MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR SECOND SEMESTER EXAMINATION FOR

MASTER OF SCIENCE (CHEMISTRY)

SCH 832: NATURAL PRODUCTS

DATE: 11/4/2019 **TIME: 2.00-5.00 PM**

INSTRUCTIONS TO CANDIDATES

- The paper consists of **two** sections.
- Section **A** is **compulsory** (20 marks).
- Answer any **two** questions from section **B** (each 20 marks).

SECTION A

QUESTION ONE (30 MARKS)

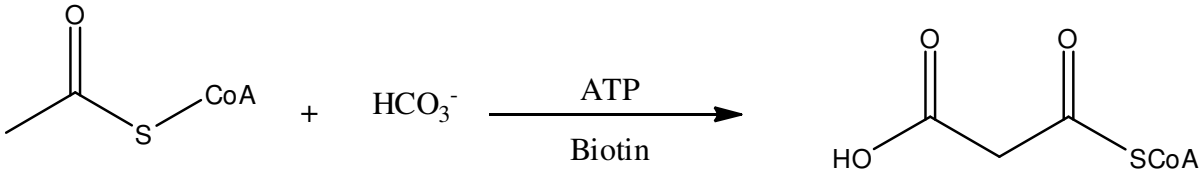
a) Using examples, differentiate between the following;

i. Primary and secondary metabolites

ii. Essential and non-essential fatty acids

iii. Condensed and hydrolysable tannins (6 marks)

b) Acetyl-SCoA is the precursor in fatty acid biosynthesis. However, for most of the reactions, acetyl-CoA needs to be further activated by a biotin-dependent enzyme before it can be used by the fatty acid synthase complex. Provide the mechanism of the reaction shown below (4 marks)



Acetyl CoA Malonyl CoA

c) Describe three biological functions of fatty acids. (3 marks)

d) Show how acetyl SCoA is a common precursor to: a) Saturated fatty acids; and b) Polyketides; (6 marks)

e) Discuss the biological importance of prostaglandins. (2 marks)

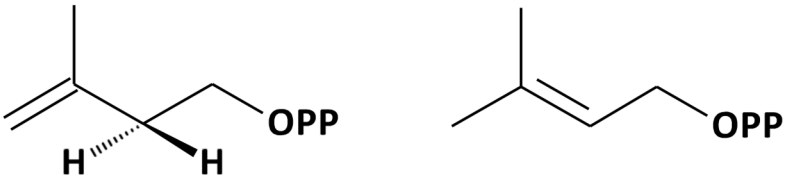
f) Discuss the three main pathways followed in synthesis of secondary metabolites (6 marks)

g) The functions of terpenes in plants is generally considered to be both ecological and physiological; name three these functions (3 marks)

QUESTION TWO (20 MARKS)

a) Polyketides undergo cyclization reactions of the Knovengel and Claisen types to give phenolic compounds. Show how these reactions are used in the biosynthesis of polyketide derived phenolic compounds (6 marks)

b) Isopentenyl pyrophosphate (IPP) and dimethylallylpyrophosphate (DMAPP) are comparable in structure, but differ markedly in reactivity and in the role each plays in terpene biosynthesis.

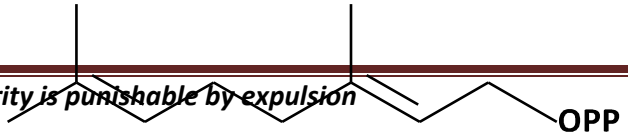


IPP DMAPP

i. Explain how the two are biosynthesized (3 marks)

ii. Explain the difference in their reactivity (3 marks)

iii. Illustrate the role each compound plays by outlining the formation of geranyl pyrophosphate from these two C5 intermediates (4 marks)

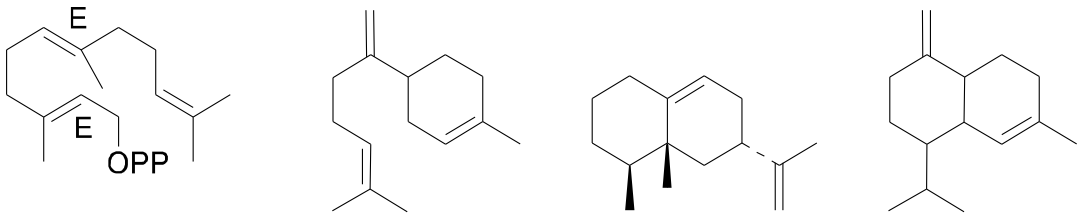


Geranyl pyrophosphate

c) State four classes of terpenes based on the number of 5-carbon units (4 marks)

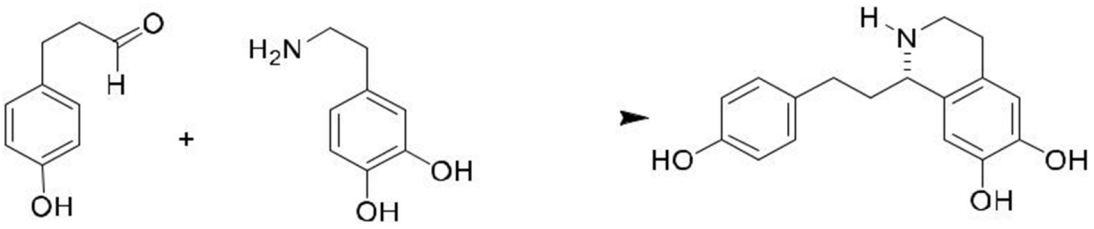
QUESTION THREE (20 MARKS)

a) Show how the following sesquiterpenes are biosynthesized from E, E-FPP. Include all intermediates and utilize arrows to indicate the flow of electrons. (9 marks)



b) Flavonoids are said to be secondary metabolites derived from mixed synthetic pathway. Identify the two pathways. (2 marks)

c) Draw a mechanism for the condensation of aldehyde (**1**) with dopamine (**2**) to give tetrahydroisoquinoline (**3**), which is an alkaloid. (5 marks)

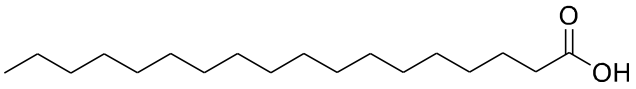


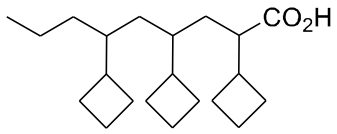
(1) (2) (3)

d) Discuss the importance of secondary metabolites. (4 marks)

QUESTION FOUR (20 MARKS)

a) Show how the following fatty acids are biosynthesized (6 marks)

(i) 

(ii) 

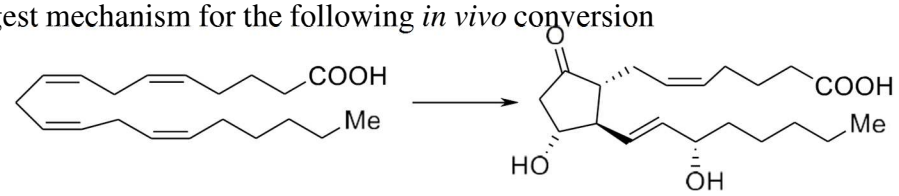
b) Linoleic acid [(18:2 (9c, 12c)] is an essential dietary constituent of animals (5 marks)

i. Give the chemical structure of linoleic acid.

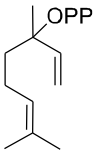
ii. Show how it is formed from stearic acid (18:0) in plants.

iii. Show how it is converted to the tetraenoic acid, 20:4 (5c, 8c, 11c, 14c) in animals.

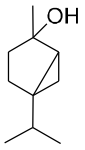
c) Suggest mechanism for the following *in vivo* conversion (5 marks)



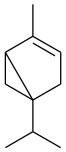
d) Show how the following moneterpenes are biosynthesized from LPP. Include all intermediates and utilize arrows to indicate the flow of electrons (6 marks)



LPP



(i)

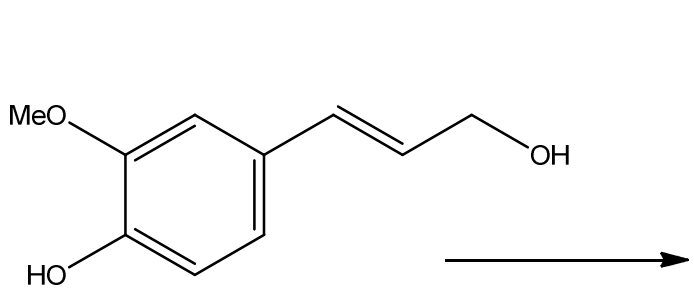


(ii)

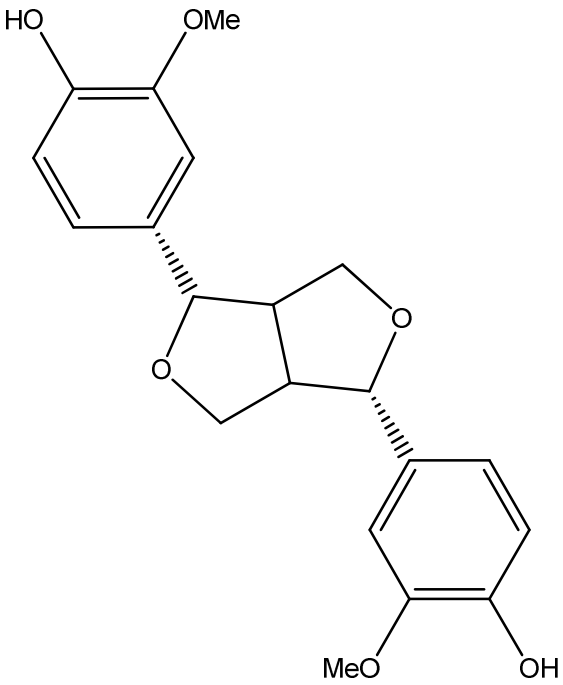
QUESTION FIVE (20 MARKS)

a) Show how Conniferyl alcohol (1) shown below dimerizes to form Pinoresinol (2)

(10 marks)



conniferyl alcohol **(1)**



Pinoresinol **(2)**

b) Shikimic acid pathway is important for production of shikimic acid, which is the main unit for synthesis of aromatic amino acids such as tyrosine and phenyl alanine. Starting with PhosphoEnolPyruvate (PEP) and D-erythrose 4-phosphate, show the mechanism leading to the formation of Shikimic acid. (10 marks)