

(b) A thermic fluid is used as a heating medium in a particular process. A pump circulates the thermic fluid at atmospheric pressure and 473K. The circulation rate is 10,000lph. The fluid discharged from the pump, passes through a heat exchanger and receives the heat from product gases of combustion. The heat transfer rate is 232.6kW. The motor of the pump consumes 1.1kW. The overall efficiency of the pump and motor is 50%. The pressure of the fluid at the inlet of the heater is 100kPag. Assume negligible kinetic energy and potential energy changes, negligible frictional loss and no heat loss to the surrounding. The specific gravity and the mean heat capacity of the fluid are 0.75 and 2.6 kJ/kg°C respectively at the operating conditions, calculate the outlet temperature of the fluid.

Group - E

8. *Saccharomyces cerevisiae* is grown anaerobically in continuous culture. Glucose is used as carbon source and ammonia as the nitrogen source. At steady state ethanol and glycerol is produced. At steady state, mass flows to and from the fermenter at steady state are as follows:

- Glucose in: 36kg/h
- NH<sub>3</sub> in: 0.4kg/h
- Cell out: 2.81kg/h
- Glycerol out: 7.94kg/h
- Ethanol out: 11.9kg/h
- CO<sub>2</sub> out: 13.6kg/h
- H<sub>2</sub>O out: 0.15kg/h
- Estimate the cooling requirements.
- Heat of combustion of glucose = -2805kJ/mol
- Heat of combustion of NH<sub>3</sub> = -382.6kJ/mol
- Heat of combustion of glycerol = -1655.4kJ/mol
- Heat of combustion of ethanol = -1366.8kJ/mol
- Molecular weight of glycerol is 92.

9. Baker's yeast is produced in a 50,000l fermenter under aerobic conditions. The carbon substrate is sucrose; ammonia is provided as nitrogen source. The biomass composition is CH<sub>1.83</sub>O<sub>0.55</sub>N<sub>0.17</sub> with 5% ash. Under efficient conditions, biomass is the only major product; the biomass yield from sucrose is 0.5g/g. If the specific growth rate is 0.45h<sup>-1</sup>, estimate the rate of heat transfer required to maintain constant temperature in the fermenter when the sucrose concentration is 10g/l.

Time Allotted : 3 hrs

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group - A  
(Multiple Choice Type Questions)

10 x 1 = 10

Choose the correct alternatives for the following:

- (i) The net gain of ATP molecule resulting from complete oxidation of 1 molecule of glucose:
  - (a) 2
  - (b) 4
  - (c) 32
  - (d) 38.
- (ii) Hexokinase
  - (a) catalyses transfer of phosphate group from ATP to any hexose
  - (b) catalyses transfer of phosphate group from ATP to only glucose
  - (c) transfers inorganic phosphate to hexose
  - (d) converts fructose 6 phosphate to fructose-1,6-bisphosphate.
- (iii) TCA cycle is
  - (a) catabolic
  - (b) amphibolic
  - (c) anabolic
  - (d) cyclic.
- (iv) Rubisco binds to
  - (a) CO<sub>2</sub>
  - (b) O<sub>2</sub>
  - (c) both CO<sub>2</sub> and O<sub>2</sub>
  - (d) none.
- (v) Alanine is deaminated to produce
  - (a) pyruvic acid
  - (b) citric acid
  - (c) oxalic acid
  - (d) fumeric acid.
- (vi) Three amino acids that donate amino group for purine biosynthesis are
  - (a) glycine, glutamine and aspartate
  - (b) glycine, beta-alanine and aspartate
  - (c) glycine, alanine and aspartate
  - (d) lysine, glutamine and asparagine.
- (vii) One ketogenic amino acid is
  - (a) leucine
  - (b) arginine
  - (c) alanine
  - (d) glutamine.
- (viii) Palmitic acid is an
  - (a) odd chain saturated fatty acid
  - (b) odd chain unsaturated fatty acid
  - (c) even chain saturated fatty acid
  - (d) even chain unsaturated fatty acid.

(ix) cAMP is  
(a) first messenger (b) Ligand (c) receptor (d) second messenger

(x) The disease caused by lipid metabolism is  
(a) liver cirrhosis (b) atherosclerosis  
(c) all of the above (d) none of these.

**Group - B**

- 2.(a) Write short note on allosteric regulation with a suitable example.
- (b) Discuss with a flow chart the pay off phase of glycolysis. Which step of this phase is bypassed in gluconeogenesis and how?
- (c) Explain the hormonal regulation of glucose metabolism.
- (d) Explain with schematic diagram the mechanism of action of pyruvate dehydrogenase complex.

2 + (3 + 2) + 2 +

3.(a) Diagrammatically represent TCA cycle with structure of all intermediates mentioning all enzymes and cofactors.

- (b) How cytoplasmic NAD<sup>+</sup> is regenerated?
- (c) State and explain chemiosmotic coupling hypothesis.
- (d) Name two inhibitors of electron transport chain and explain their mechanism of action.

6 + 2 + 2 +

**Group - C**

- 4.(a) Classify hormones.
- (b) Describe backbone structure of steroid hormones and show how steroid hormones work?
- 5.(a) Classify the different classes of vitamins.
- (b) What are roles of different water-soluble vitamins?
- (c) What are roles of different lipid-soluble vitamins?

4 + 4 +

**Group - D**

What do you mean by transamination? Discuss the role of vitamin B<sub>6</sub> in transamination.

Discuss catabolism of one glucogenic amino acid.

Discuss catabolism of one ketogenic amino acid.

What do you mean by oxidative deamination?

Give a brief account of disorders of purine nucleotide metabolism.

(2 + 2) + 2 + 2 + 2 + 2 = 12

What are essential and non-essential amino acids? Give examples.

What is glutathione? Describe its synthesis and function in cell.

Describe the salvage pathway for purine biosynthesis.

Which enzyme is involved with Lesch-Nyhan syndrome?

3 + 3 + 4 + 2 = 12

**Group - E**

What are G-proteins? How are G-proteins activated?

Show how insulin cascade works?

(4 + 2) + 6 = 12

What are second messengers?

Describe the mechanism by which tyrosine kinase works?

What are the different types of gap junctions?

2 + 6 + 4 = 12