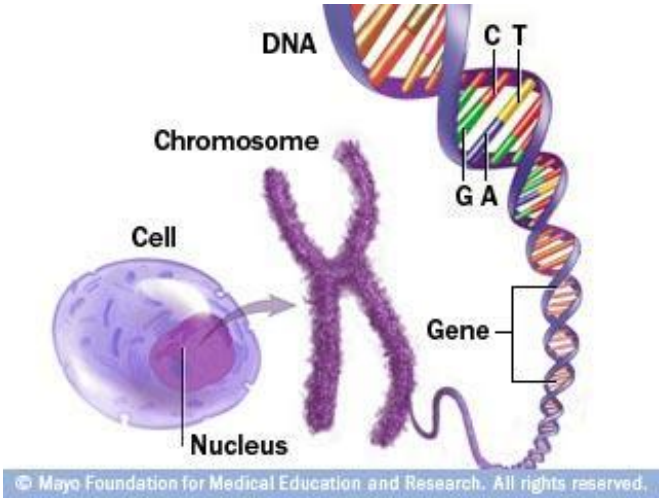
BIOL1020 Study Guide Sample

This study guide covers generally all of the content from weeks 1 to 13 primarily based on the textbook with moderate input from lecture slides. These study notes aim to balance conciseness and thoroughness of course content. They structured in the way of key concepts week by week with additional notes that are less relevant but could still pop up in exams. Only key diagrams have been included to reduce excessive pages. Note that some of the practical components are not included. Highlighted words/concepts are of critical importance in understanding. Furthermore, some "Note to self" points have been included to guide the learning of content.

Week 1

Key Concepts

- Evolution – Pre-Darwin: where most taxonomic schemes classified organisms based on structural, anatomical and physiological characteristics. Carl Linnaeus pioneered binomial nomenclature (i.e. homo sapiens).
- Charles Darwin – Proposed the theory of evolution through natural selection which is a process resulting in the survival of individuals from a population that are best adapted to specific environmental conditions. The survivors tend to produce more offspring than those less well adapted, so that the characteristics of the population change over time to meet the environmental conditions.
- DNA constitutes the heritable information molecule in cells. Genes are encoded in DNA.



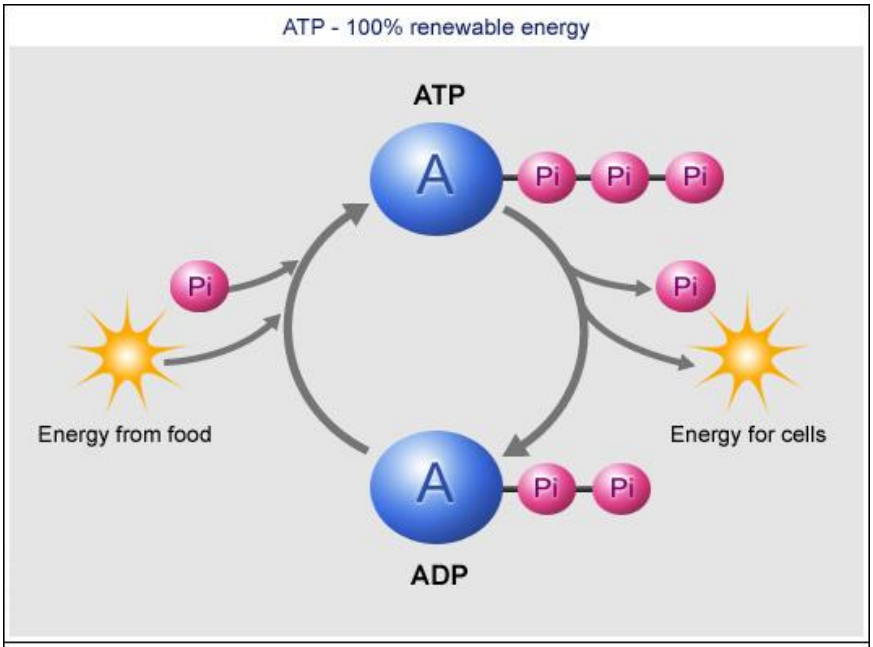
- Cells are basic unit of all life for organisms and reproduce through mitosis, meiosis, asexual, transduction or conjugation.
- All cells have cell membranes which are made up of primarily phospholipids (discussed further in week 2). Phospholipids consist of a hydrophilic head and

hydrophobic tail and thus are semi-permeable (allows some things to get through but blocks others).

- All cells also require and utilise energy to function.
- Different types of cells include eukaryotic and prokaryotic (bacterial) cells. The main similarities are that they all have a membrane, cytoplasm and proteins and carbohydrates. The major difference is that eukaryotic cells have a well defined nucleus where the DNA is located.
- Prokaryotic and eukaryotic cells will be elaborated in more detail in week 3.

Extra Notes

- One main form of energy is ATP (elaborated further in week 3 and 4).



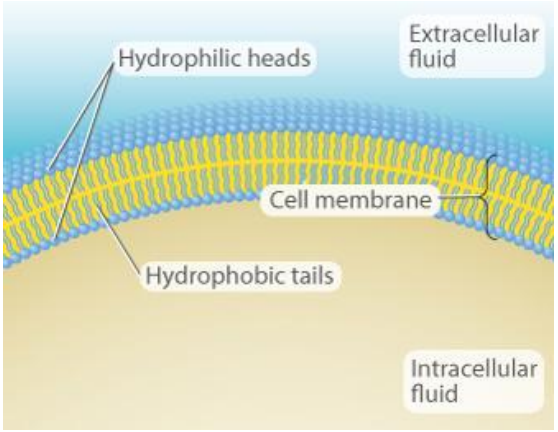
All living cells rely on one source of energy to do everything from building molecules to flexing muscles - ATP (adenosine triphosphate). Breaking down ATP releases energy, and cells constantly replace their ATP by wacking a spare phosphate onto ADP (adenosine diphosphate). The energy for that comes from food we eat (in animals) or make (in plants). Enzymes control the breaking and making of ATP.

- Eukaryotic cells also have organelles (specialised structures) for different process and thus this compartmentalises cellular processes.
- How are physical traits inherited and determined? Genes encode proteins which depending on expression and activity determine structure and function of cell.
- Note to self: You do not need to know every single component of a cell. Some main components will be touched upon in week 2/3.

Week 2

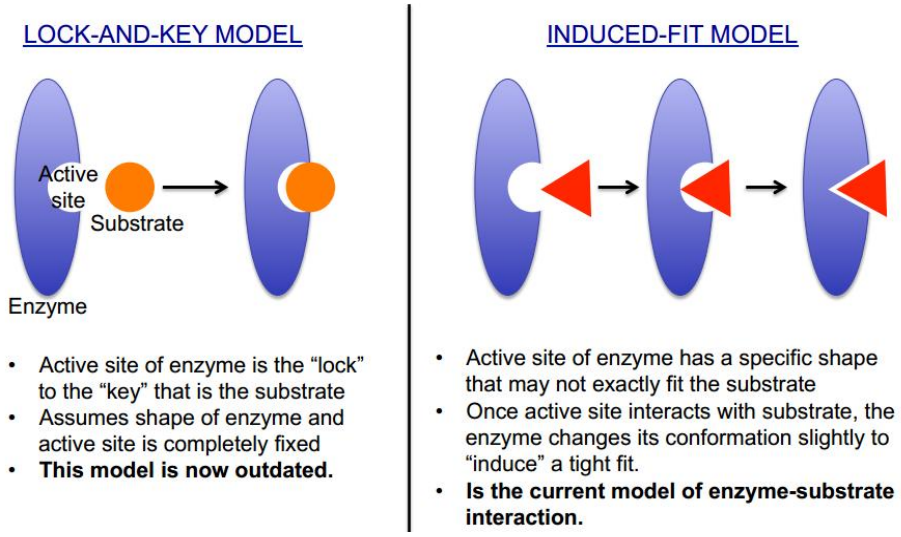
Key Concepts

- Cells are made up of 4 main macromolecules: Carbohydrates, Lipids, Nucleic acids and Proteins. In turn these 4 macromolecules are made up of smaller molecules or units known as monomers.
- A polymerisation also called a dehydration reaction is the reaction of linking of monomers. The opposite reaction is a hydrolysis reaction (removal of monomers)
- Carbohydrate monomer: monosaccharide (through glycosidic bond) and include glucose, disaccharide and polysaccharides.
- Lipids include fats (1 glycerol and 3 fatty acids), fatty acids and phospholipids. Fats are hydrophobic.
- Phospholipids are lipids with a phosphate group attached and are amphipatheic meaning they have both polar and non-polar regions. Phospholipids have hydrophilic heads (water-loving) and hydrophobic tails (water-hating).



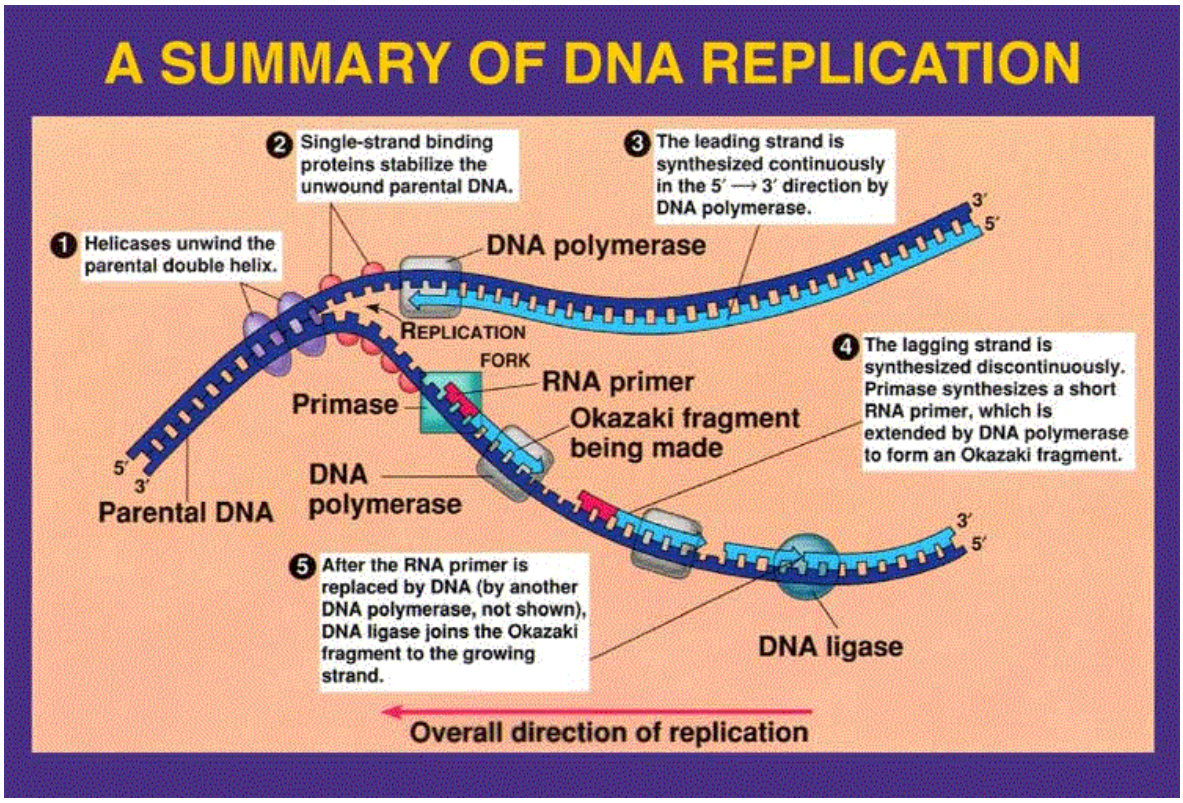
- Proteins have polymers of amino acids and are joined together by peptide bonds. Proteins are polymers of amino acids and have a wide range of regulatory and structural roles in a cell.
- Amino acids contain both carboxyl and amino groups. 20 amino acids make up all the proteins in the world.
- Proteins have 4 levels of structure: primary (unique order of amino acids linked together), secondary (the folding or coiling of the protein which shows its 3D structure and includes alpha helices and/or beta pleated sheets), tertiary (the overall 3D structure of the protein and focuses on the bonds/forces that hold the protein together. Includes hydrogen bonding, hydrophobic interactions, ionic bonding and van der waals forces) and Quaternary (the combination of 2 or more polypeptide chains also known as subunits).
- Enzymes are a specific enzyme that bind to a specific substrate in order to catalyse a reaction or process.

- Enzymes work like a lock and key model; and they lower the activation energy barrier of a reaction or process.



- The melhesen and stahl experiment was conducted in order to show that DNA replication was semiconservative which means that the new DNA strand contains an old parent strand and a newly synthesised strand.
  - The experiment worked by growing ecoli cells in nitrogen-15 isotope.
  - The ecoli cells with only nitrogen 15 isotope were placed back into a nitrogen 14 medium and allowed to divide.
  - DNA was extracted from the combined ecoli cells and compared to DNA extracted from both ecoli grown in pure nitrogen 15 and pure nitrogen 14.
  - The combined nitrogen 14 and 15 ecoli DNA was an intermediate of the pure nitrogen 14 and 15 DNA samples thus supporting the idea of semi conservative replication i.e. one strand of the combined nitrogen 14 and 15 DNA was of the pure nitrogen 14 and the other being the pure nitrogen 15 DNA samples
- DNA exists in ALL living cells.
- DNA is made up of nucleic acids (including deoxyribonucleic acid and ribonucleic acid). Joined together through phosphodiester bonds.
- DNA consists of a nitrogenous base attached to deoxyribose sugar further attached to 3 phosphates.
- How is DNA replicated? Firstly, background information: replication is semi-conservative, DNA replication occurs in the 5 prime to 3 prime direction (read from the new DNA strand) and a family of polymerases catalyse DNA synthesise.
  - Initially, DNA Helicase opens up the double helix at the origin by breaking hydrogen bonds. A replication fork is formed where the parent strands have their bases exposed. A replication fork occurs at both ends resulting in a replication bubble (less relevant).
  - Leading Strand: To start DNA synthesis, enzyme DNA primase adds RNA primer to the leading strand.

- DNA polymerase III extends RNA primer and continues the synthesis of the leading strand 5 prime to 3 prime.
- Lagging strand: replication is fragmented as polymerase III moves away from the origin (see diagram next page). RNA primers have to be made frequently to continue DNA synthesis which creates okazaki fragments (DNA fragments).
- Polymerase I then removes the RNA primers.
- Ligase joins the okazaki fragments to create continuous DNA strand.



Extra Notes

- Fatty acids can be classified as saturated and unsaturated where the former means they have no double bonds and they compact together meaning saturated fats are solids at room temp. Unsaturated fats have double bonds as well as kinks in their structure therefore are generally liquids at room temp.
- Amino acids differ in properties due to their differences in side chains.
- Lipids are important components of cell membranes.
- Complementary DNA strands of the double helix are considered to be antiprallel to each other as they run in opposite directions to each other. In biochemistry, this means that they run parallel to each other but with opposite alignments.
- Topoisomerase and single strand binding proteins prevent “tangling” of the parental DNA strand as it opens up.

- Note to self: You do not need to know: 1) the specific details of synthesis or hydrolysis reactions just know generally how the reaction and what is produced. 2) the specific structures or names of the 20 amino acids.