ANSWERS

INSTRUCTIONS TO CANDIDATES

1. This examination paper contains TWO (2) parts and comprises EIGHT (8) pages.

2. Answer all questions.

3. Part A contains TWENTY (20) questions. Answer each question of PART A on the multiple choice answer sheet provided. Of the four (4) options (A,B,C,D), shade only the option of your choice using a pencil. All questions in part A carry equal weight.

4. Part B contains THREE (3) questions. Answer each question of PART B in the answer book provided, beginning on a FRESH page for each question. All questions in part B carry equal weight.

6. Write your matriculation number on the multiple choice answer sheet.

7. This is NOT an OPEN BOOK exam.
Part A
(Provide your answers to the questions in PART A on the multiple choice answer sheet offered; Choose one of the four choices provided that best fits in the blank space).

(2 marks for each question and total 40 marks)

1  As a type of food source, Spirulina algae is a(an) __________
   A.  plant
   B.  animal
   C.  single-cell organism
   D.  fungus
   C

2  A nutrient is a substance that an organism relies on to live and grow, and must be taken from its environment. Nutrients are in general used by humans to __________
   A.  build and repair their tissues
   B.  provide energy
   C.  regulate some metabolic processes
   D.  all of the above
   D

3  Lactose in milk is a __________
   A.  polysaccharide
   B.  trisaccharide
   C.  disaccharide
   D.  monosaccharide
   C

4  __________ is sweeter than any other carbohydrate compounds
   A.  glucose
   B.  fructose
   C.  galactose
   D.  sucrose
   B

5  A food emulsifier molecule usually contains __________ in its molecular structure.
   A.  at least one hydrophobic moiety and one lipophilic moiety
   B.  two lipophilic moieties
   C.  at least one lipophilic moiety and one hydrophilic moiety
   D.  two hydrophilic moieties
   C

6  Fat substitutes are substances used __________
   A.  to prevent oxidative rancidity of food oil
   B.  to increase fluidity of food oil
   C.  to decrease fluidity of food oil
   D. to replace food oil
   D
When being viewed from the food energy perspectives, Salatrim contains _______ Calories (Cal) per gram
A. 0
B. 5
C. 9
D. 15

Stearic acid most likely occur in___________ in the form of triesters
A. soy bean oil
B. sunflower oil
C. beef tallow
D. flour

When it is consumed, soluble dietary fiber is hydrolyzed by enzymes__________
A. in the mouth
B. in the stomach
C. produced by intestines
D. produced by bacteria in the colon

Sucrose (table sugar) can be considered as _______ linked together through a glycosidic bond
A. fructose and galactose
B. fructose and glucose
C. lactose and maltose
D. glucose and galactose

Honey contains more ______ than any other individual type of carbohydrate sugars.
A. sucrose
B. glucose
C. fructose
D. maltose
12 The molecule with its molecular structure shown below is a ________
   A. carbohydrate
   B. protein
   C. lipid
   D. none of the above
   C

13 The sugar in jams and jellies serve mainly as a ________
   A. sweetener
   B. preservative
   C. gelling agent
   D. none of the above
   B

14 Triglycerides are hydrolyzed mainly ____________
   A. in the mouth
   B. in the stomach
   C. in the intestines
   D. by the lipase produced by bacteria in colons
   C

15 Bacteria in fat/oil could __________
   A. cause hydrolytic rancidity of the fat/oil
   B. cause oxidative rancidity of the fat/oil
   C. promote the absorption of odor molecules by the fat/oil
   D. convert fat/oil into dietary fiber
   A

16 Fatty acids in food can be classified into ____________
   A. saturated fatty acids, monounsaturated fatty acids, diunsaturated fatty acids, triunsaturated fatty acid and polyunsaturated fatty acids
   B. saturated fatty acids, monounsaturated fatty acids, diunsaturated fatty acids and polyunsaturated fatty acids
   C. saturated fatty acids, monounsaturated fatty acids, and polyunsaturated fatty acids
   D. saturated fatty acids and monounsaturated fatty acids
   C

17 High fructose corn syrup are produced in the following stepwise order:
   A. Glucose syrups → HFCS 42 → HFCS 55 → HFCS 90
   B. Glucose syrups → HFCS 55 → HFCS 42 → HFCS 90
   C. Glucose syrups → HFCS 90 → HFCS 42
   D. HFCS 90 → HFCS 55 → HFCS 42 → glucose syrups
   C
18 Sugar alcohol is
   A. a mixture of sugar and alcohol
   B. sugar prepared from alcohol
   C. alcohol prepared from sugar
   D. none of the above  
   C

19 If butter is left on the kitchen counter on a warm day for a certain period of time, a characteristic rancid smell will frequently develop due to the presence of lipase in the butter. The rancid smell in the butter is caused most likely by
   A. CH_3COOH
   B. CH_3CH_2COOH
   C. CH_3CH_2CH_2COOH
   D. All of the above  
   C

20 α-Linolenic acid is a(an)_________
   A. essential fatty acid
   B. Omega-3 fatty acid
   C. essential fatty acid and Omega-3 fatty acid
   D. none of the above  
   C
Part B

Question 1

(Total 20 marks)

1 (i) Explain why insoluble dietary fiber such as cellulose can increase the fecal size and soften the stool; (ii) Polydextrose is synthesized from glucose, sorbitol and citric acid. Describe briefly why the synthetic polydextrose can serve as dietary fiber. (4 marks)

(i) Cellulose contains various hydroxyl groups that can attract water molecules.

(ii) Amylase can only hydrolyze 1,4 and 1,6 linkage of glucose in polysaccharides while the condensation reactions of glucose do not always take place at 1,4 or 1,6 position.

2 (i) Explain briefly why sugar could prevent the growth of microorganisms in food; (ii) Explain why addition of citric acid to table sugar can prevent the sugar from crystallization during some food processing operation; (iii) “Sugaring” is a type of preservation measures for some food. Describe briefly how the “sugaring” process is commonly carried out. (6 marks)

(i) Sugar molecules contain various hydroxyl groups that can interact with water molecules through hydrogen bonding, thus decreasing the amount of free water to be used by bacteria.

(ii) As an acid, citric acid can catalyze hydrolysis of sugar molecules (sucrose) into fructose and glucose while fructose and glucose cannot crystallize out as easily as sucrose.

(iii) Dehydration of food followed by addition of sugar to the food.
3 (i) Explain briefly why hydrogenation can increase the shelf life of vegetable oil; and (ii) Acid and sucrose or divalent metal ions (acids and sucrose and divalent metal ions are considered as food additives) are required for the formation of gel by pectin while no food additive is needed for forming gelatin from peptides/proteins. Explain briefly why no food additive is needed for promoting the formation of gelatin from peptides/proteins. (4 marks)

(i) The molecules of vegetable oil contain carbon-carbon double bonds which are vulnerable to oxidation by \( O_2 \) in the air. Hydrogenation reduces the number of carbon-carbon double bonds in the triglyceride molecules in vegetable oil, which makes vegetable oil less oxidable.

(ii) Unlike pectin molecules that contain only negative charged groups, peptides/proteins molecules contain both positive and negative charges in their side chains. The positive and negative charged groups in peptides/proteins alone can form stronger interactions.

4 (i) Both cheese and butter are solid at room temperature. Write down the most crucial difference between cheese and butter; and (ii) Describe briefly what is called “winterization” in food science. (4 marks)

(i) Cheese contains mainly proteins while butter contains mainly triglycerides.

(ii) Winterization consists of two separate steps:
   1) Decreasing the temperature of vegetable oil to allow solid to form; and
   2) Filtering out the solid generated during temperature decrease.
“High Fructose Corn Syrups” were used illegally to "stretch" honey by some food manufacturers in some countries. Write down the reason(s) that make “High Fructose Corn Syrups” (rather than other sugars such as table sugar) suitable for making fake honey. (2 marks)

This is because (1) HFCS 55 has a similar sugar profile to honey, (2) its production cost is low, and (3) both are viscous solution and hold similar viscosities.
Question 2

1. Explain briefly (1) why Olestra may not be held properly by the final sphincter of human body in elimination (anal sphincter); (2) what methods does the food industry use to solve the problem.

   (3 Marks)

   (1) Olestra is not soluble in water

   (2) Long chain fatty acids are used for synthesizing Olestra.

2. Write down three reasons why high-fructose corn syrup has been more popularly used nowadays in the US as a food sweetener than sucrose.

   (3 Marks)

   [1] high-fructose corn syrup is cheaper than sucrose;

   [2] fructose is more sweeter than sucrose; and

   [3] fructose has lower Glycemic index than sucrose

3. Describe briefly why food manufacturers use acetylated vegetable oil rather than non-acetylated vegetable oil as coating agents for dried raisins, meats, cheeses and nuts to avoid losing water content.

   (3 Marks)

   The viscosity (fluidity) of acetylated vegetable oil is lower than that of non-acetylated vegetable oil.
(i) Explain briefly why Olestra could cause the loss of Vitamin E when the fat substitute is consumed; and (ii) Salatrim is a FDA-approved calorie-reducing fat substitute. Explain briefly how the calorie-reducing effect is achieved by Salatrim after it is consumed.

(7 Marks)

(i) Vitamin E goes along with Olestra through intestines because Vitamin E is soluble in Olestra (both Vitamin E and Olestra are non-polar molecules).

(ii) Salatrim contains more short chain and long chain fatty acids than regular vegetable oil. Short chain fatty acid contains less energy because it possesses less carbon in its structure while long chain fatty acids cannot be metabolized as effectively as medium and short chain fatty acids.

5 List four distinctive properties of sorbitol in comparison with those of glucose from the food chemistry perspective.

(4 Marks)

Sorbitol:

1) is sweet (relative sweetness: ~0.6)

2) contains low energy (0.92 Cal/g while sucrose contains 4 Cal/g)

3) is transformed in human body into fructose rather than glucose (low glycemic index)

4) cannot be fermented as readily as regular sugars by microorganisms in the mouth (lactic acids are the main fermentation products that cause tooth decay)
Question 3

(4 marks for each question and total 20 marks)

1. Based on enzymatic catalysis, describe briefly what the most critical factor is that makes Olestra unhydrolyable by human lipase (enzyme).

   **Olestra molecule is too big to fit the active site of lipase.**

2. The ratio of protein to fat (weight of protein/weight of fat) in soy milk is 1:0.68 while the ratio of protein to fat in tofu is 1:0.59 (Table 1). These data indicate that the ratio of protein to fat in tofu is higher than the ratio in soy milk.

   On the other hand, the ratio of protein to fat in cow milk is 1:1.02 while the ratio of protein to fat in cheese is 1:1.03. These data indicate the ratio of protein to fat in cheese is almost the same as that in cow milk.

   Explain briefly (i) why the ratio of protein to fat from soy milk to tofu varies; and (ii) why the ratio of protein to fat in cow milk and in cheese is almost the same.

   **Table 1:**

<table>
<thead>
<tr>
<th>Soy milk (100 grams):</th>
<th>Protein (g)</th>
<th>Fat (g)</th>
<th>Carbohydrate (g)</th>
<th>Water (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.8</td>
<td>1.9</td>
<td>1.8</td>
<td>93.3</td>
</tr>
<tr>
<td>Relative ratio</td>
<td>1</td>
<td>0.68</td>
<td>0.04</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tofu, raw, regular (100 grams) :</th>
<th>Protein (g)</th>
<th>Fat (g)</th>
<th>Carbohydrate (g)</th>
<th>Water (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8.1</td>
<td>4.8</td>
<td>1.9</td>
<td>84.6</td>
</tr>
<tr>
<td>Relative ratio</td>
<td>1</td>
<td>0.59</td>
<td>0.23</td>
<td>-</td>
</tr>
</tbody>
</table>

   **Table 2:**

<table>
<thead>
<tr>
<th>Cow milk composition :</th>
<th>Protein (g)</th>
<th>Fat (g)</th>
<th>Carbohydrate (g)</th>
<th>Others (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.2</td>
<td>3.9</td>
<td>4.8</td>
<td>87.8</td>
</tr>
<tr>
<td>Relative ratio</td>
<td>1</td>
<td>1.02</td>
<td>1.50</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cheese composition :</th>
<th>Protein (g)</th>
<th>Fat (g)</th>
<th>Carbohydrate (g)</th>
<th>Water (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>26.9</td>
<td>27.8</td>
<td>5.4</td>
<td>30.9</td>
</tr>
<tr>
<td>Relative ratio</td>
<td>1</td>
<td>1.03</td>
<td>0.2</td>
<td>-</td>
</tr>
</tbody>
</table>

   The fats (animal product) in cow’s milk possess usually longer carbon chains than those in soymilk (plant) while long chain fatty acids-containing triglycerides can precipitate out easily.
As seen in Table 1 and Table 2 above, a much higher percentage of carbohydrates is lost in the production of cheese from cow milk than in the production of tofu from soy milk. Explain briefly why the carbohydrates in soy milk do not get lost as easily as those in cow milk during the transformation from liquid (soy milk or cow milk) to solid (tofu or cheese).

Lactose (disaccharide) is more soluble in water than polysaccharide. Cow’s milk contains mainly lactose as its carbohydrate content while soy milk contains polysaccharides, besides monosaccharide and disaccharides.

For the pectin with a low degree of esterification, divalent metal ions are often used to induce the formation of pectin gel. As to the pectin with a high degree of esterification, acids and sucrose (or sorbitol) are often used to promote the formation of pectin gel.

Explain briefly (i) why divalent metal ions are not capable of promoting gel formation by the pectin that possess a high degree of esterification; and (ii) why acids and sucrose are able to promote gel formation by the pectins that possess a high degree of esterification.

As to the pectin with a high degree of esterification, bridge molecules are needed to link two pectin molecules together. Sucrose and acid molecules can serve as such bridge molecules.

As to the pectin with a low degree of esterification, divalent metal ions alone can serve as bridge molecules.

Whey protein cannot precipitate out under the conditions for making tofu and cheese because (i) polar groups are highly abundant on the surfaces of whey proteins; and (ii) disulfide bonds are commonly present in the structures of whey proteins. Explain briefly why highly abundant polar groups and disulfide bonds could make whey proteins resist precipitation of protein molecules

i. under the condition where the environmental pH is equal to the isoelectric point of whey protein
ii. under the condition where rennet is added to whey protein solution.

(i) It is the non-charged polar side chains (rather than charged side chains) that make whey protein molecules soluble in water.

(ii) Disulfide bonds make protein molecules more stable, thus resisting hydrolysis of protein by protease to certain degrees.