ASSIGNMENTS

1. Describe the functions of each region of the gastro intestine tract.

**The major functions of each region of gastrointestinal tract are described below;**

* **Mouth**
* Starch hydrolysis catalysed by amylase, secreted by the salivary glands
* Fat hydrolysis catalysed by lingual lipase, secreted by the tongue
* Absorption of small amounts of vitamin C and a variety of non-nutrients (including nicotine).
* **Stomach**
* Denaturation of dietary proteins and the release of vitamin B12, iron and other minerals from protein binding, for which gastric acid is important
* Protein hydrolysis catalysed by pepsin
* Fat hydrolysis catalysed by lipase
* Secretion of intrinsic factor, required for the absorption of vitamin B12
* **Small intestine (**duodenum, jejunum and ileum)
* Starch hydrolysis catalyzed by amylase secreted by the pancreas
* Hydrolysis of disaccharides within the brush border of the intestinal mucosa
* Fat hydrolysis catalysed by lipase secreted by the pancreas
* Protein hydrolysis catalysed by a variety of exo- and endopeptidases secreted by the pancreas and small intestinal mucosa
* Hydrolysis of di- and tripeptides within the brush border of the intestinal mucosa
* Absorption of the products of digestion
* Absorption of water (failure of water absorption, as in diarrhea, can lead to serious dehydration
* **Large intestine** (ceacum & colon)
* Bacterial metabolism of undigested carbohydrates & shed intestinal mucosa cells
* Absorption of some of the products of bacterial metabolism
* Absorption of water
* **Rectum**
* Storage of undigested gut contents prior to evacuation as feaces

1. Explain the digestion and **absorption of lipids**, the role of **bile salts** and the **formation** of **chylomicrons**.
2. Digestion & absorption of lipids

In developed countries, the lipid diet contains 60-150g/day.

The major dietary lipids are;

* **Ttriacylglycerols** (TGL) also known as triglycerides in which glycerol is esterifies to three fatty acids such as saturated fatty acid e.g. stearic acid,mono unsaturated fatty acid e.g. oleic acid & polyunsaturated fatty acid e.g.linoleic acid.

These are the oils & fats of the diet which provide between 30-45% of average energy intake

* **Steroids** including cholesterol & variety of plant sterols & stanols & extremely small amounts of steroid hormones. Chemically these are completely different from triacylglycerols and phospholipids, and are not a source of metabolic fuel.
* **Phospholipids** (**PL**) in which glycerol are esterified to two fatty acids with phosphate & a hydrophilic group esterified to carbon-3. Phospholipids are major constituents of cell membranes
* Digestion of lipids is initiated in the **stomach**, catalyzed by;

***Lingual lipase*** which is secreted by Ebner’s gland present on the dorsal surface of the tongue with ph range from 0-7.5 (optimum 4-4.5) In the stomach 30% of **TGL** may be digested while the milk fats with shorter **FA** are best substrate. More specific for ester linkage at 3rd position

**Gastric Lipase is** acid stable, optimum ph of 5.4 secreted by chief cells, the secretion is stimulated by gastrin. Action is negligible because no emulsification of fat take place in stomach & low ph in stomach is unfavorable for the action of gastric lipase.

* Digestion in **small intestine** which is the major site of fat digestion is facilitated by digestive enzymes present in pancreatic juice such as;

**Pancreatic lipase**-hydrolysis the FA esterified to the 1st & 3rd carbon atoms of glycerol forming 2-monoacylgcerol & 2 molecules of FA

**Phospholipase A2-**are responsible for the hydrolysis of phospholipids

**Cholesterol esterase-**cleaves cholesterol ester to produce cholesterol & FFA

1. The role of the bile salts

Bile salts help binding of lipase with two molecules of colipase.The combination of the two enhances lipase activity in the intestinal ph which helps in emulsification of fats. Calcium precipitates FFA as insoluble Ca soaps & facilitates lipase action. Absorption of lipids is due to mixed **micelle** formation. Bile salts & soaps formed in the intestinal lumen & bicarbonate of pancreatic & intestinal juices collected in the higher FA, mono & diglycerides, lecithins, cholesterol in form of water soluble molecular aggregates called “**micelles**”

Micelles are absorbed mainly from duodenum & jejunum. Bile salts are absorbed in the lower part of the intestine & return to liver via portal vein & resecreted into the bile known as **enterohepatic** circulation.

1. The formation of chylomicrons

Inside the epithelial cell, triglycerides are resynthesized in smooth endoplasmic reticulam, protein component (APO-B48) is synthesized in rough endoplasmic which is incorporated & **chylomicrons** are formed. Glycerol-free glycerol (22%) released in intestinal lumen is not utilized for resynthesis of TG in intestinal epithelial cell. It directly passes to the portal vein & taken to the liver while short chain & medium chain & unsaturated FA are absorbed to portal blood directly & taken to liver

**CHYLOMICRONS-**are comprised of **TG 87%, PL 8%,** free & **esterified cholesterol 3%** & **Apoprotein 0.05-2%.** It passes through cell membrane of bases & lateral walls of intestinal epithelial cells & moves through extra cellular spaces, enter lymphatic vessels of abdomen later goes to systemic circulation through **thoracic duct**

1. Describe the absorption of minerals, especially iron.

Most minerals are absorbed by carrier-mediated diffusion into intestinal mucosal cells and accumulated by binding to intracellular proteins. There is then sodium-dependent active transport from the epithelial cells into the bloodstream, where again they are usually bound to transport proteins. Genetic defects of the intracellular binding proteins/ active transport systems at the basal membrane of the mucosal cell can result in functional deficiency despite an apparently adequate intake of the mineral.

The absorption of many minerals is affected by other compounds present in the intestinal lumen. A number of reducing compounds can enhance the absorption of iron, and a number of chelating compounds enhance the absorption of other minerals. For example, zinc absorption is dependent on the secretion by the pancreas of a zinc-binding ligand. Failure to synthesize and secrete this zinc-binding ligand as a result of a genetic disease leads to the condition of acrodermatitisenteropathica –functional zinc deficiency despite an apparently adequate intake.

Polyphenols and especially tannic acid in tea, can also chelateiron and other minerals, reducing their absorption, and large amounts of free fatty acids in the gut lumen can impair the absorption of calcium and magnesium, forming insoluble soaps.

**Iron absorption**

Only about 10% of dietary iron is absorbed, and only as little as 1–5% of that in many plant foods. However, iron deficiency is a serious problem; some 10–15% of women of child-bearing age have menstrual iron losses greater than can be met from a normal dietary intake. Haem iron in meat is absorbed better than is inorganic iron from plant foods, and by a separate transport system.

Inorganic iron is absorbed only in the Fe2+ (reduced) form. This means that a variety of reducing agents present in the intestinal lumen together with dietary iron will enhance its absorption. The most effective such compound is vitamin C and, although intakes of 40–60 mg of vitamin C per day are more than adequate to meet requirements, an intake of 25–50 mg per meal is sometimes recommended to enhance iron absorption. Alcohol and fructose also enhance iron absorption.

Like other minerals, iron enters the mucosal cells by carrier-mediated passive diffusion and is accumulated in the cells by binding to a protein, ferritin. Once all the ferritin in the mucosal cell is saturated with iron, no more can be taken up from the gut lumen. Iron can leave the mucosal cell only if there is free transferrin in plasma for it to bind to and, once plasma ferritin is saturated with iron, any that has accumulated in the mucosal cells will be lost back into the intestinal lumen when the cells are shed at the tip of the villus.

The mucosal barrier to the absorption of iron has a protective function. Iron overload is a serious condition, leading to deposition of inappropriately large amounts of iron in tissues, and about 10% of the given populations are genetically susceptible to iron overload. Once the normal tissue iron-binding proteins are saturated, free iron ions will accumulate in tissues. Iron ions in solution are able to generate tissue-damaging oxygen radicals, and this may be a factor in the development of cardiovascular diseases & some form of cancers. One of the reasons why women are less at risk of atherosclerosis than men be that women generally have lower iron status than men due to menstrual blood loses. This raises the interesting problem of whether or not it is desirable to recommend high intake of iron for women of child-bearing age in order to raise their iron reserves to the same level as seen in men. This would prevent development of iron deficiency but might also put them at risk of atherosclerosis due to iron overload

1. Describe and explain the classification of amino acids according to their chemical and nutritional properties.

Twenty-one amino acids are involved in the synthesis of proteins, together with a number that occur in proteins as a result of chemical modification after the protein has been synthesized. Chemically the amino acids all have the same basic structure – an amino group (–NH2) and a carboxylic acid group (–COOH) attached to the same carbon atom (the α-carbon).what differs between the amino acids is the nature of the other group that is attached to the a-carbon. In the simplest amino acid glycine, there are two hydrogen atoms while in all other amino acids there is one hydrogen atom & a side-chain varying in chemical complexity from the simple methyl group (-CH) of alamine to aromatic ring structures of phenylalanine, tyrosine & tryptophan. The amino acids can be classified according to the following;

1. **Chemical nature** of the side-chain, whether it is hydrophobic or hydrophilic & the nature of the group;

* Small hydrophobic amino acids;glycine,alanine & proline
* Branched –chain amino acids;leucine,isoleucine & valine
* Aromatic amino acids; phenylalanine, tyrosine & tryptophan
* Sulphur-containing amino acids;cysteine & methionine
* Neutral hydrophilic amino acids; serine & threonine
* Acidic amino acids; glutamic & aspartic acids
* Amides of the acidic amino acids; glutamine & asparagines
* Basic amino acids; lysine,arginine & histadine

1. Classification **based on nutritional** properties/requirements

Based on Nutritional requirement, amino acids can be divided into 3 types.

* Essential Amino acids (EAA)-These are some of the amino acids that don’t synthesize in the human body. It should be supplied through diet. They are required for proper growth & maintenance of the individual such as Methionine,Arginine,Threonine,Tryptophan,Valine,Isoleucine,Leucine,Phenylalanine,Histidine & Lysine
* Non-Essential Amino acids (NEAA)-These are amino acids that a body can synthesize to meet the biological needs, hence they need not to be consumed in the diet such as Glyceine,Alanine,Serine,Cysteine,Aspartic,Asparagine,Glutamic,Glutamine,Tyrosine & Proline
* Semi-Essential Amino acids (SEAA-*These are amino acids required in the food for the essential growth of children but not essential for the adult individual growth such as Histidine* and *Arginine* are semi-essential amino acids.

**Protein structure and denaturation**

Proteins are composed of linear chains of amino acids, joined by condensation of the carboxyl group of one with the amino group of another, to form a peptide bond . Chains of amino acids linked in this way are known as **polypeptides**.

The sequence of amino acids in a protein is its primary structure is different for each protein, although proteins that are closely related to each other often have similar primary structures. The primary structure of a protein is determined by the gene containing the information for that protein

**Secondary structure of proteins**

Polypeptide chains fold up in a variety of ways. Two main types of chemical interaction are responsible for this folding: hydrogen bonds between the oxygen of one peptide bond and the nitrogen of another and interactions between the side- chains of the amino acids. Depending on the nature of the side-chains, different regions of the chain may fold into one of the following patterns:

• α-Helix, in which the peptide backbone of the protein adopts a spiral (helix) form. The hydrogen bonds are formed between peptide bonds which are near each other in the primary sequence.

• β-Pleated sheet, in which regions of the polypeptide chain lie alongside one another, forming a ‘corrugated’ or pleated surface. The hydrogen bonds are between peptide bonds in different parts of the primary sequence, and the regions of polypeptide chain forming a pleated sheet may run parallel or antiparallel.

• Hairpins and loops, in which small regions of the polypeptide chain form very tight bends;

• Random coil, in which there is no recognizable organized structure. Although this appears to be random, for any one protein the shape of a random coil region will always be the same.

A protein may have several regions of α-helix, β-pleated sheet (with the peptide chains running parallel or antiparallel), hairpins and random coil, all in the same molecule.