesis occurs @ higher rate
- Rate of primary production
  - ↳ Rate @ which producers => light into chemical E

Area: $gm^{-2}y_r^{-1}$

Volume: $gm^{-3}yr^{-1}$ ↳ in aquatic habitats

Secondary Production

- Heterotroph => Organism that gains CC through consumption ⁝ ingestion
  - ↳ The chemical energy stored in organism's biomass is transferred to consumer
    - Stored in their own biomass [not all] → CO_2 lost (respiration), → E lost during excretion

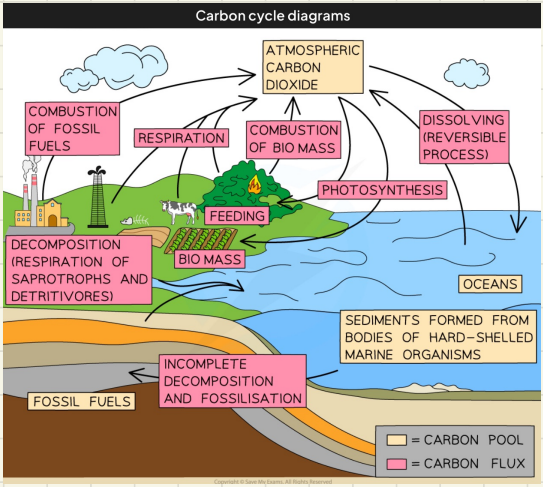
Rate of secondary production < rate of primary production (considering losses)

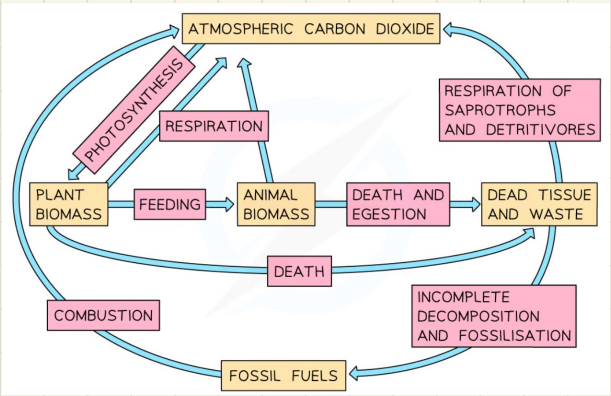
Subtracting respiratory losses from stored energy ingested.

Carbon Cycle

Many processes by which carbon is transferred from one store ⇒ another

- During carbon cycle ⇒ carbon is present in both organic ⁝ inorganic forms
  - i) Organic carbon ⇒ carbs ⁝ proteins
  - ii) Inorganic carbon ⇒ atmosphere as CO_2 / HCO^-





Carbon Sinks ⁝ Sources

- **Carbon Sink** ⇒ part of the carbon cycle that takes up and stores carbon
  - a) Plants take up CO_2 when they photosynthesise and convert it into cc which they store in their tissues
  - b) Plant material sometimes fail to decompose
  - c) CO_2 dissolves in oceans
- **Carbon Source** ⇒ part of the carbon cycle that releases carbon
  - a) Plant material burned ⇒ carbon stored in tissues is released back into the atmosphere
  - b) The decay of dead / waste material ⇒ release of carbon

Net uptake ⁝ release of carbon dioxide

If... organism performs photosynthesis > respiration, net uptake of CO_2 ↳ "carbon sink"

If... organism performs photosynthesis < respiration, net release of CO_2 ↳ "carbon source"

Release of CO_2

- Through burning fossil fuels & organic material
  - ↳ Combustion
    - a) CO_2
    - b) H_2O

  } byproducts

1. Fossil fuels:
   - i) Coal
   - ii) Oil
   - iii) Natural gas

   } These = formed over millions of years from bodies of dead plants / animals
   Releases C that has been stored for a prolonged time
2. Peat:
   - ↳ Material formed when plant matter does not fully decompose [waterlogged / acidic conditions]
3. Biomass:
   - ↳ Plant matter

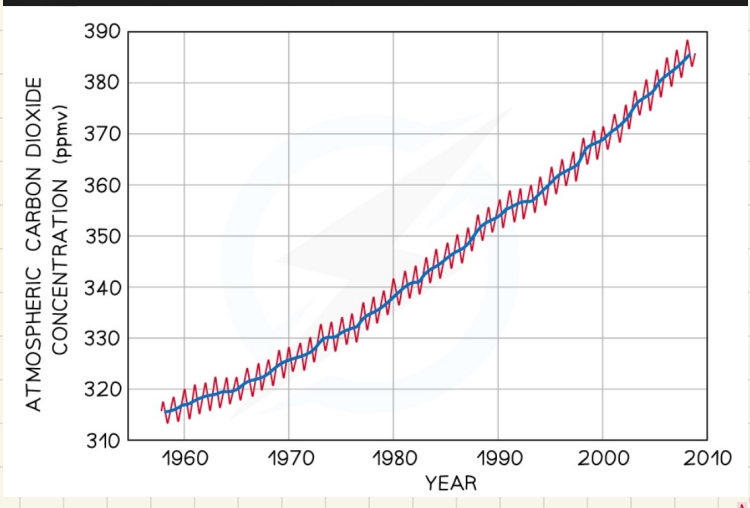
- Organic material burns when fires occur
  - ↳ Increased over time
    - a) Humans
    - b) Climate change

Burning of biomass has less environmental impact than burning peat / fossil fuel
- ↳ C contained in plants has been removed recently from atmosphere
- ↳ C in peat -> 1000+ years
- ↳ C in fossil fuels -> 1,000,000+ years

decrease of CO_2 during Spring & Summer

increase of CO_2 during autumn & Winter

Keeling curve graph



Interaction between autotrophs ⋮ heterotrophs

- Photosynthesis => autotrophs
  - ↳ CO_2 => O_2
  - ↳ Atmospheric oxygen
- Respiration => autotrophs ⋮ heterotrophs
  - ↳ O_2 => CO_2

transfer of carbon = fluxes

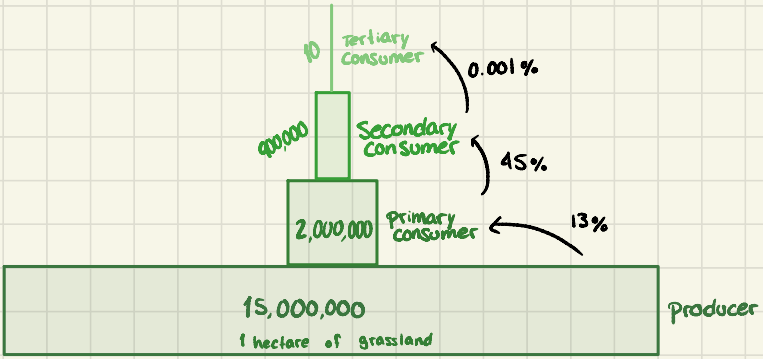
Recycling of chemical elements in ecosystems

- Carbon
- Nitrogen
- Calcium
- Phosphorus
- Sulfur
- potassium

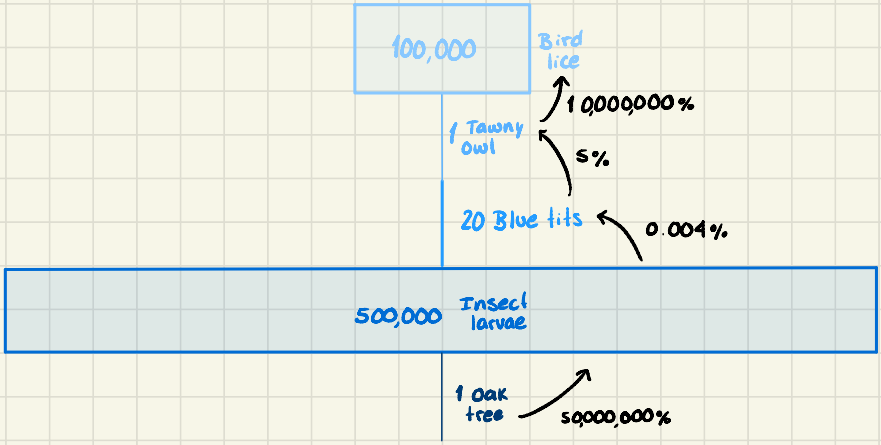
These are incorporated into biological molecules within tissues of living organisms => released back when decomposed.

Pyramids of numbers

1sq = 1,000,000

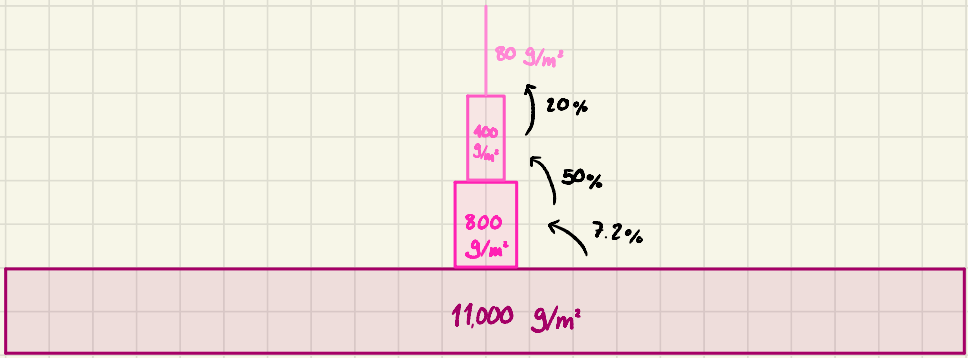


1 sq = 25,000

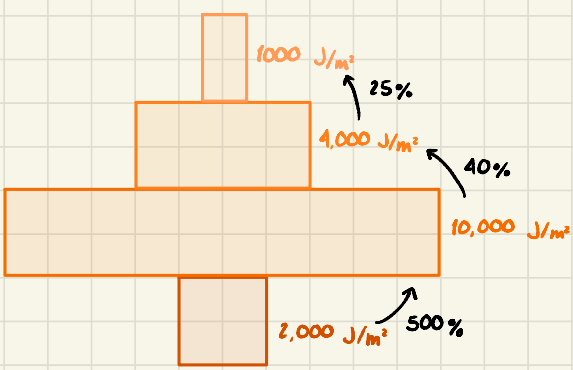


Pyramids of biomass

1sq = 500



1sq = 1000



Pyramid of Productivity/Energy

1sq = 200