

Q11 Outline protein metabolism, including the effects of starvation (Sept 2011)

Proteins:

- Protein is lost continuously by catabolism (approx. 200-400g protein catabolised and resynthesized per day)
- Dietary intake of 30-50g per day is needed to maintain protein balance
- 10 of the 20 common amino acids (including tyrosine, valine and leucine) are termed 'essential' amino acids and cannot be resynthesized by the body
- Protein caloric value 4kcal/g

Metabolism:

- Protein digestion in GIT produces amino acids which are absorbed into the bloodstream
- Within 5-10 minutes they are taken up by cells (active transport / facilitated diffusion) and link with other AAs to form cellular proteins (large stores exist in muscle, liver and kidneys)
- Cellular proteins can be rapidly degraded by digestive enzymes (proteases) to increase plasma amino acid levels (thus providing a continual amino acid 'pool')
- The main plasma proteins (albumin, globulin, fibrinogen) are formed in the liver and can be degraded to amino acid constituents if required
- Amino acids are freely filtered by the glomerulus but actively reabsorbed by the proximal epithelium → this system can become overwhelmed, in which case amino acids will be lost through urine
- Once cells have reached their limit of protein storage, excess amino acids are deaminated in the liver, producing keto acids which can be oxidized for energy. This produces ammonia which must be removed via the urea cycle

Starvation:

- A state of relative or absolute inadequate energy supply
- During the first 24 hours, hepatic and skeletal muscle glycogen stores are used (Phase 1 – glycogenolysis)
- Once glycogen stores are depleted, body fat and protein stores are utilized for gluconeogenesis (Phase 2 – gluconeogenesis)
- Alanine is the most important amino acid for gluconeogenesis (via the alanine-glucose cycle). It is formed in muscle from the transamination of pyruvate derived from the oxidation of leucine, valine and isoleucine.
- Glutamine is the major precursor for renal gluconeogenesis
- Liver and skeletal muscle catabolism occurs first, with relative sparing of the heart and brain
- During the first week of starvation protein catabolism is 75g/day, but by the third week of starvation it reduces to 30g per day due to ketone body formation (Phase 3 – ketogenesis)