Physiology week 22 – Metabolism VIVAs

Describe the enzymes required for the digestion of carbohydrates and their location:

1. Salivary amylase

2. duodenum – pancreatic amylase

3. brush border oligosaccharidases

4. examples of these oligosaccharidases are: alpha-dextrinase (isomaltase), lactase, sucrase, maltase, trehalase

5. Final oligosaccharides: alpha-dextrins, maltotriose, maltose, trehalose, lactose, sucrose are metabolised to one of the hexoses (monosaccharides – galactose, fructose or glucose)

Describe how carbohydrates are absorbed from the GI tract:

1. 2 phases: 1st into intestinal mucosal cell and second into interstitial fluid and thus into capillaries and portal blood

2. glucose/galactose "secondary active transport" with sodium – low conc of Na inhibits transport (co-transporters: SGLT-1 and SGLT-2 – sodium-dependent glucose transporter)

3. glucose/galactose – "facilitated diffusion" into ICF by GLUT-2

4. fructose – "facilitated diffusion" from intestinal lumen by GLUT-5, thence GLUT-2 into ICF

5. ribose/deoxyribose Diffusion

What factors control blood glucose levels?

1. Absorption: dietary intake, renal tubule reabsorption

2. rate of entry into cells (including factors which affect this such as insulin, glucagon)

3. glucostatic activity of the liver (storage of glycogen, breakdown of glycogen, gluconeogenesis)

What are the potential pathways for glucose metabolism in the body?

1. aerobic

2. anaerobic

3. glycogen

4. pentoses

Describe the enzymes required for the digestion of proteins and their location:

1. Stomach – pepsinogens activated by gastric HCL (pH 1.6-3.2) to pepsins result in polypeptides

2. Small intestine lumen (pH 6.5) – proteolytic enzymes of the pancreas and intestinal mucosa

3. Examples – endopeptidases (trypsin, chymotrypsin, elastase) and exopeptidases to amino acids

4. Brush border: (amino, carboxy, endo and di) peptidases to amino acids

5. Cytoplasm of mucosal cells: after absorption by active transport

Describe how proteins are absorbed from the GI tract:

1. 2 phases: first into intestinal mucosal cell and second into ICF and thus into capillaries and portal blood

2. Into enterocytes: 7 different transport systems for amino acids (Na dependent and independent)

3. Out of enterocytes: 5 different transport systems

Describe how proteins are digested in the GI tract:

Stomach – pepsinogens are activated by the gastric acid to produce pepsins and these cleave bond of amino acids

Small intestine – powerful proteolytic enzymes from pancreas and intestinal mucosa

Endopeptidases and exopeptidase hydrolyse amino acids

How are proteins absorbed from the GI tract:

2 phases: 1. mucosal cell and 2. interstitial fluid and then into capillaries and portal blood

Seven transport system: 5 require Na and 2 Na independent (Na similar to glucose transport)

Absorption is rapid in duodenum and jejunum and slow in ileum

How does protein absorption and digestion differ in infants and young children compared to adults?

Infants absorb more undigested protein; results in more food allergy but passive immunity

Describe the enzymes required for the digestion of lipids and their location:

1. Lingual lipase (Ebner's Gland) – active in the stomach on triglycerides

2. Pancreatic lipase – requires colipase for maximal activity (triglycerides)

3. Pancreatic bile-salt activated lipase (not triglycerides but also cholesterol esters, some vitamins and phospholipids)

4. Cholesteryl ester hydrolase (cholesterol)

What other process is involve in the digestion of lipids?

1. emulsification

2. Micelles – formed from bile salts, lecithin and monoglycerides surrounding fatty acids, monoglycerides and cholesterol

3. transport lipids thru "unstirred layer" to brush border of muscosal cells

Please describe for lipids are absorbed from the GI tract.

1. 2 phases – first into intestinal mucosal cell and second into interstitial fluid (ECF) and thus into capillaries and portal blood (FFAs) or into lymphatics (chylomicrons)

2. into enterocytes: passive diffusion and carriers

3. out of enterocytes: depending on size (<10-12 carbons – directly into portal blood (FFAs) OR >10-12 carbons – reesterified to triglycerides or cholesteryl esters and packages in chylomicrons (coating of protein, cholesterol and phospholipids)

How is iron absorbed from the GI tract?

1. as heme iron (bound) or free iron

2. heme iron absorption independent of pH

3. more Fe2+ (soluble form) with gastric acid

4. affected by other gut contents

5. in small bowel

6. Binds to apoferritin

7. Transported to portal circulation

8. Feedback alters rate of absorption

How is iron transported?

1. free Fe2+ bound to transferring

2. to liver then bone marrow

Physiologically, how is iron lost from the body?

1. Gut cells

2. Menstruation

How is ingested iron absorbed?

1. most ingested iron is ferric (3+) but the ferrous (2+) form is absorbed

Minimal absorption in stomach but gastric secretions dissolve iron and aid conversion to ferrous form

Almost all absorption in duodenum.

Iron is transported into enterocytes via DMT1

Some stored as ferritin

Remainder transported out via ferroportin 1 (basolateral transporter) in the presence of hephaestin.

Then converted to ferric form and bound to transferrin

Dietary heme is absorbed by an apical transporter and iron is removed from the porphyrin in cytoplasm.

What are the mechanisms that regulate iron absorption?

Precise mechanisms uncertain, probably related to:

- recent dietary intake of iron
- state of body iron stores
- state of erythropoeisis in bone marrow
- the regulatory mechanisms are unclear