JAMES COOK UNIVERSITY

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SCHOOL OF PHARMACY AND MOLECULAR SCIENCES
Chemistry Department

FIRST SEMESTER EXAMINATIONS 2005

Cairns Campus

This paper must be handed in at the end of the Examination: Yes
Release to Library: No

STUDENT NAME:
(*block letters*)

STUDENT NUMBER:

SUBJECT CODE: CH1010:03

SUBJECT NAME: BIOLOGICAL CHEMISTRY

EXAMINER: Dr M. Liddell **PHONE NO:** (07) 4042 1275

DURATION OF EXAMINATION (hours): TWO (2) HOURS

PERUSAL TIME (minutes): FIFTEEN (15) MINUTES

TOTAL NUMBER OF QUESTIONS: 27

INSTRUCTIONS TO STUDENTS:
The exam is composed of two sections:

Section A -	Multiple choice -	22 questions - 33%
Section B -	Short answer -	5 questions - 67%

Total marks for paper = 100
Answer **ALL** questions. All questions are **not** of equal value.
Timings are indicated to allow 15 minutes of check-over time.

MATERIALS TO BE SUPPLIED BY EXAMINATION SECTION:
Examination Booklets required: Yes
Multiple choice scanner sheets Scanner A- E: Yes

MATERIALS STUDENTS MAY USE:
Scientific calculator with no text storage facilities.
Access to an English Dictionary: Yes

SECTION A

MULTIPLE CHOICE QUESTIONS (EACH QUESTION IS WORTH 1.5 MARKS). ANSWER ALL QUESTIONS – SHADE WITH A PENCIL THE MOST CORRECT ANSWER ON THE MULTICHOICE SCANNER SHEET.

Timing: you should complete the multi-choice section in 30 minutes (≈ 1.5 minutes per question).

This section has been deleted it is just multi-choice of the same calibre as the modules.

SECTION B

SHORT ANSWER QUESTIONS. (MARKS FOR EACH QUESTION ARE AS INDICATED) ANSWER EACH OF THE FIVE (5) QUESTIONS.

Question 1

Timing: you should complete this question in 15 minutes.

(a) Hydrogen bonding, although weak, is one of the most important types of bonding in biology.

- Define **hydrogen bonding**.
- Provide an example of **intermolecular** hydrogen bonding.
- Are **hydrophilic** or **hydrophobic** regions of a protein more likely to participate in hydrogen bonding with the surrounding solvent – explain your answer.

(4 marks)

(b) There are a variety of acids and bases found in cellular systems.

- Provide an example of a common **weak acid** and its conjugate base.
- Provide an example of a common **weak base** and its conjugate acid.
- Explain how you could prepare a **buffer** from the acid and base components you have just written down.

(4 marks)

(c) A colourless organic oil gave the following microanalytical results:

C: 54.55 % H: 9.09 %

Infrared spectroscopy of a sample of the oil gave several strong bands at 3200 and 1721 cm^{-1}. In a mass spectrum of the compound a molecular ion was found at m/z 88.

- Provide a **molecular formula** and a **line-angle structure** for this compound. Explain clearly how you arrived at the formulae.
- Would the molecule you have drawn be likely show a UV absorption – explain why or why not?
- How could you **verify the purity** of the sample?

(6 marks)

Question 2

Timing: you should complete this question in 15 minutes.

(a) Proteins have complex structures that relate to their function

- What are the two major **structural types** of protein. Provide an example of a protein in each structural type and give the function each protein.
- The primary structure of a protein is at the outset responsible for dictating which structural type a protein will be in. Draw a short stretch of a peptide chain (3 different amino acids) indicating what the **primary structure** is and how the amino acids are joined together.
- Why is it important to know the **isolelectric point** important when purifying proteins?

(5 marks)

(b) Enzymes are cellular catalysts which control almost all reactions in a cell.

- What is the definition of a catalyst.
- Describe the following : **coenzyme**, **proenzyme**, **isoenzyme**, **active site**. Provide examples to illustrate your answer.

(4 marks)

(c) There are two major classes of **vitamins: lipid soluble** and **water soluble,** give one example of each type of vitamin and explain the function of each.

- What role does the protein component of the diet have?

(4 marks)

Question 3

Timing: you should complete this question in 15 minutes.

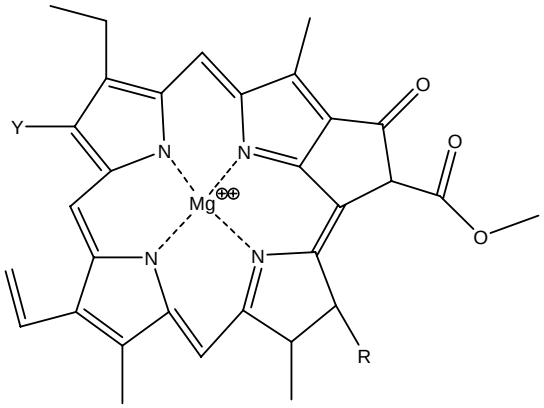
(a) **Lipids** play a variety of roles in cells and as such come in many different types.
Provide an example of each of the following types of lipid (draw a structure) and indicate the function the lipid has.

- Steroid.
- Glycerophospholipid.

Describe the structure of a **cellular membrane**.

(4 marks)

(b) The **chlorophyll** molecule has the following coordinated metallic centre.



- What is the **coordination geometry** at the metal?
- What is the name of this type of ligand**?**
- Is **chelation** present in this molecule? Explain why or why not.
- What is the function of the R group which is referred to as a **phytol side chain?**.
- There are two different chlorophylls A and B which differ only in the group Y. What is the Y group in ChlA and the Y group in ChlB?

(4 marks)

(c) Photosynthesis is divided into two major parts the light reactions and the dark reactions.

- What are the **light reactions of photosynthesis** and where do they occur?
- What are the **dark reactions of photosynthesis** and where do they occur?

(5 marks)

Question 4

Timing: you should complete this question in 15 minutes.

(a) **Pyruvate** plays a major role in both aerobic and anaerobic respiration.

- Define **aerobic respiration**.
- Draw the structure of pyruvate.
- Why is pyruvate important in both aerobic and anaerobic respiration?

(5 marks)

(b) **Fatty acid synthesis** involves the so called 'merry-go-round' synthesis.

- Why is this called a 'merry-go-round' synthesis, indicate the starting substrate and the normal product from mammalian fatty acid synthesis and the enzyme system that is involved.

(4 marks)

(c) **Oxidative phosphorylation** when coupled to the citric acid cycle produces the bulk of the energy in oxidative respiration.

- What is **oxidative phosphorylation**?
- How is the citric acid connected to oxidative phosphorylation?

(4 marks)

Question 5

Timing: you should complete this question in 15 minutes.

(a) **Chromosomes** are the physical structures that DNA is found in inside the nucleus of the cell.

- What are the different levels of structural organization inside a chromosome.
- Why is this complex structural organisation necessary?
- Define a **gene**.

(4 marks)

(b) The copying of the genome of an organism requires great accuracy and reasonable speed.

- Describe briefly the **6 major steps** in **DNA replication**
- How is the **error count** kept very low in this process?
- How is a **reasonable speed** maintained given that in many organisms there are millions of kb pairs to process in the genome?

(4 marks)

(b) The ribosomes are the site of **protein synthesis** in the cell.

- What is the structure of the **ribosome**?
- Describe the various steps in **DNA transcription**
- What are **transcription factors** and why are they required in transcription.
- List the various steps in **DNA translation**.

(6 marks)

Equation List

$E = \frac{h c}{\lambda} = h \nu$

$h = 6.63 \times 10^{-34}\ J\ s^{-1}$

$A = \varepsilon\ l\ [i]$

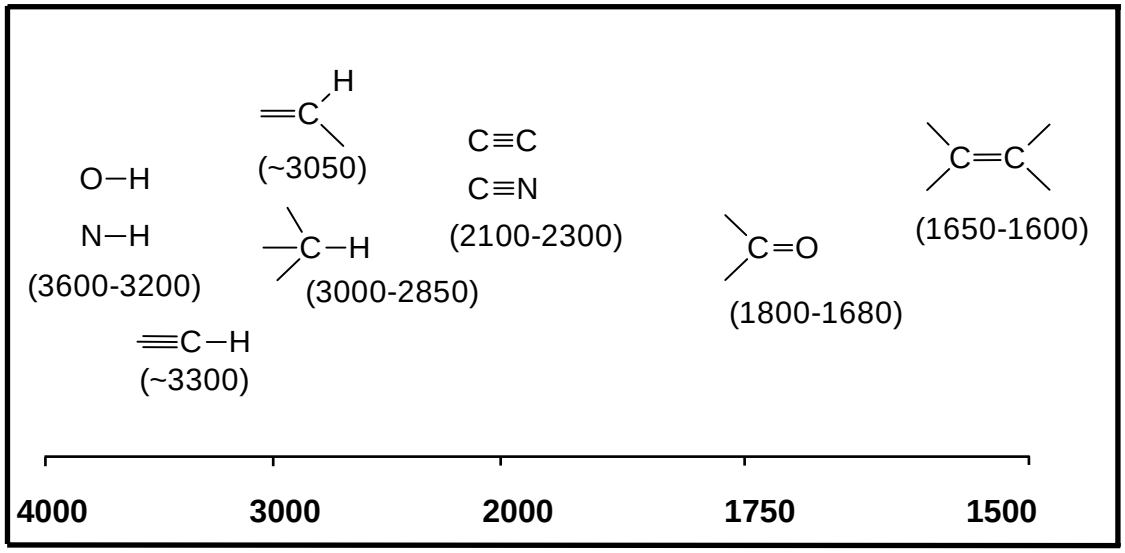
$c = 3.00 \times 10^{8}\ m\ s^{-1}$

$T(K) = T(^{o}C) + 273.15$

$R = 8.314\ J\ mol^{-1}\ K^{-1}$

Spectroscopy Table

Typical Infrared (IR) frequencies of common functional groups



Carbonyl Absorptions ν (cm^{-1}) **Acid chlorides** ~ 1790**; Esters** ~ 1740**;**
Aldehydes ~ 1720**;** **Ketones** ~ 1710**;** **Acids** ~ 1700; **Amides** ~ 1650

TABLE 1

Physical Quantity	Name of Unit	Symbol for Unit
Length	metre	m
Mass	kilogramme	kg
Time	second	s
Electric Current	ampere	a
Thermodynamic Temperature	kelvin	K
Amount of Substance	mole	mol

TABLE 2

Physical Quantity	Name of S.I. Unit	Symbol for S.I. Unit
Volume	cubic metre	m^3
Frequency	hertz	Hz
Velocity	metre per second	ms^{-1}
Acceleration	metre per second squared	ms^{-2}
Density	kilogramme per cubic metre	kg m^{-3}
Molar Mass	kilogramme per mole	kg mol^{-1}
Concentration	mole per cubic metre	mol m^{-3}
Molality	mole per kilogramme	mol kg^{-1}
Force	newton	N
Pressure	pascal	Pa
Energy	joule	J
Electric Charge	coulomb	C
Electron Potential Difference	volt	V

PERIODIC TABLE
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