BIOL1020 Notes

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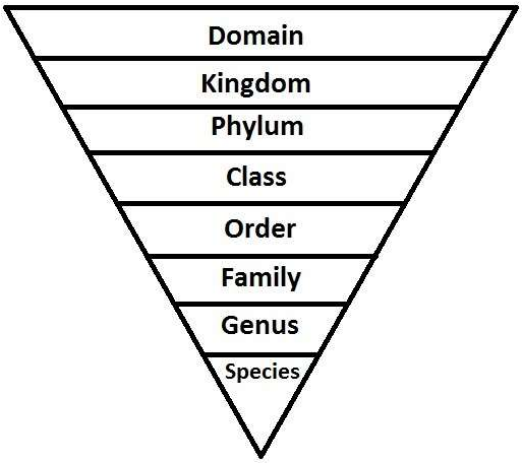
GENERAL TERMS

Polar = molecule is overall neutral, but arrangement of electrons in molecule is such that one end has a positive charge while the other has a negative charge

Charged = molecule has been ionized such that it has an overall negative or positive charge

TAXONOMY [1.2]

Refers to the classification of organisms.



e.g. Eukarya -> Animalia -> Chordata -> Mammalia -> Primate -> Hominidae -> Homo -> Homo Sapiens

PRE-EVOLUTION EXPLANATIONS OF DIVERSITY & UNITY [1.2]

Aristotle & Linnaeus: all forms of nature are fixed

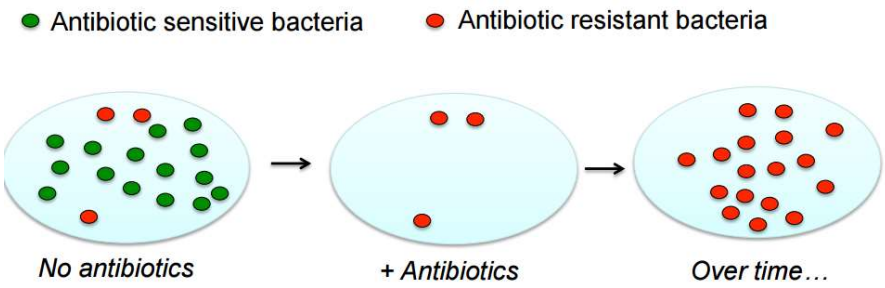
> **FLAW:** low explanatory power

Lamarck: Animal traits change through its lifetime though use and disuse. New traits are passed onto off spring. *E.g. Giraffe's have long necks because they stretch to reach high places*

> **FLAW:** animals do not tend to pass on traits acquired through lifetime to offspring.
> *E.g. gym goers do not produce babies with rock hard abs*

EVOLUTION [1.2]

Traits evolve though natural selection. Organisms with advantageous traits survive & reproduce. Minor changes in organisms are caused by mutations; minor dna changes caused by errors in replication or environmental factors like UV light.



genetic drift: the change in the frequency of a gene variant (allele) in a population due to random events (e.g tree falls on family, allele by chance not passed on in sexual reproduction, etc).

Gene flow: also known as **migration** is any movement of individuals, and/or the genetic material they carry, from one population to another

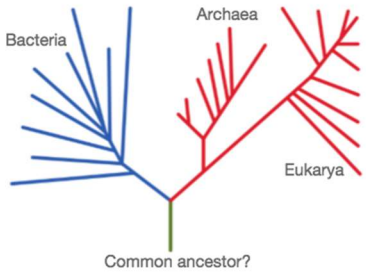
Reproductive isolation: populations cannot reproduce with each other due to e.g. geographical separation. Can result in independent evolution in response to differing environments. Mechanism of macroevolution

Microevolution: occurs over a smaller timescale; results in altered gene frequencies in populations
Macroevolution: occurs over a longer timescale; results in macro effects such as speciation

THREE DOMAIN TREE OF LIFE

Three broad domains of life: Bacteria, Archaea, Eukaryote

Despite **Archaea** being morphologically similar to **bacteria**, they are actually more closely related to **eukaryotes**.



ENERGY AND MATTER

Organic molecules: molecules that contain carbon & hydrogen

Producers: convert carbon dioxide into organic molecules. Energy required to do this is manly acquired from the sun.

Photosynthesis: process by which sunlight is used to make organic molecules from carbon dioxide
carbon dioxide + water + energy -> organic molecules + oxygen

Consumers: acquire organic matter by eating producers (and other consumers). Attain energy from organic matter via **CELLULAR RESPIRATION**
organic molecules + oxygen -> carbon dioxide + water + energy

Decomposers: consume organic matter from waste products and once-living organisms

Geochemical cycles: transfer of matter through living and non-living parts of the ecosystem (e.g. carbon cycle, water cycle)

SCIENTIFIC PRINCIPALS

Scientific law: general statement based on repeated observations that can be used to predict future observations (e.g. the cell is the basic unit of all forms of life)

Scientific theory: attempts to explain a broad group of laws and observations (e.g. the concept that natural selection results in evolution is a theory that attempts to explain how differences arose among various organisms)

DNA [1.2]

DNA = **D**eoxyribo**n**ucleic **A**cid

Heritable information molecule in cells.

Geans encoded on DNA.

Geans encode proteins.

Expression of proteins determine structure and function of cells.

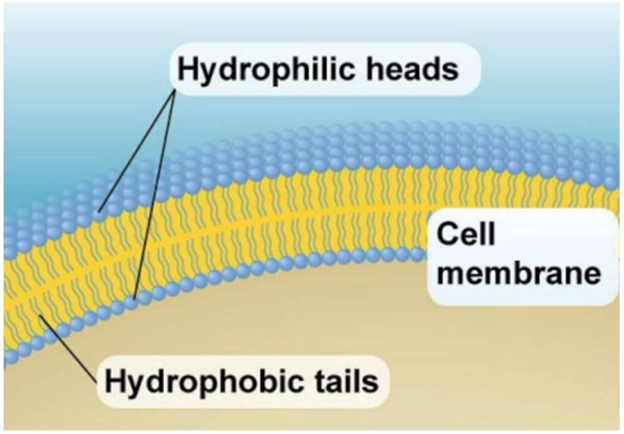
Cells can inherit DNA from other cells via:

- Conjugation/Transduction
- Mitosis (cloning)
- Meiosis
- Asexual + Sexual reproduction

CELL MEMBRANES // PLASMA MEMBRANE [1.2]

All cells have membranes

- Lipid bilayer
- Hydrophobic heads on outer and inner surfaces of membrane
- Hydrophobic tails in middle of membrane
- Semi-permeable; nutrients, waste, proteins, ions, etc can pass



CARBOHYDRATES [2.1]

Sugars and their polymers

provide energy & structure

Consists of carbons bonded with waters (hence name)

Monosaccharide: single sugar molecule (also referred to as **simple sugars**) (e.g. glucose, fructose, galactose)

have the chemical formula $(CH_2O)_n$

Monosaccharides can be joined by a **GLYCOSIDIC LINKAGE**, forming:

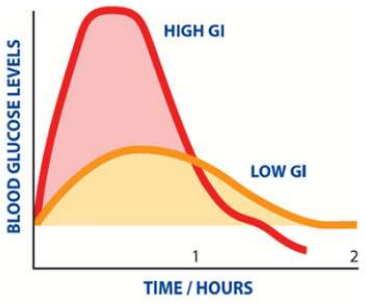
Disaccharide: two sugar molecules (e.g. sucrose, lactose)
Oligosaccharide: three to ten sugar molecules
Polysaccharide: long chain of sugar molecules (e.g. starch, glycogen, cellulose)

Body needs to break complex sugars into simple sugars to use.

CARBS IN FOOD: GLYCEMIC INDEX (GI)

GI measures how quickly your blood-glucose level rises after eating carbs

Quicker good digested -> faster blood glucose rises -> high GI



MONOSACCHARIDES

Simplest sugars
can be used for fuel
con be used as raw materials to synthesise things like amino acids and nucleotides
can be combined into sugar polymers

Skeleton: 3-7 carbon atoms connected in chain
carbonyl group ($\mathbf{C=O}$): attached to one of these carbons
hydroxyl groups ($-\mathbf{OH}$): attached to other carbon atoms

Monosaccharides classified by:
1 - the location of the carbonyl group
2 – number of carbons in carbon skeleton
3 – the spatial arrangement of the hydroxyl groups around the asymmetric carbons (referred to as **chirality or handedness**)

[1] LOCATION OF CARBONYL GROUP
aldose: carbonyl group on a terminal carbon

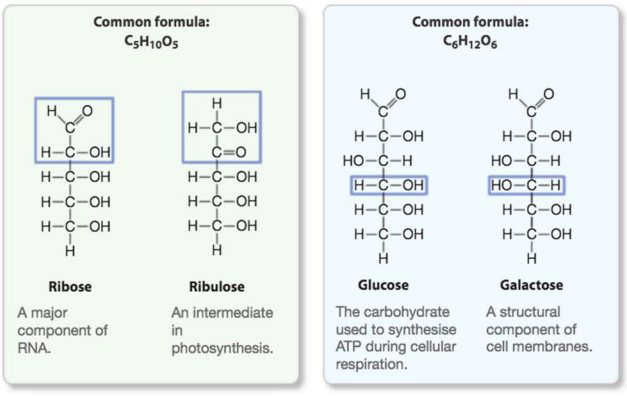
ketose: carbonyl group is within the carbon skeleton
(e.g. carbon bonded to two other carbons + double bonded to oxygen)

[2] NUMBER OF CARBONS IN CARBON SKELETON
ranges from 3 to 7

triose: three carbons
tetrose: four carbons
pentose: five carbons
hexose: six carbons
heptose: seven carbons

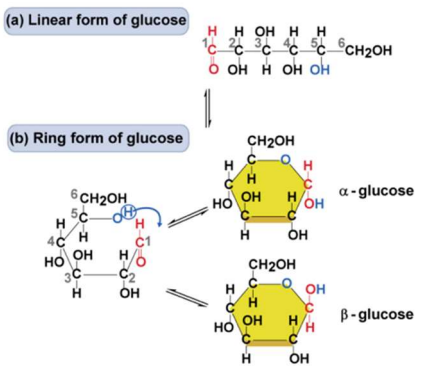
Naming conventions [1] and [2] can be combined, e.g. aldohexoses

[3] HOW HYDROXYL GROUPS ARE SITUATED AROUND CARBON ATOM (chirality or handedness)
EXAMPLE: glucose and galactose are both aldohexoses with identical chemical formulas. The only difference is the orientation of the middle hydroxyl group, yet these chemicals have different properties. (SEE FIG)



Linear VS Ring

Generally we talk about glucose in its linear form, but it can also exist in a ring form when in water.



The ring can assume two conformations:
alpha = OH below C1
beta = OH above C1

Other monosaccharides can exist in a ring form. This ring form occurs when a bond is formed between the carbonyl group and the hydroxyl group.

POLYSACCHARIDES

Monosaccharides can be joined together to form polysaccharides. used for energy storage and structure (e.g. cell walls)

Oligosaccharides = polysaccharides of 3 to 10 monosaccharides

For example, if a cell has more glucose than it immediately needs it may join glucose monomers together into a storage polysaccharide that is tightly packed, permitting efficient long term storage.

GLYCOSIDIC LINKAGE: the covalent bond that holds two monosaccharides together in a polysaccharide. It is is formed when a hydroxyl group (-OH) is lost from one monomer and a hydroxyl hydrogen (H) atom is lost from the other, resulting in the production of a water molecule (hence called a **DEHYDRATION REACTION**).

Immune system uses **oligosaccharides** attached to **glycoproteins** on cell surfaces. These oligosaccharides are unique to different types of cells, and can hence be used for identification.

STARCH

- Polymer of glucose monomers
- major storage form of glucose in plants
- 1-4 bonds form main chain
- 1-6 linkages to branches [INFREQUENT]
- Glucose monomers in α configuration -> humans can digest
    - As humans have enzyme that can break links between α glucose

Starch comprised of:
Amylopectin: Polysaccharide, highly brached, hence digested quickly
Amylose: Polysaccharide, tightly packed, hence resistant to digestion

GLYCOGEN

- Polymer of glucose monomers
- Major storage form of glucose in animals and fungi
- 1-4 bonds form main chain
- 1-6 linkages to branches [FREQUENT]
- Glucose monomers in α configuration -> humans can digest
    - As humans have enzyme that can break links between α glucose

CELLULOSE

- Major component of tough walls that enclose plant cells
- Humans cannot digest as monomers in β config – do not have enzyme to break links

GLYCOPROTEINS

- Combo of proteins and carbs
- Usually found on cell surfaces
- Carb units + protein chains
- Can be used to ID type of cell
    - Immune system IDs bacteria & viruses based on their unique cell-surface glycoproteins

CHITIN

- Occurs in cell walls of fungi
- Highly resistant to digestion
- Can be used as surgical thread

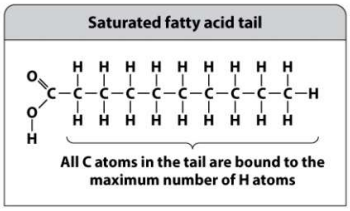
LIPIDS [2.1]

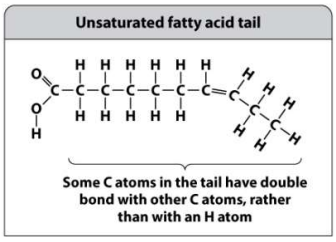
Diverse range of hydrophobic molecules

Found in cell membrane, storage compounds, etc

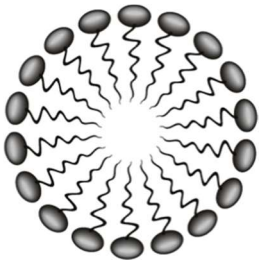
Cholesterol: prevents Phospholipids from bunching together too close or separating too far in temperature extrema, maintains integrity of cell membrane

FATTY ACIDS



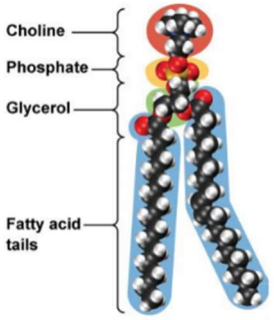


- Long hydrocarbon chain with carboxylic acid functional group on one end
- Energy stored within hydrocarbon tail
- Hydrocarbon chain held together by nonpolar covalent bonds, which are hydrophobic
- Carboxylic acid functional group is polar and hydrophilic
- Vary in length, # bonds, location of double bonds
- As **amphipathic** (hydrophilic at one end, hydrophobic at the other). Hydrophobic tail points away from water, hydrophilic head points toward water. In fatty acids this forms **MICELLE** (see right).



- **Saturated fatty acid**
  - Max number of hydrogen atoms possible
  - No double bonds
    - Tails straight -> pack tightly -> solid at room temp
- **Unsaturated fatty acid**
  - Have one or more double bonds
    - Kink in tails -> don't pack tightly -> liquid at room temp

PHOSPHOLIPIDS



- Derived from glycerol
- **Amphipathic**: hydrophobic at one end and hydrophilic at the other
- Hydrophilic head – negative charge
  - Glycerol
  - Phosphate functional group
    - In cell membrane incorporate choline chemical modification
- Hydrophobic tails – no charge
  - Fatty acid tails
  - Attached to glycerol by **ESTER LINKAGE**
  - Hydrocarbon chains repel water
  - Kink exists in fatty acid chain when double bond occurs – prevents v. tight packing
- Preferentially form bilayer of cell membrane. Can form micelles, but bilayers are preferred as kink in tail prevents tight packing requisite of micelles.

EXCEPTIONS IN ARCHAEA:

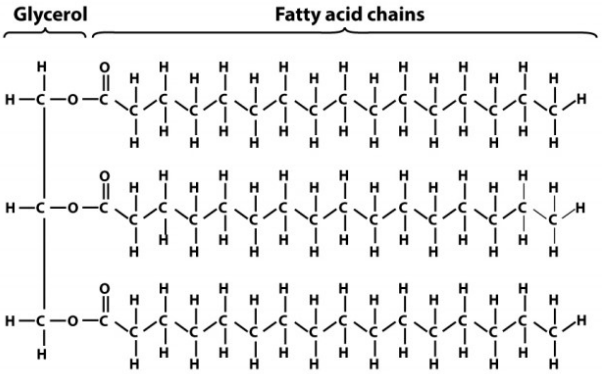
- isoprene chains instead of fatty acid chains (similar to fatty acid chains, but with methyl side groups)
- Ether linkage rather than ester linkage connect isoprene to glycerol
- isoprene chains on opposite sides of the bilayer can become fused, forming a more rigid monolayer

all three properties work to make archaea more capable of survival in hostile environments.

FATS AKA TRIACYLGLYCEROL

Constructed from:

- Single glycerol
- three fatty acids



Formed from dehydration reaction between carboxyl functional group on fatty acid and hydroxyl functional group on glycerol. Linkage between glycerol and fatty acid chain are **ester links**

Hydrophobic

If all three chains are saturated then likely solid at room temp due to tight packing

If some chains are unsaturated and hence kinked, likely liquid at room temp (e.g. oil)

Trans fat: unsaturated, but trans double bond does not produce kink, allowing for solid at room temp. Have adverse health effects re cholesterol

Plants mainly store energy in polysaccharides molecules (e.g. starch), but in seeds oil is also found.

In animals, fats are the main form of long term energy storage (as twice as energy dense as polysaccharides)

STEROIDS

Are lipids

Inc. sex hormones and cholesterol

Cholesterol is a precursor for other steroids, and exists in the cell membrane of animal cells to increase fluidity

Steroids are transported through blood by lipoproteins (large aggregates of molecules made of proteins and lipids). Lipoproteins have hydrophilic exteriors that allow them to move through blood.

There are five categories of lipoproteins, but most important: high-density lipoprotein (HDL) and low-density lipoprotein (LDL)

LDL (bad cholesterol) carries cholesterol from liver to cells in body. This can cause an accumulation of fatty substances of artery walls.

HDL (good cholesterol) carries cholesterol from cells of body to liver where it can be eliminated

LDL/HDL ratio is a good indicator of cardiovascular health

Atherosclerosis: deposits of fatty material on artery walls, significant contributing factor is cholesterol and trans fats