

SBI 4U Exam Outline

Topics:

Biochemistry: Macromolecule structure and Bonding, Denaturation of Proteins, Dehydration Synthesis and Hydrolysis

Metabolic Processes: Cellular Respiration and Photosynthesis (general processes, not details), Aerobic vs. Anaerobic Resp, Rf Calculations, Metabolism of Carbs vs Lipids

Genetics: Structure of DNA, Lac and Trp Operons, DNA replication, Protein synthesis, Mutations, Sanger Sequencing

Homeostasis: Types of Hormones, Adrenal Hormones, Anterior Pituitary Hormones, Reflex Arc, Neuron structure, Action Potential Graph, Feedback Diagram

Population Dynamics: Basic Terminology, Sampling Methods, Types of Distribution, Calculations (all formulas provided)

Exam Breakdown:

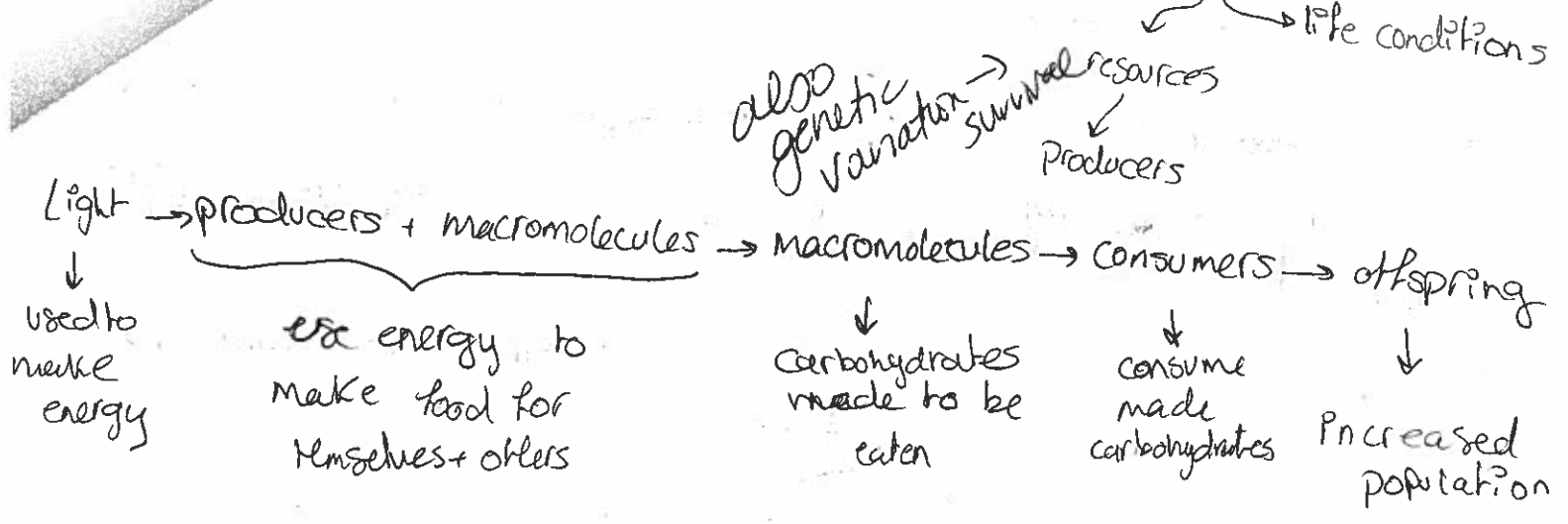
Part A – Multiple Choice	32 marks	20-30 min
Part B – Matching	8 marks	5-8 min
Part C – Short Answer and Calculations	35 marks	30-45 min
Part D – The Big Question	25 marks	30-45 min

Explain, how/why the **function and interaction of macromolecules** could be an *underlying theme* of the course.

Criteria:

1. Your answer must fit on one piece of ledger paper (both sides may be used).
2. You must include text explanation and diagrams.
3. You must use course terminology to illustrate your answer.
4. You must show course content across all 5 units, and clear connections between units.
5. Your answer must be clear, organized and focused.

...nd unit, we learned how populations are controlled (4)



Lack of macromolecules = lack of producers = lack of food = decrease in resources = competition = decrease in population = population termination

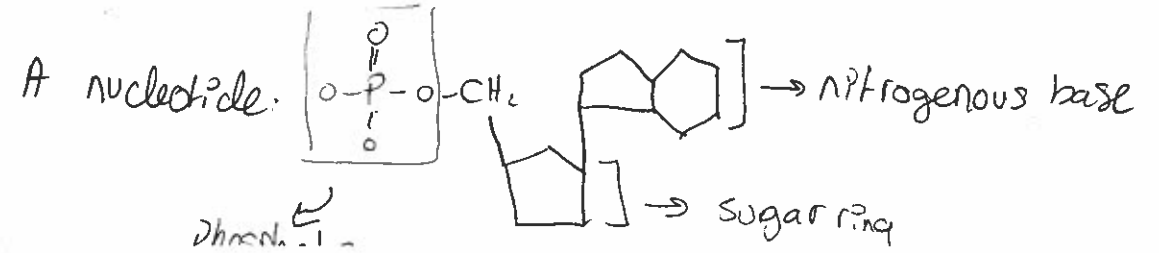
CONCLUSION

- * Macromolecules are the basic molecules needed for life
- * Organisms can't survive without them → biological processes won't happen
- * They make this course important as they are its foundation
- * This all means that they are the building blocks and underlying theme of this course.

This biology course consisted of five units: (1) Biochemistry, Metabolic processes, Genetics, Homeostasis, and Population Dynamics.

* As we go through each unit, we'll discover the underlying theme of macromolecules. * In the first unit, Biochemistry, we defined the macromolecules and their four types:

- ① Carbohydrates: they make up the most important sugars in the human body + other organisms
 - Monosaccharides { glucose, ribose/deoxyribose
 - Disaccharides { lactose, sucrose
 - Polysaccharides { cellulose, glycogen
- ② Lipids: made of C, O, H
 - Wax - protect organisms
 - Phospholipids - make up cellular membranes
 - Steroid - e.g. sex hormones and cholesterol
 - Triglycerides - energy source, cushion organs
- ③ Proteins: chains of amino acids that contribute to important functions that help organisms survive.
 - speed up reactions
 - transport important substances around the body.
- ④ Nucleic Acids: chains of nucleotides that make up DNA + RNA



* As we moved onto the second unit, we learned about their important roles.

* Two processes discussed were cellular respiration + photosynthesis.

In cellular respiration,

- Glycolysis: the breakdown of glucose into pyruvate to produce needed energy.

carbohydrate
=
macromolecule ✓

* This happens in the mitochondria.

* It needs ATP molecules and many enzymes to be done.

nucleic acids
=
macromolecules ✓

proteins
=
macromolecules ✓

- Krebs cycle: A process that generates more energy in the form of ATP

- Oxidative phosphorylation: the conversion of produced molecules from the previous processes into energy for cell functions.

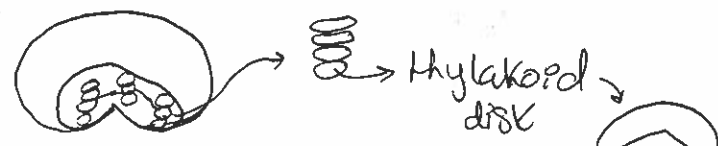
In photosynthesis:

- Light-dependent reactions: Use light to make ATP and NADPH

- Light-independent reactions: use CO₂ to make organic molecules that make carbohydrates.

* These take place in the thylakoid disks + their membranes in chloroplasts.

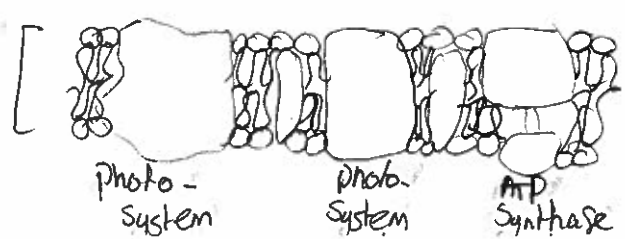
Chloroplast



lipids + proteins ✓

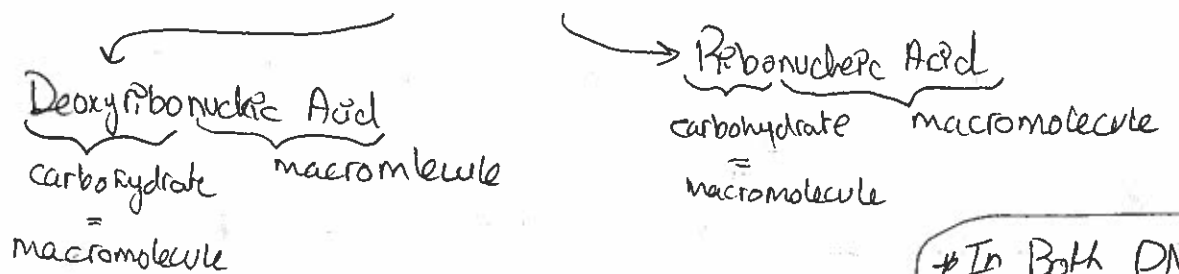
Thylakoid membrane

phospholipids

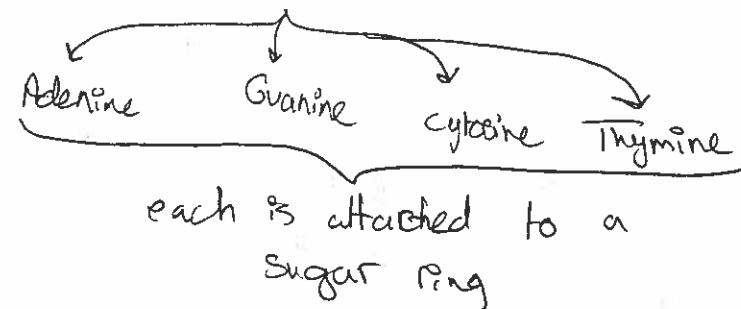


proteins
= macromolecules

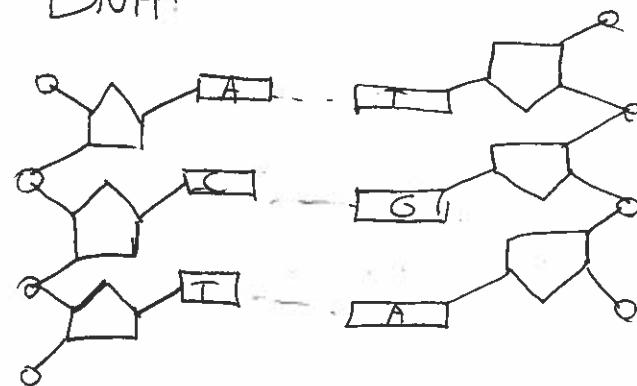
* In the third unit, we discovered their importance in the structure + function of DNA + RNA.



* It is made of the nitrogenous bases in nucleotides

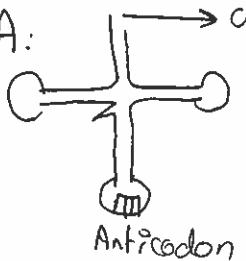


DNA:



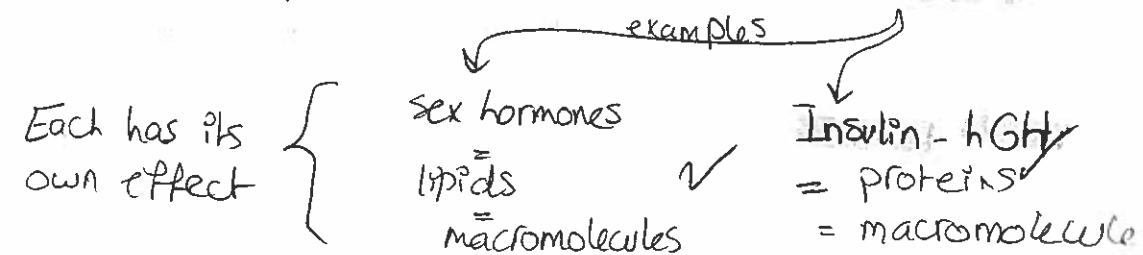
these make proteins!

tRNA:



* In both DNA replication + RNA synthesis → enzymes + amino acids are involved
* DNA replication → enzymes to unwind the DNA + copy
* RNA synthesis → enzymes + different forms of RNA need to translate the copied code and identify proper amino acid sequences to build a protein.

* In our fourth unit, we discovered that bodily functions are controlled by the endocrine system → prohibits/allows the release of hormones



* Glucose has a great impact on body hormone regulation under long-term stress: → high blood sugar → insulin production

Insulin-Glucagon = proteins = macromolecules

→ low blood sugar → glucagon produced
also membrane structure of insulin

The function and interactions of all macromolecules was indeed an underlying theme of the course

1. For Biochemistry Unit:

- we learned in the first chapter all about macromolecules and their structures and bonding. For example
 - Proteins are amino acids that make peptide bonds
 - Carbohydrates are hydrocarbons with many hydroxyl groups that make glycosidic linkage.
 - Fats are long chains of hydrocarbon that may end by a carboxyl group and make ester bonds
 - Nucleic acids are the basis of DNA and RNA and make phosphodiester bonds.
- After that we used the knowledge learned about them in other topics.

The understanding of properties and function of macromolecules helped in fully understanding the Fluid Mosaic Model of the Cell Membrane. See Figure 1.

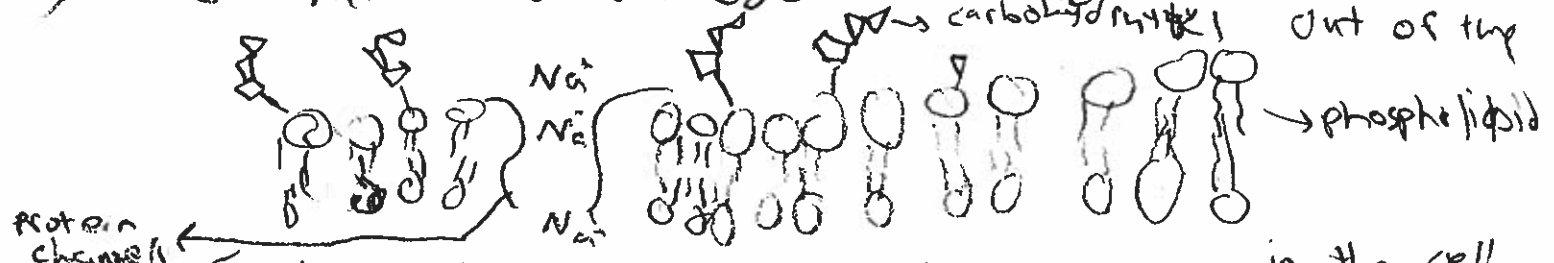


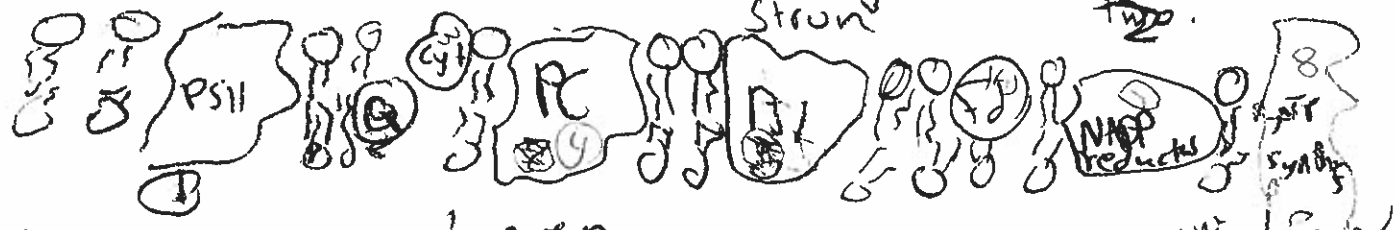
Figure one: animal cell membrane

As shown in this example, this topic is about the transport of substances in and out of the cell. However, it is dictated by three main macromolecules (lipids, proteins, carbohydrates). In the inside to prevent certain molecules (especially polar or ionic) to enter randomly. Then come the proteins that have hydrophobic walls that anchor them in the membrane (interaction of macromolecules) and also allows the movement of ions, polar, and large molecules in the cell. Finally the carbohydrates found on the top of the membrane bind with phospholipids to create markers that reveal the identity of the cell to messenger such as hormones.

2. Metabolic Pathways

Without the presence of macromolecules such as proteins, lipids, and carbohydrates this pathway would have not existed. When we learned about respiration, we learned that there are 10 different reactions in glycolysis alone. These reactions were not going to even pass through the first step if it was not for proteins. This is because every single reaction taken requires a specific enzyme, (which are made from proteins). Macromolecules are also used as starters of these pathways - for instance lipids, proteins and carbs can all be used and are needed for these processes to produce ATP.

Secondly proteins were also used in photosynthesis principally to create NADPH and ATP (in the light reaction). The set up of the macromolecules in thylakoid membrane is similar to figure 1. Now take a look at figure 2.



This unit is based around the production & breakdown of glucose carb.

Figure 2: the thylakoid membrane

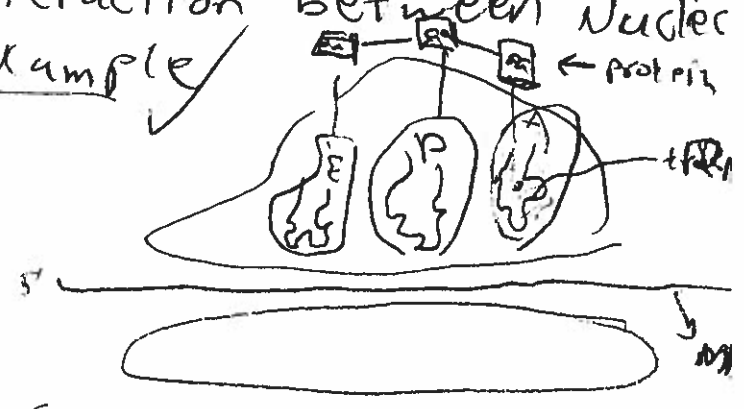
All the numbered structures are integral proteins that have molecular complexes that allow the movement of e^- to create H^+ in the lumen and to finally reduce $NADP^+$ to $NADPH$ so that ATP and $NADPH$ can be used in the Calvin cycle. Without these proteins and the fact that phospholipids keep it from diffusing out, photosynthesis could not have occurred.

3. Genetics The Primary Macro molecule discussed in this unit is Nucleic acids, and the primary purpose is the production of proteins

- The structure of DNA and RNA is basically nucleic acid which are made of either ribose or deoxyribose sugars, phosphates, and a nitrogenous base.

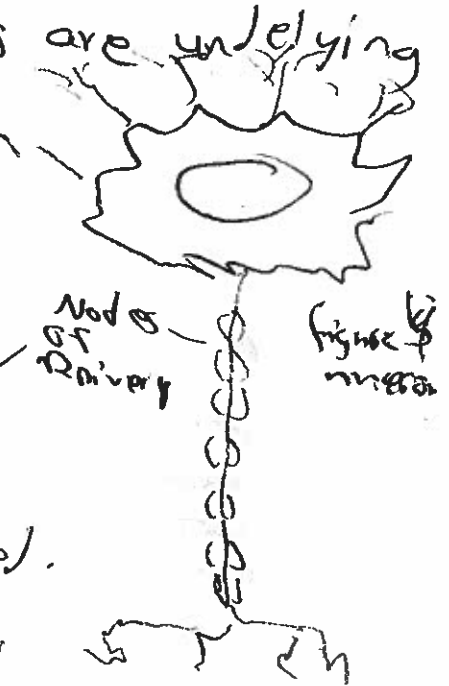
- Protein synthesis is a great example of interaction between nucleic acids and proteins. Look at figure 3 for example

- As shown in the Ribosomes which are made from rRNA and proteins are holding tRNA and mRNA (All nucleic acids) to make anticodon fit with the codon to ~~produce~~ produce amino acids which we then modified to be proteins. This shows how nucleic acids interact with proteins to synthesize new needed structures



4) Homeostasis In this unit lipids and proteins are underlying the content.

- We first learned about neurons see (figure 4), these neurons are what carry messages through the body. This happens through action potential where without the voltage gated ion pumps (proteins) the process would have never happened. In the node all of sodium ions in a second as the threshold is reached. This then creates the nerve that travels through the body



- Second lipids and proteins are used by the endocrine system to produce steroid hormones and protein hormones. Both of which require the properties of lipids and proteins. Without these molecules the hormones (which are important) would not be produced thus humans won't be able to grow, metabolize, or respond to stress properly. Also pancreas control of blood sugar

5) Population also genetic mutations affect survival

- We learned in this unit that one of factors that affect a population is food availability (or all macromolecules availability) as they are essential to life.

- This as result caused humans to do deforestation (for farm lands), overexploit, create monocultures, to finally have the biggest amount of food possible, which contain all nutrients.

- This as a result, made population size for humans exhibit exponential growth as shown in figure 5

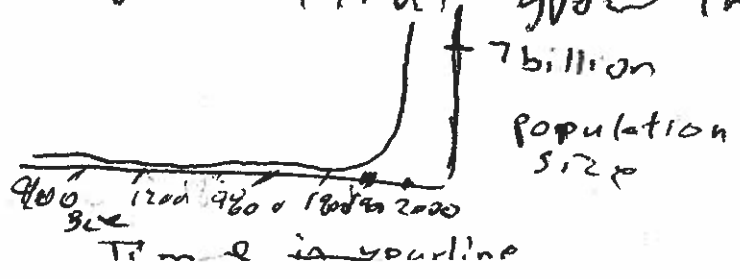


Figure 6: A trend showing the population growth of humans over the years.