



TECHNICAL UNIVERSITY OF MOMBASA

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School of Applied and Health Sciences  
DEPARTMENT OF PURE AND APPLIED SCIENCES

**UNIVERSITY EXAMINATION FOR:**

BACHELOR OF TECHNOLOGY IN APPLIED CHEMISTRY

ABT 4316: NATURAL PRODUCTS CHEMISTRY

END OF SEMESTER EXAMINATION

**SERIES: December 2024 SERIES**

**TIME: 2 HOURS**

**DATE: December 2024**

**Instructions to Candidates**

You should have the following for this examination

*Answer Booklet, examination pass and student ID*

This paper consists of **FIVE** questions. Attempt question ONE (Compulsory) and any other **TWO** questions.

**Do not write on the question paper.**

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**Question One (30 Marks)**

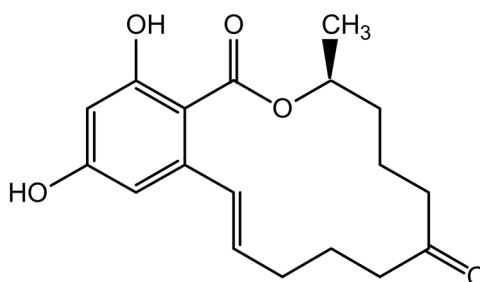
- (a) State the differences between **primary** and **secondary metabolism** in living organisms. [2 marks]
- (b) Outline functions of secondary metabolites to the producing organisms. [5 marks]
- (c) State five classes of secondary metabolites informed by their exploitation as medicinal products. [4 marks]
- (d) (i) What are biosynthetic building blocks as applied in biosynthesis of natural products? [2 mark]
- (ii) Name any four biosynthetic building blocks and provide the class of natural product in which each serve as a precursor molecule. [4 marks]

- (e) Outline the isolation and qualitative analysis of bioactive compounds from plant materials. Include the steps involved in sample preparation, solvent extraction, separation, bioactivity determination, and structure identification processes. [8 marks]
- (f) Discuss the potential for abuse and addiction related to drugs derived from natural sources, using analgesic and antibiotic drugs as examples. [5 Marks]

## Question Two (20 Marks)

(a) Outline the biosynthesis of aromatic polyketides, including the building blocks and major steps in their construction as well as the enzymatic complexes involved in their synthesis (mechanism not required). [7 marks]

(b) Zearalenone (Structure 1) is a potent estrogenic metabolite first isolated from the fungal species *Gibberella zeae*, and has been explored for hormone replacement therapy, although its toxicity limits its use.



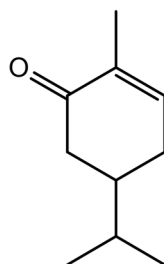
(1)

- (i) Account for the name of the molecule, Zearalenone. [2 marks]
- (ii) Account for all the carbon atoms in the molecule as relate to the biosynthetic building blocks involved in the assembly of the molecule. [3 marks]
- (iii) Provide the structure of the precursor molecule leading to:  
 I. The formation of the aromatic moiety of the compound, and make use of curly arrows to account for its formation. [4 marks]  
 II. The formation of the heterocyclic moiety of the compound, and make use of curly arrows to account for its conversion mechanism to the final molecule. [4 marks]

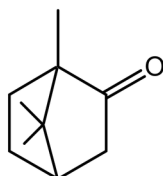
## Question Three (20 Marks)

- (a) Describe the occurrence and chemical structure of terpenoids. [6 marks]
- (b) Outline areas of industrial exploitation of terpenes and terpenoids. [4 marks]
- (c) Carvone (Structure 2), Camphor (Structure 3), and Linalool (Structure 4) are part of the terpenoids that constitute the essential oil obtained from *Mkilua fragrans*

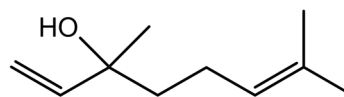
flowers, that are used by Kenya coastal Swahili and Digo communities during wedding ceremonies due to its nice aroma. Make use of curly arrows to show mechanistically how the compounds are formed from the precursor molecule Geranyl pyrophosphate (GPP). [12 marks]



(2)



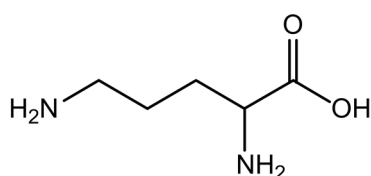
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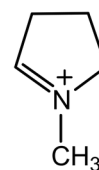
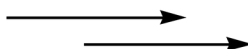
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### Question Four (20 Marks)

- (a) Outline how alkaloids have been exploited in human medicine and agriculture. [6 marks]
- (b) Account for the basic nature of alkaloids and explain how this property aid in their extraction from plant materials. [4 marks]
- (c) By making use of ornithine (structure 5), describe the Mannich reaction involved in alkaloid synthesis and make use of curly arrows to show the mechanism involved in its conversion to N-methyl-1-pyrrolium cation (structure 6). [10 marks]



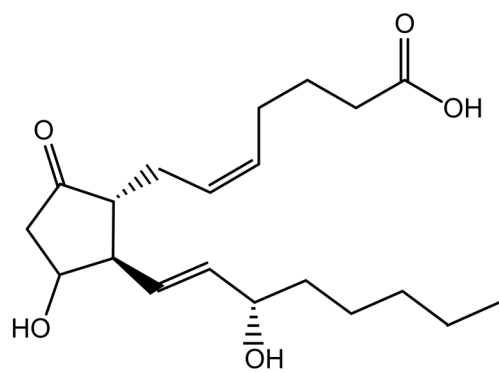
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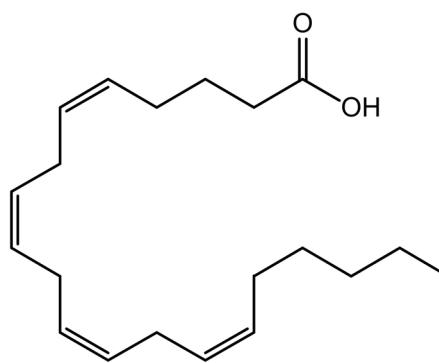
(6)

### Question Five (20 Marks)

- (a) What is biomimetic synthesis? [2 marks]
- (b) What are the key advantages of this approach compared to traditional synthetic methods? [4 marks]
- (c) Provide a plausible biomimetic synthesis scheme of Prostaglandin E2 (PGE2) (Structure 7) starting with arachidonic acid (Structure 8) clearly indicating the enzymes and steps being mimicked and the intervening compounds. [14 marks]



(7)



(8)