UNIT 1: chemistry of life

Class	BIO
Weighting	low

structure of water and hydrogen bonding

- components of molecules and their sequence determine their properties

- living systems NEED properties of water that come from its **polarity** and **hydrogen bonding**
  - water = 2 hydrogen + 1 oxygen (more electronegative than hydrogen)
  - **polarity = difference in electronegativity**
  - **hydrogen bond = weak bond interaction between negative and positive regions of two molecules**

- hydrogen bonds between water molecules result in:
  - ***cohesion*** — water can stick to other water (e.g. the sea)
  - ***adhesion*** — water can stick to other stuff (e.g. rain on window)
  - ***surface tension*** — water can resist external force (e.g. water strider can float)

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elements of life

- organisms must exchange matter with each other to grow, reproduce, and maintain order

- cellular energy

organisms require constant **input** of energy to facilitate metabolism

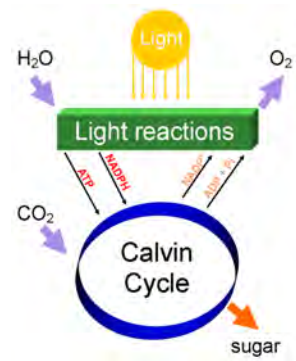
- ***second law of thermodynamics*** 🔥 — `input energy > energy loss` to **maintain order**
  - processes that lose energy require gain of energy
  - `loss of order/energy flow = death` 💀
- energy is **conserved**; energy is released as waste and acquired through plants (energy transferred from plants → trophic levels) 🔁

- photosynthesis

$H_2O + CO_2 \rightarrow glucose + O_2$

photosynthetic organisms (plants/bacteria) capture energy from sun and produce sugars 🌟

- photosynthesis first evolved in **prokaryotes** 🧬
- **cyanobacteria** were responsible for producing **oxygenated** atmosphere
  - foundation for eukaryotic photosynthesis 🌱



- cellular respiration

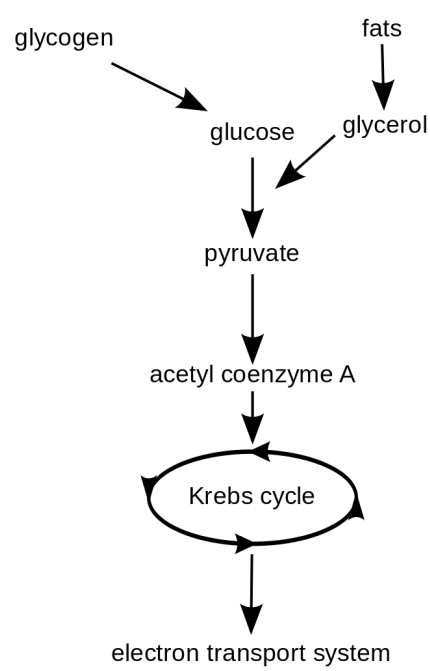
$glucose + O_2 \rightarrow H_2O + CO_2$

all organisms undergo cellular respiration/fermentation by breaking down carbohydrate to produce energy (i.e. **ATP**)

1. **glycolysis**
2. **Krebs cycle**
3. **e- transport chain**

in the absence of oxygen, organisms respire **anaerobically** i.e. **fermentation**

- Krebs cycle and e- transport chain **cannot** take place because there is **no final electron acceptor**
- other molecules will have to be used as electron acceptors (e.g. making lactic acid/alcohol)
- since only glycolysis is underway, ATP production is way lower



3. **tRNA** molecules bind amino acids that correlate to **anticodon** on mRNA

RNA Molecule	Function
Messenger RNA (mRNA)	Serves as a temporary copy of the DNA, travels from the cell's nucleus to the cytoplasm for transcription.
Ribosomal RNA (rRNA)	The structural component of the ribosome in which transcription takes place
Transfer RNA (tRNA)	Brings the correct amino acid to each of the mRNA's codons

4. enzymes modify **mRNA transcript** via
   a. add **poly-A-tail** — extra adenines to tail; added so when there is mutation (i.e. deletion), the actual code is unaffected
   b. add **GTP cap** — added to beginning of strand (guanine triphosphate) to act as recognition signal for ribosome to bind to mRNA strand
   c. **alternative splicing** — to remove **introns** and combine **exons** together; removes unnecessary patterns

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translation

converting RNA → polypeptide chain

- in eukaryotic cells, this happens in the rough ER
- in prokaryotic cells, this happens at the same time as transcription

1. ***initiation*** — when rRNA interacts with mRNA at **start codon**
   - nucleotide triplet code = **codons**
     - pair with anticodons
     - universal genetic code = common ancestry between living organisms
2. ***elongation*** — tRNA brings amino acid needed by mRNA codons
   - chain of amino acids = polypeptide which forms a protein
3. ***termination*** — polypeptide chian grows until **stop codon** is reached
   - releases newly formed protein
   - ***retrovirus*** — viruses deviate from central dogma because they use reverse transcriptase to make DNA from RNA
     - **reverse transcriptase —** enzyme that copies viral RNA genome to DNA
       - the now-viral DNA is integrated into host genome
       - became translated and transcribed into new viral progeny

- organisms that gain more energy than it uses will grow and store energy, leading to survival and reproductive fitness

population

▼ `SYI` **describe factors that influence population growth dynamics**

> 💡 population growth is dependent on birth/death rate, resource availability and environment condition. when there is no carrying capacity, population grows exponentially. if there is a carrying capacity, then there is a logistic growth and levels off when the max carrying capacity is reached.

- all organisms need food, shelter, etc. and if any of these change, population changes

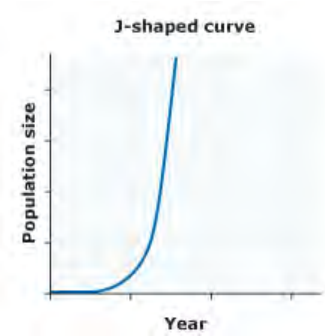
$$dN/dT = B - D$$

N = population size
dT = change in time
B = births
D = deaths

$$dN/dT = r_{max}N$$

N = population size
dT = change in time
r_{max} = maximum per capita growth rate of a population

exponential

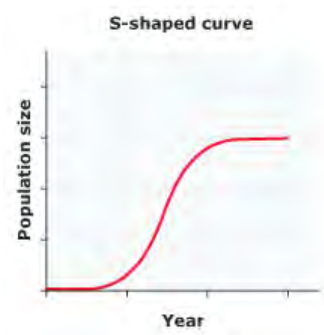


- growth in an **ideal** environment
- no carrying capacity

$\Delta N/\Delta t = r\textbf{max}\ N$

$r\textbf{max} =$ maximum growth rate per capita

logistic



- has **carrying capacity**
- growth levels off when capacity is reached