

---

UNIVERSITI SAINS MALAYSIA

Second Semester Examination  
2010/2011 Academic Session

April/May 2011

**KOE 322 – Natural Product Chemistry**  
*[Kimia Hasil Semulajadi]*

Duration: 2 hours  
*[Masa : 2 jam]*

---

Please check that this examination paper consists of FOURTEEN pages of printed material before you begin the examination

**Instructions:**

Answer **FIVE** (5) questions only.

Answer each question on a new page.

You may answer either in Bahasa Malaysia or in English.

If a candidate answers more than five questions, only the answers to the first five questions in the answer sheet will be graded.

In the event of any discrepancies, the English version shall be used.

...2/-

1. (a) Give brief explanation for the following terms.

- i. Primary metabolites
- ii. Secondary metabolites
- iii. Extraction process
- iv. Column chromatography

(12 marks)

(b) The biosynthesis of phenylalanine is outline below.

- i. Give the structures of compounds **A – C**.
- ii. Show the mechanism for the formation of phenylalanine from prephenic acid.

(8 marks)

(c) Write the common isolation strategy of a natural product and explain each step in general.

(5 marks)

2. (a) The reaction below forms compound **A**.

- i. Give the structure of **A**.
- ii. Show the mechanism for the reaction.

(5 marks)

(b) Provide the major organic product for each of the reactions below.

(10 marks)

(c) Phytochemical screening is a process of tracing plant constituents. Write a standard test procedure for chemical constituents listed below of the medicinal plant *Emilia coccinea*.

- i. Alkaloids
- ii. Flavonoids
- iii. Saponins
- iv. Tannins

(10 marks)

3. (a) Transamination of hydroxyphenylpyruvic acid, **A** yields tyrosine, **B**, which is one of the non-essential amino acids used by cells to synthesize proteins. Suggest a mechanism for the transamination process.

(5 marks)

- (b) Name the class of terpenes for these compounds.

limonene

guaiol

camphor

$\beta$ -selinene

(4 marks)

- (c) Anthranilic acid (vitamin L) is an intermediate in the biosynthesis of tryptophan, as shown below. Provide a synthesis of anthranilic acid from chorismic acid
- (4 marks)
- (d) Write briefly on any FOUR of the following:
- i. Flavin mononucleotide (FMN)
  - ii. Nicotinamide adenine dinucleotide (NAD<sup>+</sup>)
  - iii. Methylation in biosynthesis
  - iv. Wagner-Meerwein rearrangements
  - v. Phenolic oxidative coupling
- (12 marks)
4. (a) Draw the structure of the polyketide you would expect to obtain from one unit of acetyl coenzyme A and three units of malonyl coenzyme A.
- (6 marks)
- (b) Show how cyclization of the polyketide obtained from propionyl coenzyme A and three molecules of malonyl coenzyme A to produce 4-hydroxy-6-methyl-2-pyrone.

4-Hydroxy-6-methyl-2-pyrone

(12 marks)

- (c) Show the acetate pathway using the biosynthesis of lauric acid ( $C_{12}$ ) as an example.

(7 marks)

5. (a) Show how geranyl pyrophosphate (GPP) and farnesyl pyrophosphate (FPP) are produced from isopentenyl pyrophosphate.

(5 marks)

- (b) Circle the acetate units or isoprene units in the following structures:

limonene

pinene

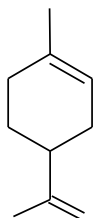
zingiberine

bisabolene

(8 marks)

(c) Suggest mechanisms for the formation of the following compounds from GPP or FPP:

i. Limonene



ii. Camphor

iii.  $\alpha$ -Selinene

(12 marks)

## TERJEMAHAN

---

**Arahan:**

Jawab **LIMA** (5) soalan sahaja.

Jawab setiap soalan pada muka surat yang baru.

Anda dibenarkan menjawab soalan ini sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.

Jika calon menjawab lebih daripada lima soalan, hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.

Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.



1. (a) Berikan penjelasan ringkas bagi istilah berikut

- i. Metabolit primer
- ii. Metabolit sekunder
- iii. Proses pengestrakan
- iv. Kromatografi kolum

(12 markah)

(b) Biosintesis bagi fenilalanina digambarkan di bawah.

- i. Berikan struktur bagi sebatian **A – C**.
- ii. Tunjukkan mekanisme bagi pembentukan fenilalanina daripada asid prefenik.

(8 markah)

(c) Tuliskan strategi yang lazim bagi pemencilan hasil semulajadi dan jelaskan setiap langkah secara umum.

(5 markah)

2. (a) Tindak balas di bawah menghasilkan sebatian **A**.

- i. Berikan struktur bagi **A**.
- ii. Tunjukkan mekanisme bagi tindak balas ini.

(5 markah)

(b) Berikan hasil organik utama bagi setiap tindak balas di bawah.

(10 markah)

- (c) Analisa fitokimia ialah proses surihan jujuk kimia tumbuhan. Nyatakan langkah bagi satu ujian piawai untuk jujuk kimia yang digariskan di bawah bagi tumbuhan ubatan *Emilia coccinea*.
- i. Alkaloid
  - ii. Flavonoid
  - iii. Saponin
  - iv. Tannin
- (10 markah)
3. (a) Transaminasi asid hidroksifenilpiruvik, **A**, menghasilkan tirosina, **B** iaitu salah satu asid amino 'non-essential' yang digunakan oleh sel untuk mensintesis protein. Cadangkan satu mekanisme bagi proses transaminasi ini.
- (5 markah)
- (b) Namakan kelas terpena bagi sebatian berikut.

limonena

guaiol

kamfor

$\beta$ -selinena

(4 markah)

- (c) Asid antranilik (vitamin L) ialah bahan perantara dalam biosintesis triptofan, seperti yang ditunjukkan di bawah. Tunjukkan sintesis bagi asid antranilik daripada asid korismik.

(4 markah)

- (d) Tulis secara ringkas bagi sebarang EMPAT topik yang berikut:

- i. Flavin mononukleotida (FMN)
- ii. Nikotinamida adenina dinukleotida ( $\text{NAD}^+$ )
- iii. Tindak balas pengalkilan
- iv. Penyusunan semula Wagner-Meerwein
- v. Pengkupelan oksidatif fenol

(12 markah)

4. (a) Lukiskan struktur poliketida yang anda jangka perolehi daripada satu unit asetil koenzim A dan tiga unit malonil koenzim A.

(6 markah)

- (b) Tunjukkan bagaimana pensiklikan poliketida yang diperolehi daripada propionil koenzim A dan tiga molekul malonil koenzim A untuk menghasilkan 4-hidroksi-6-metil-2-piron.

4-Hidroksi-6-metil-2-piron

(12 markah)

- (c) Tunjukkan laluan asetat dengan menggunakan biosintesis asid laurik ( $C_{12}$ ) sebagai suatu contoh.
- (7 markah)
5. (a) Tunjukkan bagaimana geranil pirofosfat (GPP) dan farnesil pirofosfat (FPP) dihasilkan daripada isopentenil pirofosfat .
- (5 markah)
- (b) Bulatkan unit asetat atau unit isoprena dalam stuktur yang berikut:

limonena

pinena

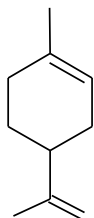
zingiberina

bisabolena

(8 markah)

(c) Cadangkan mekanisme bagi pembentukan sebatian yang berikut daripada GPP dan FPP:

i. Limonena



ii. Kamfor

iii.  $\alpha$ -Selinena

(12 markah)