

National Exams

04-BS-13, Biology

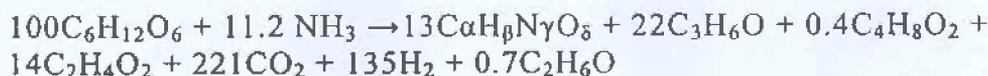
3 hours duration

NOTES:

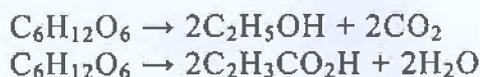
1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is a CLOSED BOOK EXAM. One aid sheet allowed written on both sides. Any Casio or Sharp approved calculator is permitted.
3. FIVE (5) questions constitute a complete exam paper. Complete the questions as indicated on the question paper. Many choices are provided. The first five questions as they appear in the answer book will be marked.
4. Each question is of equal value.
5. Most questions require an answer in essay format. Clarity and organization of the answer are important.

Part I: Solve any 3 questions out of the following 6 questions (20 marks for each)

1. *Clostridium acetobutylicum* ($C_\alpha H_\beta N_\gamma O_\delta$, biomass) anaerobically converts glucose ($C_6H_{12}O_6$) to acetone (C_3H_6O), butanol ($C_4H_{10}O$) and smaller concentration of butyrate, acetate, etc. In a fermentation, the following products were obtained from 100 moles of glucose and 11.2 moles of NH_3 as a nitrogen source.



- (a) Determine the elemental composition of the biomass (i.e. α , β , γ , δ values), and
 (b) Determine the number of electrons lost during fermentation using available electron balances.
2. In the anaerobic fermentation of grain, the yeast *Saccharomyces cerevisiae* digests glucose ($C_6H_{12}O_6$, molecular weight = 180) from plants to form the products ethanol (C_2H_5OH , molecular weight = 46) and propenoic acid ($C_2H_3CO_2H$, molecular weight = 72) by the following overall reactions:



In a batch process, a tank is charged with 4000 kg of a 12% glucose/water solution. After fermentation, 120 kg of CO_2 (molecular weight = 44) are produced together with 90 kg of unreacted glucose. What are the weight percents of ethyl alcohol and propenoic acid remaining in the broth? Assume that none of the glucose is assimilated the bacteria. Molecular weight of water = 18.

3. In a continuous fermenter for the production of *Penicillium chrysogenum*, the cells generate 27.6 kJ/(kg.h), and the mass in the well-insulated fermenter is 2 kg. The feed temperature is 25°C and the exit temperature is equal to the temperature in the fermenter. *Penicillium chrysogenum* can not grow above 42°C. Will the cells survive? Inlet and outlet streams have a specific heat of 4 kJ/(kg.°C) and the mass flow rates of 1.025 kg/h.
4. Aerobic growth of *S. cerevisiae* on ethanol is given by:



- (a) Determine the coefficients a, b, c and d, where respiratory quotient (RQ, i.e. ratio of moles of CO₂ produced and moles of O₂ consumed) = 0.66.
- (b) Determine the biomass yield coefficient, and oxygen yield coefficient on mass basis.
5. Describe protection tissues, conductive tissues and ground tissues (use figures where needed). How these are related the material properties of plant and animal products?
6. How rheological properties of biological material are influenced by size, shape and volume of the cells and the physical nature and characteristics of the intercellular spaces.

Part II. Answer any 2 questions out of the following 4 questions (20 marks for each question)

7. Describe how water move into and out of cells and how water is retained in plant and animal cells. Explain free water, bound water, mechanisms of molecular adsorption and water activity. How these influence material properties?
8. Using suitable figures, describe how from a morphological point of view, organization of the plant and animal material is related to physical handling and processing of these materials.
9. (a) What are the three basic shapes of bacteria? How are prokaryotic and eukaryotic cells alike? How are they differ?
(b) What uses do bacteria make of carbon source? What other nutrients might bacteria require, and why? How do selective, differential, and enrichment media differ?
10. (a) Describe the shapes of viruses. List the main characteristics of viruses.
(b) What characteristics distinguish fungi from other microorganisms? In what ways are fungi beneficial, and in what ways are they harmful in food?

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Marking Scheme

1. 20 marks total, (a) 12 and (b) 8
2. 20 marks total (10 marks per percent of the product)
3. 20 marks total
4. 20 marks total (a) 15 marks, 3 for each unknown, (b) 5 marks
5. 10 marks of each section, 20 marks total
6. 20 marks total
7. 20 marks total (7, 7 and 6 for 3 sections)
8. 20 marks total
9. (a) 4, 4 and 2 marks for three sections, (b) 3, 3 and 4 marks for three sections
10. (a) 5 marks for each section, (b) 4 and 6 marks for two sections