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UNIVERSITI SAINS MALAYSIA

Second Semester Examination  
2009/2010 Academic Session

April/May 2010

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

Duration : 3 hours  
*[Masa : 3 jam]*

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

**Instructions:**

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

You may answer the questions either in Bahasa Malaysia or in English.

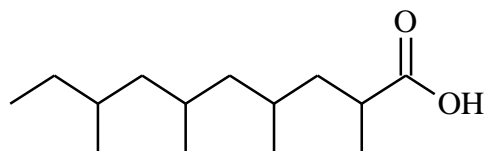
If a candidate answers more than five questions, only the answers to the first five questions in the answer sheet will be graded.

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

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Answer any **FIVE** questions.

1. (a) Suggest a biosynthetic pathway for the following saturated fatty acid:

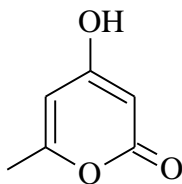


(5 marks)

- (b) Draw the structure of the polyketide you would expect to obtain from propionyl coenzyme A and three molecules of malonyl coenzyme A.

(5 marks)

- (c) Show how cyclization of the polyketide you draw in (b) would give 4-hydroxy-6-methyl-2-pyrone.

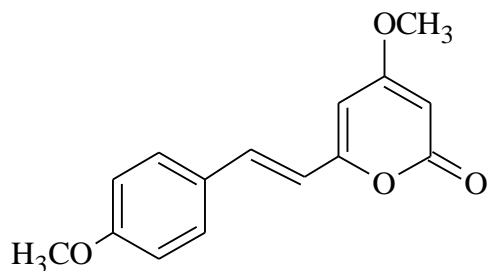


4-Hydroxy-6-methyl-2-pyrone

(10 marks)

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2. (a) Give the product at  $\beta$ -oxidation of cinnamic acid. (5 marks)
- (b) Suggest a reasonable biosynthetic pathway to yangonin from the coenzyme A derivative of cinnamic acid.

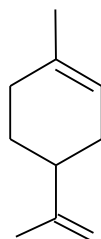


Yangonin

(15 marks)

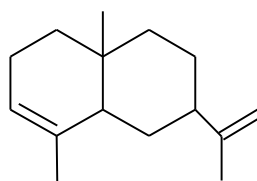
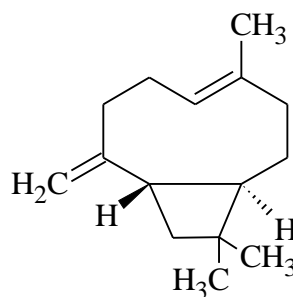
3. (a) Show how geranyl pyrophosphate (GPP) and farnesyl pyrophosphate (FPP) are produced from the isopentenyl pyrophosphate. (4 marks)
- (b) Suggest mechanisms for the formation of the following compounds from GPP or FPP:

- (i) Limonene



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(ii) Camphor

(iii)  $\alpha$ -Celinene(iv)  $\beta$ -Caryophyllene

(16 marks)

4. (a) What are terpenes?

(4 marks)

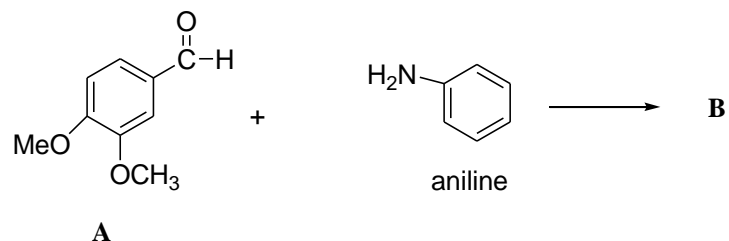
(b) Write briefly on the following topics:

- (i) Phenolic oxidative coupling
- (ii) Wagner-Meerwein rearrangements

(6 marks)

-5-

- (c) Schiff bases are important intermediate in the synthesis of natural products derivatives. A vanillin derivative (**A**) is used in the reaction with aniline to form Schiff a base (**B**).



- (i) Draw the structure of the product (**B**).
- (ii) What is the reaction involved?
- (iii) Suggest the mechanism of this reaction.

(10 marks)

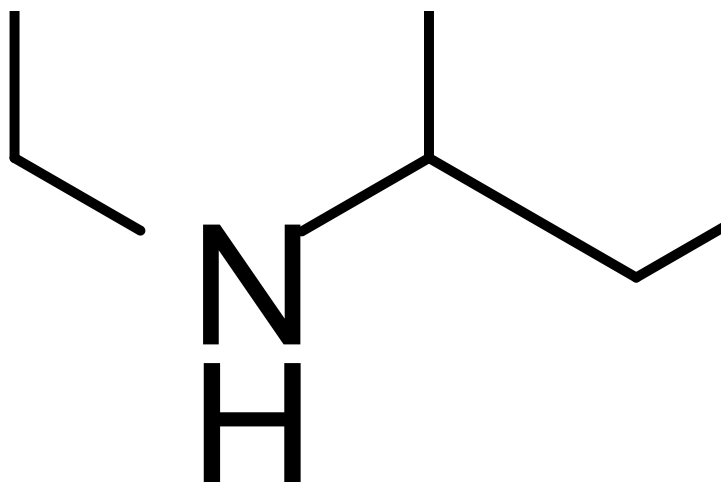
5. (a) Write briefly on the following topics:

- (i) Primary and secondary metabolites.
- (ii) Column chromatography in the isolation of natural products.
- (iii) Hydro distillation in the extraction of essential oil.

(10 marks)

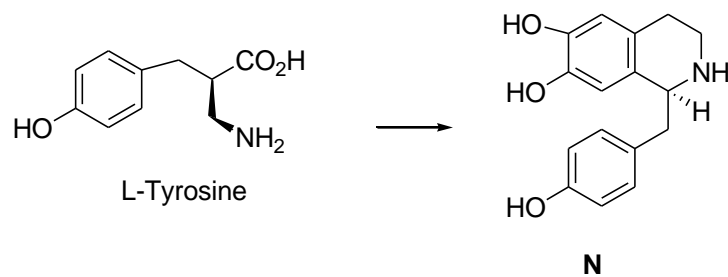
-6-

- (b) Circle the skeleton of indole, tyrosine or lysine in the following alkaloids:



(4 marks)

- (c) L-Tyrosine is a precursor of the natural product, norkoclaurene. Suggest a mechanism for the formation of norkoclaurene (N).



(6 marks)

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6. (a) Suzuki had reported the *O*- to *C*-glycoside rearrangement to form a stable  $\beta$ -glycoside in glycosylation reaction between compound **R** and **S**.



- (i) Draw the possible products of the reaction. Which product is more stable?  
(ii) Show the *C*-glycoside bond in this reaction.  
(iii) Show the mechanism involved.

(12 marks)

- (b) The structure of adrenaline (**U**), was confirmed by a three steps synthesis from catechol (**T**).

- (i) Suggest the reagents used in this reaction.  
(ii) Show the mechanism of the first step in the reaction

(8 marks)

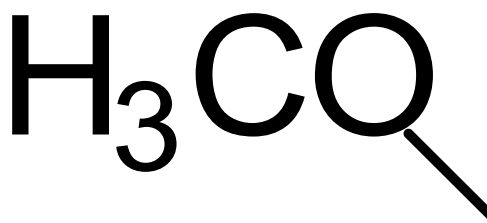
-8-

7. Amyl nitrite (RONO) is used in Ginsberg's synthesis of morphine.

(a) Explain how NOCl is generated from amyl nitrite and hydrochloric acid.

(6 marks)

(b) In the first application of amyl nitrile, alkene (X) is converted to oxime (Y) in two steps.



(i) What is the reaction involved?

(ii) Provide a mechanism for the both steps of the reaction.

(10 marks)

(c) Recently microwave is used in the synthesis of organic compounds. Suggest what are the advantages of using microwave in some of the organic reactions.

(4 marks)



## TERJEMAHAN

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### **Arahan:**

Jawab **LIMA** (5) soalan.

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

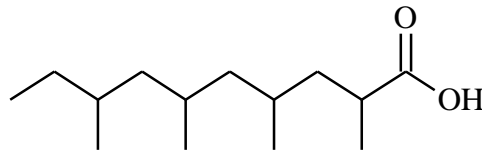
Jika calon menjawab lebih daripada lima soalan, hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.

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

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Jawab hanya **LIMA** soalan.

1. (a) Cadangkan suatu laluan biosintesis bagi asid lemak tepu yang berikut:

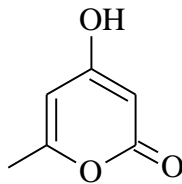


(5 markah)

- (b) Lukiskan struktur poliketida yang anda jangka perolehi daripada propionil koenzim A dan tiga molekul malonil koenzim A.

(5 markah)

- (c) Tunjukkan bagaimana pensiklikan poliketida yang anda lukiskan di (b) akan menghasilkan 4-hidroksi-6-metil-2-piron.

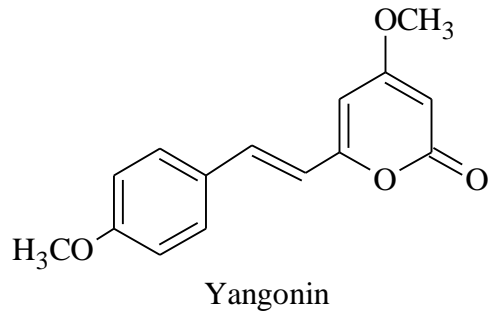


4-Hidroksi-6-metil-2-piron

(10 markah)

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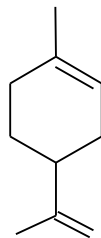
2. (a) Berikan hasil pengoksidaan- $\beta$  asid sinamik. (5 markah)
- (b) Cagangkan suatu laluan biosintesis yang menasabah bagi yangonin daripada terbitan koenzim A asid sinamik.



(15 markah)

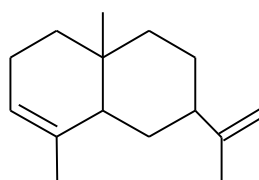
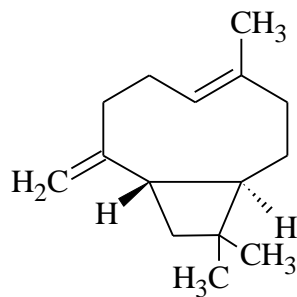
3. (a) Tunjukkan bagaimana geranil pirofosfat (GPP) dan farnisil pirofosfat (FPP) dihasilkan daripada isopentenil pirofosfat. (4 markah)
- (b) Cadangkan mekanisme bagi pembentukan sebatian yang berikut daripada GPP dan FPP:

- (i) Limonena



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(ii) Kamfor

(iii)  $\alpha$ -Selinena(iv)  $\beta$ -Kariofilena

(16 markah)

4. (a) Apakah terpena?

(4 markah)

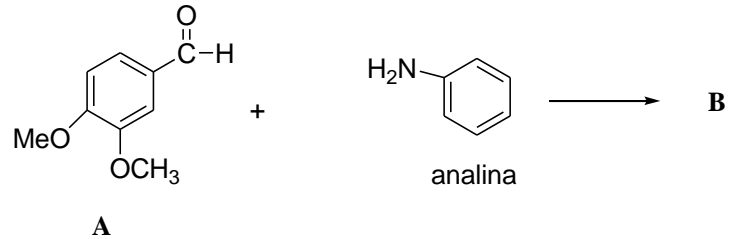
(b) Tulis secara ringkas bagi topic-topik yang berikut:

- (i) Pengkupelan oksidatif fenol.
- (ii) Penyusunan semula Wagner-Meerwein.

(6 markah)

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- (c) Bes Schiff adalah penting sebagai bahan perantaraan untuk mensintesis derivatif hasil semulajadi. Derivatif vanillin (**A**) digunakan dalam tindak balas dengan analina untuk menghasilkan bes Schiff (**B**).



- (i) Lukis struktur hasil (**B**).
- (ii) Apakah tindak balas yang terlibat?
- (iii) Cadangkan mekanisme tindak balas ini.

(10 markah)

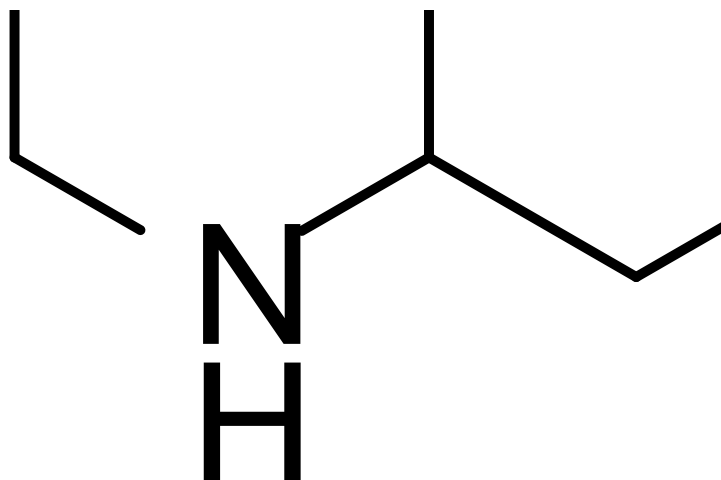
5. (a) Beri penerangan ringkas bagi perkara berikut:

- (i) Metabolit primer dan sekunder.
- (ii) Kromatografi turus dalam pemencilan hasil semulajadi.
- (iii) Penyulingan hidro dalam pengekstrakan minyak meruap

(10 markah)

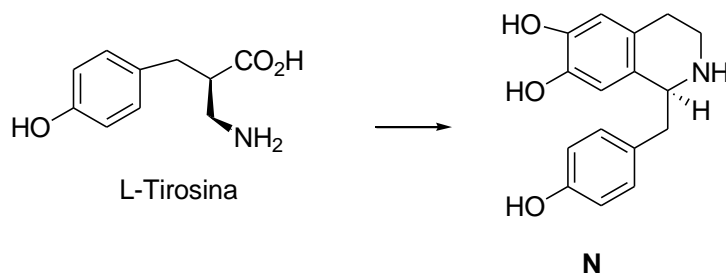
-14-

- (b) Bulatkan rangka indola, tirosina atau lisina dalam alkaloid berikut:



(4 markah)

- (c) L-Tirosina adalah bahan mula hasilan semulajadi, norkoklauren. Cadang mekanisme untuk pembentukan norkoklauren (**N**)



(6 markah)

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6. (a) Suzuki melaporkan penyusunan semula *O*- kepada *C*-glikosida untuk membentuk  $\beta$ -glikosida yang stabil dalam tindak balas penglikosilan antara sebatian **R** dengan **S**.



- (i) Lukis hasil yang mungkin dalam tindak balas tersebut. Hasil yang mana lebih stabil?  
(ii) Tunjukkan ikatan *C*-glikosida dalam tindak balas ini.  
(iii) Tunjukkan mekanisme yang terlibat.

(12 markah)

- (b) Struktur adrenalina (**U**) dikenalpasti oleh tiga langkah sintesis daripada katekol (**T**).

- (i) Cadangkan reagen yang digunakan dalam tindak balas ini  
(ii) Tunjukkan mekanisme bagi langkah pertama dalam tindak balas ini.

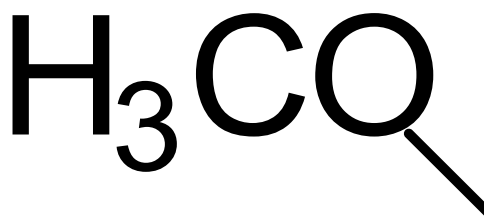
(8 markah)

7. Amil nitrit (RONO) digunakan dalam sintesis Ginsberg bagi morfin.

(a) Terangkan bagaimana NOCl dihasilkan daripada amil nitrit dan asid hidroklorik.

(6 markah)

(b) Dalam aplikasi pertama amil nitrit, alkena (X) ditukarkan ke oksim (Y) dalam dua langkah.



(i) Apakah langkah tindak balas yang terlibat?

(ii) Berikan mekanisme bagi kedua-dua langkah tindak balas ini.

(10 markah)

(c) Baru-baru ini, gelombang mikro digunakan dalam sintesis sebatian organik. Cadangkan kebaikan penggunaan gelombang mikro dalam sesetengah tindak balas organik?

(4 markah)