Nutrition for sport, exercise & health

D.1.1 Outline the principal components of the digestive system

- Mouth:

Mechanical Digestion: The large pieces of food that are ingested have to be broken into smaller particles that can be acted upon by various enzymes. This is mechanical digestion, which begins in the mouth with chewing or mastication and continues with churning and mixing actions in the stomach.

http://training.seer.cancer.gov/module_anatomy/unit10_1_dige_functions.html

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D.1.1 Outline the principal components of the digestive system

- Mouth:

Chemical Digestion: The complex molecules of carbohydrates, proteins, and fats are transformed by chemical digestion into smaller molecules that can be absorbed and utilized by the cells. Chemical digestion, through a process called hydrolysis, uses water and digestive enzymes to break down the complex molecules. Digestive enzymes speed up the hydrolysis process, which is otherwise very slow.

http://training.seer.cancer.gov/module_anatomy/unit10_1_dige_functions.html

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D.1.1 Outline the principal components of the digestive system

- Mouth:

Hydrolysis is a chemical reaction or process in which a chemical compound is broken down by reaction with water. This is the type of reaction that is used to break down polymers. Water is added in this reaction.

http://en.wikipedia.org/wiki/Hydrolysis

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D.1.1 Outline the principal components of the digestive system

- Esophagus: Is sometimes known as the **gullet**, is an organ in vertebrates which consists of a muscular tube through which food passes from the pharynx to the stomach. In humans the esophagus is continuous with the laryngeal part of the pharynx at the level of the C6 vertebra. It is usually 25-30 cm long which connects the mouth to the stomach. It is divided into cervical, thoracic, and abdominal parts. The trachea branches off the esophagus to the lungs.

http://en.wikipedia.org/wiki/Esophagus

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D.1.1 Outline the principal components of the digestive system

Food is passed through the esophagus by using the process of peristalsis. Specifically, it connects the pharynx, which is the body cavity that is common to the digestive factory and respiratory system with the stomach, where the second stage of digestion is initiated.

The esophagus is lined with mucous membrane, and is more deeply lined with muscle that acts with peristaltic action to move swallowed food down to the stomach.

The swallowing sound that we hear is the esophagus functioning.

http://en.wikipedia.org/wiki/Esophagus

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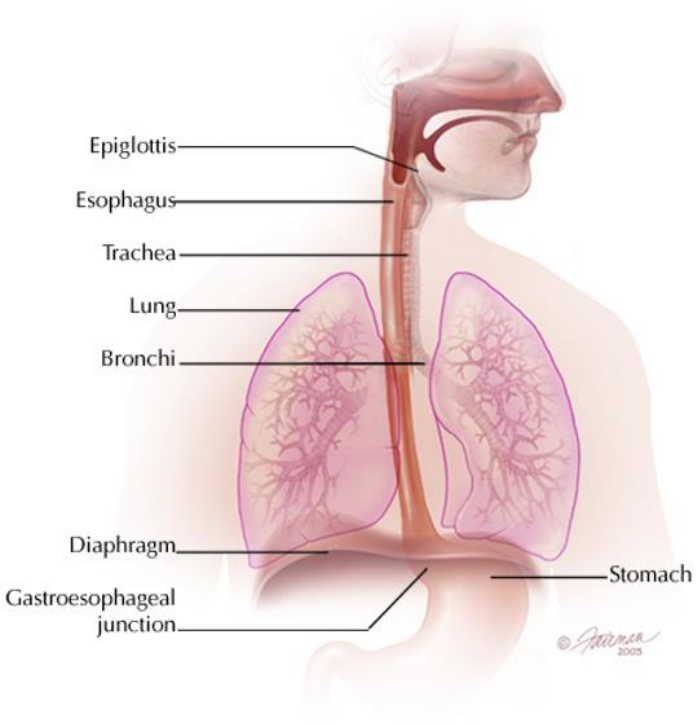
D.1.1 Outline the principal components of the digestive system



http://www.massgeneral.org/cancer/crr/types/thoracic/illustrations/images/esophagus_front.jpg

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D.1.1 Outline the principal components of the digestive system

- Stomach:

  The stomach is the expanded part of the digestive tract into which the esophagus opens. The empty stomach has a number of folds or ridges, called **rugae**, formed by the submucosa and mucosa, which serve to accomodate the filling and expanding of the stomach. Rugae are more prominent in the lower, narrow region of the stomach. The mixing and partial digestion of food by the stomach's gastric secrtions produces a pulpy fluid mix called chyme.

- http://www.courseweb.uottawa.ca/medicine-histology/English/Gastrointestinal/Gastro_Stomach.htm

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D.1.1 Outline the principal components of the digestive system

- Stomach:

  From the esophagus to the anus, the wall of the digestive tract has the same basic plan. From the **lumen** (inner space) outward four layers can be distinguished: the mucosa, submucosa, muscularis, and an outer connective covering, the adventitia.

- Solomon & Davis (1987)

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D.1.1 Outline the principal components of the digestive system

- Stomach:

  The mucosa (also called mucous membrane) is the lining of the digestive tract. It consists of epithelial tissue resting upon a layer of connective tissue. At the base of the mucosa lies a very thin layer of smooth muscle.

  The epithelial tissue provides a role in protection, secretion of mucous or digestive juices, or absorption of nutrients.

- Solomon & Davis (1987)

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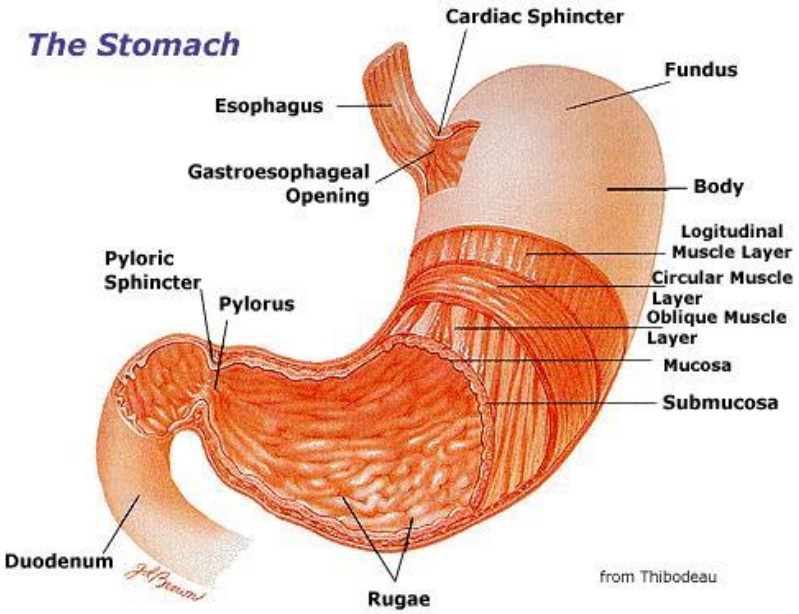
D.1.1 Outline the principal components of the digestive system

- Stomach:



http://www.acm.uiuc.edu/sigbio/project/digestive/middle/stomach2.jpg

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D.1.1 Outline the principal components of the digestive system

- Small Intestine:

  The velvety appearance of the intestinal lining is due to millions of tiny finger like projections of the mucous membrane known as the **villi**. These villi increase the surface area of the small intestine for digestion and absorption of nutrients. The intestinal surface is further expanded by thousands of **microvilli**.

Solomon & Davis (1987)

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D.1.1 Outline the principal components of the digestive system

- Large Intestine:

  The functions of the large intestine may be summarised as follows:

  1. Absorption of sodium and water. Sodium is absorbed by active transport and water follows by osmosis.

  2. Incubation of bacteria. Because the movements are slow, bacteria have time to grow and reproduce. Some types produce certain vitamins (vitamin K, thiamine, folic acid, riboflavin and vitamin B12)

Solomon & Davis (1987)

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D.1.1 Outline the principal components of the digestive system

- Pancreas: The pancreas secretes pancreatic juice, which is an alkaline fluid containing a number of digestive enzymes.

  These are produced in the pancreas and include specialised enzymes for the digestion and breakdown of proteins, fats and carbohydrates.

Solomon & Davis (1987)

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D.1.1 Outline the principal components of the digestive system

- Liver: One of the chief functions of the liver is the production and secretion of bile, which is important in the digestion of fats.

Solomon & Davis (1987)

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D.1.1 Outline the principal components of the digestive system

- Gallbladder: As bile is stored, it is concentrated by the gallbladder. Water and salts are reabsorbed into the blood, so that bile salts and other principal components are concentrated about fivefold.
- A hormone is secreted by the intestinal mucosa in the presence of fat causing the release of bile.

Solomon & Davis (1987)

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D.1.2 State the typical pH value found throughout the digestive system.

- Research Task:
  - Define pH.
  - Outline the role of pH in digestion.
  - Why is it necessary for values to be different in throughout the digestive system?

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D.1.2 State the typical pH value found throughout the digestive system.

- Web links:

http://www.le.ac.uk/pa/teach/va/anatomy/case6/frmst6.html

http://mcb.berkeley.edu/courses/mcb136/topic/Gastrointestinal/

http://en.wikipedia.org/wiki/Gastrointestinal_tracthttp://en.wikipedia.org/wiki/Gastrointestinal_tract

http://www.cybersurat.com/digestion/how_digestion_works_part2.php

http://www.womentowomen.com/digestionandgihealth/phbalance.aspx

http://www.ritecare.com/prodsheets/ETI-02769.html

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D.1.3 Describe the function of enzymes in the context of macronutrient digestion.

- As previously stated, the pancreas produces enzymes which are specific in the breakdown of the macronutrients (carbohydrates, lipids and proteins).
- Enzymes play a role as a catalyst.

  Catalysis is the process by which the rate of a chemical reaction (or biological process) is increased by means of the addition of a species known as a **catalyst** to the reaction.

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D.1.3 Describe the function of enzymes in the context of macronutrient digestion.

- A catalyst works by providing an alternative reaction pathway to the reaction product. The rate of the reaction is increased as this alternative route has a lower activation energy than the reaction route not mediated by the catalyst. The lower the activation energy, the faster the rate of the reaction.

http://en.wikipedia.org/wiki/Catalysis

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D.1.3 Describe the function of enzymes in the context of macronutrient digestion.

- Catalysts are proteins themselves and there activity is highest under optimum conditions of temperature and pH.
- This is environment is provided by the digestive tract.

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D.1.4 Explain the need for enzymes in digestion.

- **Digestive enzymes** are enzymes in the alimentary canal that break down food so that the organism can absorb it. The main sites of action are the oral cavity, the stomach, the duodenum and the jejunum. They are secreted by different glands: the salivary glands, the glands in the stomach, the pancreas, and the glands in the small intestines.
- They are able to increase the rate of digestion whilst maintaining a stable body temperature.

http://en.wikipedia.org/wiki/Digestive_enzyme

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D.1.5 List the enzymes that are responsible for the digestion of carbohydrates, fats and proteins from the mouth to the small intestine.

- Carbohydrates:
  - Salivary amylase (oral cavity)
  - Pancreatic amylase (small intestine)
- Fats:
  - Pancreatic amylase (small intestine)
  - Pancreatic lipase (small intestine)
  - Bile (small intestine)
- Protein
  - Pepsin (stomach)
  - Trypsin (small intestine)

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D.1.6 Describe the absorption of glucose, amino acids and fatty acids from the intestinal lumen to the capillary network.

- Absorption of nutrients across the intestinal walls occurs either by **active transport** or by simple **diffusion**.

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D.1.6 Describe the absorption of glucose, amino acids and fatty acids from the intestinal lumen to the capillary network.

- **Active transport** is an energy-requiring process that moves material across a cell membrane and up the concentration gradient. The cell uses active transport in three situations: when a particle is going from low to high concentration, when particles need help entering the membrane because they are selectively impermeable, and when very large particles enter and exit the cell.

http://en.wikipedia.org/wiki/Active_transport

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D.1.6 Describe the absorption of glucose, amino acids and fatty acids from the intestinal lumen to the capillary network.

- **Diffusion** is the movement of substances across a membrane along, rather than against, an electrochemical gradient.
- Simple diffusion does not require does not require transport proteins or energy in the form of ATP.

Jeukendrup (2004)

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D.1.6 Describe the absorption of glucose, amino acids and fatty acids from the intestinal lumen to the capillary network.

- Glucose, fatty acids and amino acids cross the brush-border membrane. This is a highly specialized mucosa of the small intestine that is responsible for the absorption of many nutrients.

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D.1.6 Describe the absorption of glucose, amino acids and fatty acids from the intestinal lumen to the capillary network.

- During this process nutrients pass through the cytosol (internal fluid of the cell) of the absorptive cell then cross the basolateral membrane (part of the plasma membrane) before entering the capillary network.
- Note: the plasma membrane is a selectively permeable lipid bilayer found in all cells.

http://en.wikipedia.org/wiki/Basolateral_membrane

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D.1.6 Describe the absorption of glucose, amino acids and fatty acids from the intestinal lumen to the capillary network.

- Absorption of Carbohydrates
  - Glucose is absorbed by carrier-mediated transport process (Active Transport i.e. requires energy).
  - Each day a large amount of sodium is secreted into the intestine. If it were not continually reabsorbed we would be depleted of sodium in a few hours.
  - With the help of enzymes and energy, sodium is transported through the epithelial cells and into the blood. It is believed that glucose absorption follows this same transport system.
  - Glucose then enters the capillary system, eventually circulating into the hepatic portal vein which will transport them to the liver.

Jeukendrup (2004)/Solomon & Davis (1987)

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D.1.6 Describe the absorption of glucose, amino acids and fatty acids from the intestinal lumen to the capillary network.

- Absorption of Amino Acids
  - Are absorbed by active transport in the small intestine, in much the same way as glucose molecules except that there are four different transport systems, one for each chemical class of amino acids.
  - Amino acid transport in all four systems requires energy and is coupled to the transport of sodium.
  - They cross into the capillary system and like glucose are delivered to the liver via the hepatic portal vein.

Jeukendrup (2004)/Solomon & Davis (1987)

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D.1.6 Describe the absorption of glucose, amino acids and fatty acids from the intestinal lumen to the capillary network.

- Absorption of Fatty Acids
  - The absorption of fatty acids through the epithelial membranes is by diffusion. This is a far more efficient process than that of active transport.
  - The diffusion, following re-esterification, then takes place into the aqueous environment of the lymph and blood plasma.
  - In the presence of bile salts fat absorption is almost complete at 97%.

Jeukendrup (2004)/Solomon & Davis (1987)

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D.2.1 State the reasons why humans can not live without water for a prolonged period of time.

- Water:
  - Is the basic substance for all metabolic processes in the body.
  - Regulates body temperature.
  - Enables transport of substances essential for growth.
  - Allows for the exchange of nutrients and metabolic end products.

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D.2.2 State where extracellular fluid can be located throughout the body.

- Extracellular fluid includes:
  - Blood plasma and lymph
  - Saliva
  - Fluid in eyes
  - Fluid secreted by glands in digestive tract
  - Fluid surrounding nerves and spinal cord
  - Fluid secreted from skin and kidneys

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D.2.2 State where extracellular fluid can be located throughout the body.

- Volumes of Body Fluid Compartments

BODY FLUID	ADULT MEN	ADULT WOMEN
PLASMA	5	4
INTERSTITIAL FLUID	15	11
INTRCELLULAR FLUID	40	35
TOTAL	60	50

- Values expressed as a % of body mass.

- Jeukendrup (2004)

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D.2.3 Compare water distribution in trained and untrained individuals.

- Distribution of Body Water in a Young 70kg Man

	Volume (l)	Body mass (%)	Total Body water (%)
Intracellular fluid	28	40	62.5
Extracellular fluid	14	20	37.5
Interstitial fluid	10.5	15	30
Blood plasma	3.5	5	7.5

- Total body water volume = 42 litres or 60% of body mass.

Jeukendrup (2004)

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D.2.3 Compare water distribution in trained and untrained individuals.

- Research Task: Compare water distribution in trained and untrained individuals.

http://www.ingentaconnect.com/content/bsc/aps/1998/00000163/00000003/art00016

http://www.ncbi.nlm.nih.gov/pubmed/10483806?dopt=AbstractPlus

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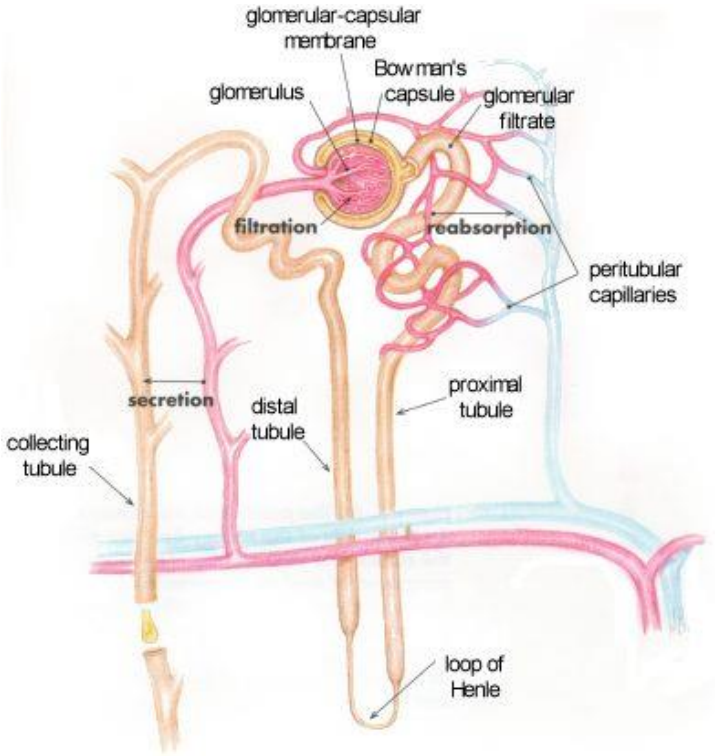
D.2.4 Annotate a diagram of a glomerulus and associated nephron.



http://www.nsbri.org/HumanPhysSpace/focus4/f4-148.jpg

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D.2.4 Annotate a diagram of a glomerulus and associated nephron.

A **nephron** is the basic structural and functional unit of the kidney. Its chief function is to regulate the concentration of water and soluble substances like sodium salts by filtering the blood, reabsorbing what is needed and excreting the rest as urine. A nephron eliminates wastes from the body, regulates blood volume and pressure, controls levels of electrolytes and metabolites, and regulates blood pH.

http://en.wikipedia.org/wiki/Renal_tubule#Renal_tubule

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D.2.4 Annotate a diagram of a glomerulus and associated nephron.

The glomerulus is a capillary tuft that receives its blood supply from an afferent arteriole of the renal circulation. The glomerular blood pressure provides the driving force for water and solutes to be filtered out of the blood and into the space made by Bowman's capsule.

http://en.wikipedia.org/wiki/Renal_tubule#Renal_tubule

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D.2.5 Explain that homeostasis involves monitoring levels of variables and correcting changes in levels by negative feedback mechanisms.

- Review the following website to address the above question.

http://www3.fhs.usyd.edu.au/bio/homeostasis/Introduction.htm

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D.2.6 Explain the roles of the loop of Henle, medulla, collecting duct and ADH in maintaining the water balance of the blood.

- The kidneys are the urinary organs – the rest of the urinary system is really the plumbing.
- It is the kidneys which produce urine, dispose of metabolic wastes and help regulate the internal environment of the body.

Solomon & Davis (1986)

Nutrition for sport, exercise & health

D.2.6 Explain the roles of the loop of Henle, medulla, collecting duct and ADH in maintaining the water balance of the blood.

- The medulla of the kidneys is the central portion which contains the nephron as its functional unit.

Solomon & Davis (1986)

Nutrition for sport, exercise & health

D.2.6 Explain the roles of the loop of Henle, medulla, collecting duct and ADH in maintaining the water balance of the blood.

- In the kidney, the **loop of Henle** is the portion of the nephron that leads from the proximal convoluted tubule to the distal convoluted tubule. The loop has a hairpin bend in the renal medulla. The main function of this structure is to reabsorb water and ions from the urine.

- http://en.wikipedia.org/wiki/Loop_of_Henle)

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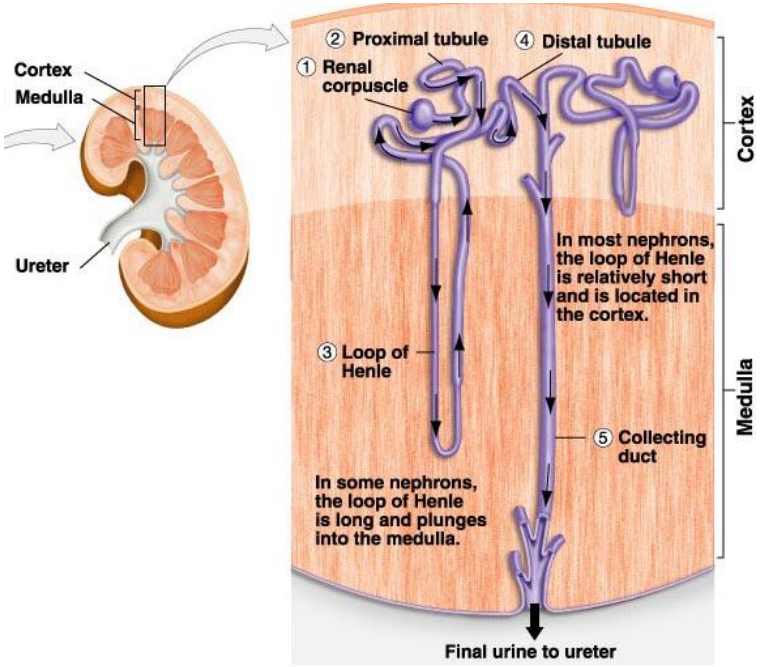
D.2.6 Explain the roles of the loop of Henle, medulla, collecting duct and ADH in maintaining the water balance of the blood.



http://www.uic.edu/classes/bios/bios100/lecturesf04am/kidney01a.jpg

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D.2.6 Explain the roles of the loop of Henle, medulla, collecting duct and ADH in maintaining the water balance of the blood.

- Using the diagram on the previous page to outline the role of the collecting duct.

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D.2.6 Explain the roles of the loop of Henle, medulla, collecting duct and ADH in maintaining the water balance of the blood.

- When water is ingested, it first absorbed by the intestinal tract; it then acts to dilute the blood. This dilution is sensed exactly but unconsciously by specialised brain receptors that then release a precisely adjusted amount of a pituitary hormone known as **ADH**.

Solomon & Davis (1987)

Nutrition for sport, exercise & health

D.2.6 Explain the roles of the loop of Henle, medulla, collecting duct and ADH in maintaining the water balance of the blood.

- If water is in short supply in the blood stream, much of it is reabsorbed; if water is present in excess, very little is reabsorbed. The extent of reabsorption is determined by **ADH**.

Solomon & Davis (1987)

Nutrition for sport, exercise & health

D.2.6 Explain the roles of the loop of Henle, medulla, collecting duct and ADH in maintaining the water balance of the blood.

- View the following web link to get a better understanding of the workings of the kidneys.

  The heading "How kidneys work" is particularly helpful.

http://www.kidney.org.au/KidneyDisease/HowourKidneyworks/tabid/590/Default.aspx

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D.2.7 Describe how the hydration status of athletes can be monitored.

- Monitoring of hydration can be based on:
  - Urine colour
  - Urine osmolarity: the amount of solute per unit volume.
  - Variation in body mass loss

Take additional notes based on the website below.

http://gamesdevelopment.gaa.ie/page/hydration_testing.html

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D.2.8 Explain why endurance athletes require a greater water intake.

Research the above topic area.

In your coverage of the topic consider the role played by sports drink manufacturers in current research.

http://www.gatorade.com/

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D.2.9 Discuss the regulation of electrolyte balance during acute and chronic exercise.

Research task: Discuss the regulation of electrolyte balance during acute and chronic exercise.

http://www.merck.com/pubs/mmanual_ha/sec3/ch18/ch18a.html

Nutrition for sport, exercise & health

D.3.1 Define the term basal metabolic rate (BMR)

Basal metabolic rate (**BMR**) is the amount of energy expended while at rest in a neutrally temperate environment, in the post-absorptive state (meaning that the digestive system is inactive, which requires about twelve hours of fasting in humans).

http://en.wikipedia.org/wiki/Basal_metabolic_rate

Nutrition for sport, exercise & health

D.3.1 Define the term basal metabolic rate (BMR)

The release of energy in this state is sufficient only for the functioning of the vital organs, such as the heart, lungs, brain and the rest of the nervous system, liver, kidneys, sex organs, muscles and skin.

http://en.wikipedia.org/wiki/Basal_metabolic_rate

Nutrition for sport, exercise & health

D.3.1 Define the term basal metabolic rate (BMR)

BMR decreases with age and with the loss of lean body mass. Increased muscle mass can increase BMR. Aerobic fitness level, a product of cardiovascular exercise, while previously thought to have effect on basal or resting metabolic rate (RMR), has been shown in the 1990s **not** to correlate with RMR.

http://en.wikipedia.org/wiki/Basal_metabolic_rate

Nutrition for sport, exercise & health

D.3.1 Define the term basal metabolic rate (BMR)

Illness, previously consumed food and beverages, environmental temperature, and stress levels can affect one's overall energy expenditure, and can affect one's BMR.

http://en.wikipedia.org/wiki/Basal_metabolic_rate

Nutrition for sport, exercise & health

D.3.1 Define the term basal metabolic rate (BMR)

BMR is measured under very restrictive circumstances when a person is awake, but at complete rest. An accurate BMR measurement requires that the person's sympathetic nervous system not be stimulated. A more common and closely related measurement, used under less strict conditions, is resting metabolic rate **(**RMR**).**

http://en.wikipedia.org/wiki/Basal_metabolic_rate

Nutrition for sport, exercise & health

D.3.1 Define the term basal metabolic rate (BMR)

BMR and RMR are measured by gas analysis through either direct or indirect calorimetry, though a rough estimation can be acquired through an equation using age, sex, height, and weight.

http://en.wikipedia.org/wiki/Basal_metabolic_rate

Nutrition for sport, exercise & health

D.3.1 Define the term basal metabolic rate (BMR)

Studies of energy metabolism using both methods provide convincing evidence for the validity of the respiratory quotient (R.Q.), which measures the inherent composition and utilization of carbohydrates, fats and proteins as they are converted to energy substrate units that can be used by the body as energy.

http://en.wikipedia.org/wiki/Basal_metabolic_rate

Nutrition for sport, exercise & health

D.3.2 State the components of daily energy expenditure

The components of daily expenditure are:

- Basal Metabolic Rate
- Thermic effect of physical activity: energy expenditure above the resting metabolic rate (RMR) to allow for physical activity.
- Thermic effect of feeding: the increment in energy expenditure above RMR due to the cost of processing food for storage and use.

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D.3.3 Explain the relationship between energy expenditure and intake.

Research Task: Explain the relationship between energy expenditure and intake.

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D.3.3 Explain the relationship between energy expenditure and intake.

Research Task: Explain the relationship between energy expenditure and intake.

Nutrition for sport, exercise & health

D.3.4 Discuss the association between body composition and athletic performance.

Research Task: Explain the relationship between energy expenditure and intake.

Consider body composition from two components, fat and fat free mass. A distinction between fat free mass and lean body mass should be made. The discussion should include reference to typical levels of fat and consider the accuracy of body fat measurements.