

Grade 11 Biology

Animals – Structure and Function
Class 10

Overall Expectations

- Analyse the relationships between changing societal needs, technological advances, and our understanding of internal systems of humans
- Investigate, through laboratory inquiry or computer simulation, the functional responses of the respiratory and circulatory systems of animals, and the relationships between their respiratory, circulatory, and digestive systems
- Demonstrate an understanding of animal anatomy and physiology, and describe disorders of the respiratory, circulatory, and digestive systems

Nutrition and the Digestive System

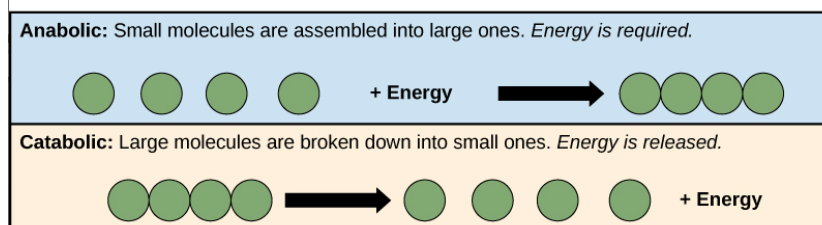
- Nutrients – chemicals obtained from the environment to survive, provide materials for growth, repair and energy
- Factors that affect energy requirements:
 - Endothermic (warm-blooded) vs. Ectothermic (cold-blooded) animals
 - Size



Metabolism

- Metabolism – the set of chemical reactions that occur in living organisms to maintain life
 - Catabolism – Breakdown of materials into smaller subunits
 - Anabolism – Building of large molecules from smaller subunits

Metabolic pathways



Metabolic Rate

- The rate at which the body converts stored energy into working energy
 - Depends on:
 - Body Size: Larger the body, more energy is needed
 - Physical Activity: muscles burn more energy than fat so physical activity requires more energy
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- Sex: Males are typically larger in females and have more muscle mass, therefore they need more energy
 - Age: Metabolic rate decreases with age (due to decreased physical activity and muscle loss)
 - Hereditary factors: some individuals have a higher metabolic rate than others

Energy

- Energy is measured in joules (J) or kilojoules (kJ)
- A calorie (small c) is the amount of energy required to raise the temperature of 1g of water by 1°C
- A Calorie (capital C) equals 1000 calories or 4180J
 - Energy of food is often described in Calories

Basal Metabolic Rate

- The minimum amount of energy required to keep you alive; the energy needed for breathing and heartbeat
- Factors:
 - Height
 - Weight
 - Age
 - Sex

Harris-Benedict Formula

female

$$\text{BMR} = [655 + (9.6 \times \text{mass in kilograms}) + (1.8 \times \text{height in centimetres}) - (4.7 \times \text{age in years})] \times 4.18$$

male

$$\text{BMR} = [66 + (13.7 \times \text{mass in kilograms}) + (5.0 \times \text{height in centimetres}) - (6.8 \times \text{age in years})] \times 4.18$$



Checkpoint



- a) Tom is a 16-year old student who is 175 cm tall with a mass of 75kg. Estimate his BMR.
- b) Tom is a fairly active student who plays sports on weekdays. Calculate his BMR.

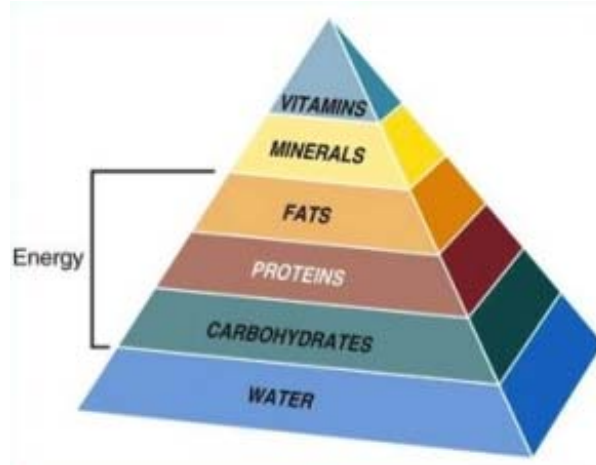
- little or no exercise $\text{BMR} \times 1.2$
- light exercise or sports 1–3 days/week $\text{BMR} \times 1.375$
- moderate exercise or sports 3–5 days/week $\text{BMR} \times 1.55$
- vigorous exercise or sports 6–7 days/week $\text{BMR} \times 1.725$
- very hard exercise daily or sports & physical job or $2 \times$ training daily $\text{BMR} \times 1.9$

Table 1 Average Energy Requirements for Various Activities

Type of activity	Energy required (kJ/kg/h)	Type of activity	Energy required (kJ/kg/h)
sleeping	4.1	walking (6.4 km/h)	20.6
sitting	5.2	badminton	21.5
writing	6.0	mowing lawn	23.0
standing	6.3	cycling (15.3 km/h)	25.8
singing	7.1	hiking, fast dancing	27.0
using a computer keyboard, playing cards	9.0	tennis, downhill skiing	36.2
washing the car, cooking	10.5	climbing stairs, running (8.8 km/h)	37.5
playing the piano	11.2	cycling (20.9 km/h)	40.5
walking (3.2 km/h)	11.6	cross-country skiing	42.0
cycling (13 km/h)	15.8	running (12.9 km/h)	62.0
walking (4.8 km/h)	16.2	competitive cross-country skiing	73.6

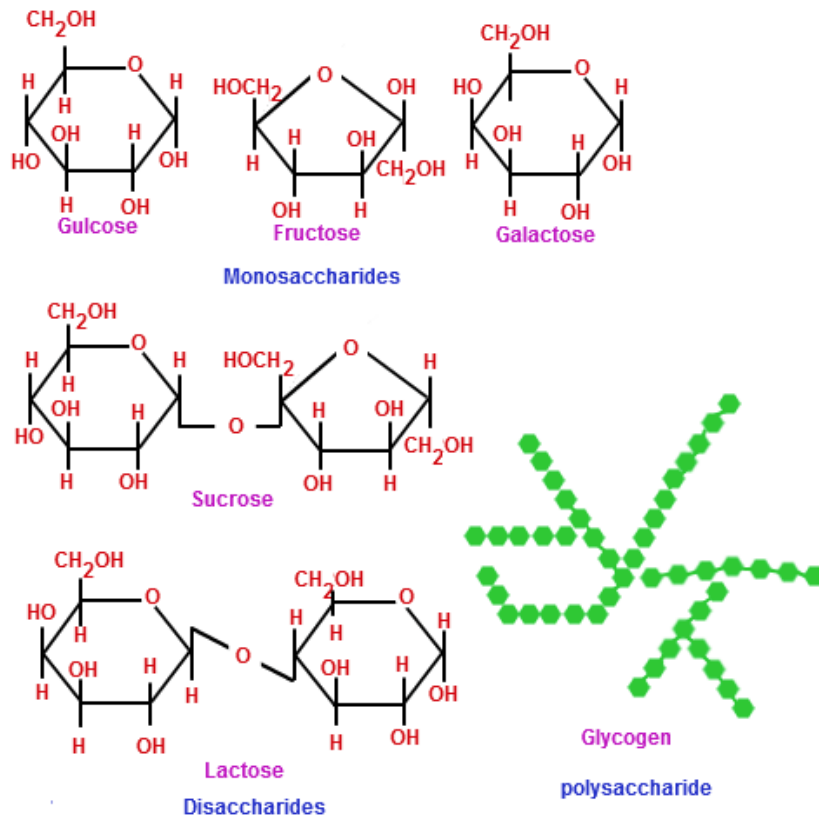
Essential Nutrients

- Body requires six essential nutrients to stay healthy:
 - Carbohydrates
 - Proteins
 - Lipids
 - Water
 - Vitamins
 - Minerals



Carbohydrates

- Made of carbon, hydrogen and oxygen
- Types:
 - Monosaccharides – one sugar; ex: glucose and fructose
 - Disaccharides – two sugars; ex: lactose and sucrose
 - Polysaccharides – more than two sugars linked together; ex: starch, cellulose, glycogen
- Monosaccharides are connected by glycosidic bond to form disaccharides/polysaccharides



- Plants use the carbohydrates they produce for energy and to create cellulose for plant structure
- Excess sugars produced are stored by plants as starch in their roots, stems, leaves and seeds



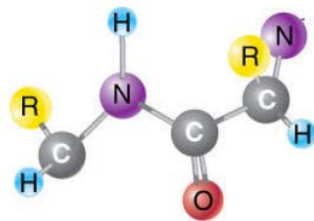
- Healthy diet requires at least 55% of carbohydrates of a person's energy needs
- Foods rich in carbohydrates include:
 - Vegetables
 - Potatoes
 - Grains
- Humans cannot digest cellulose but it provides fibre which is important for a healthy diet
- Carbohydrates are stored in the liver and muscle tissues in the form of glycogen

Proteins

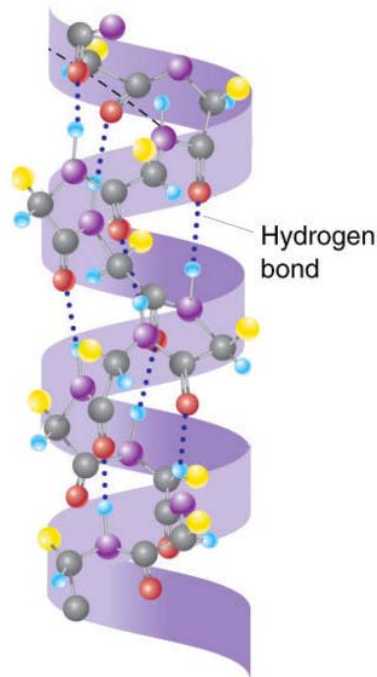
Table 1 Functions of Proteins

Function	Example
control of chemical reactions	digestive chemicals
movement	myosin in muscle cells
transporting oxygen	hemoglobin in red blood cells
structure	collagen in muscles and connective tissue; keratin in hair and nails
hormones (chemical messengers)	human growth hormone
defence	antibodies produced by the immune system
source of energy	excess proteins from diet

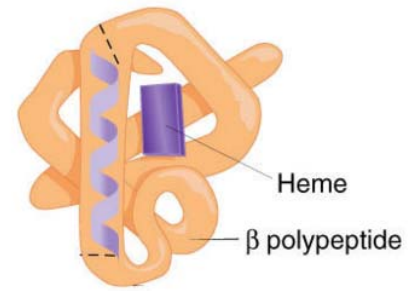
- Proteins perform a wide range of functions
- Composed of long chains of amino acids
 - 20 amino acids (12 are made by human body and 8 are obtained from diet)
 - Held together by peptide bonds



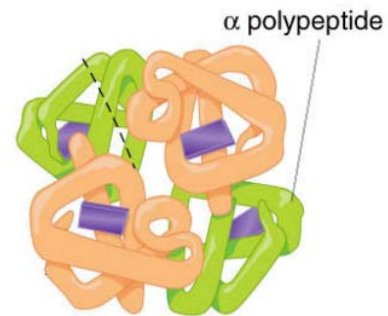
(a) Primary structure



(b) Secondary structure



(c) Tertiary structure



(d) Quaternary structure

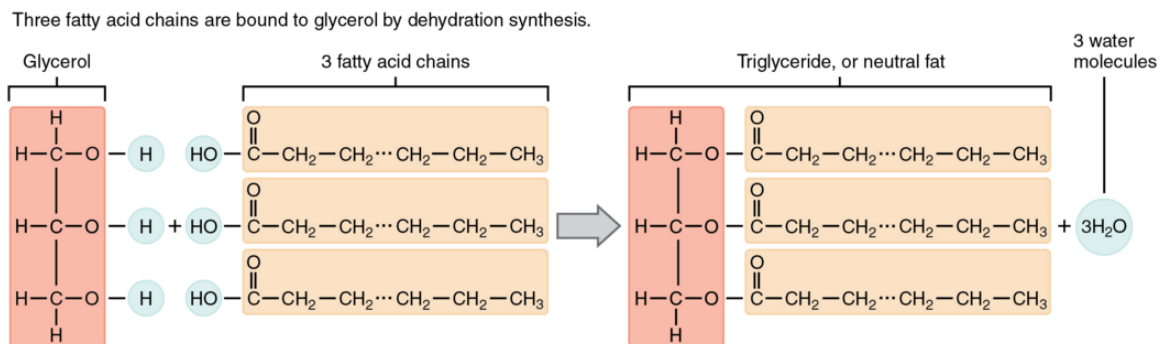
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- Sources of protein:
 - Animal – meat, eggs, fish and cheese
 - Plant – beans, lentils, seeds, nuts
- Recommended daily diet protein intake for youths is 0.86g of protein for every kg of body mass
- 10-30% of average energy requirements should come from protein

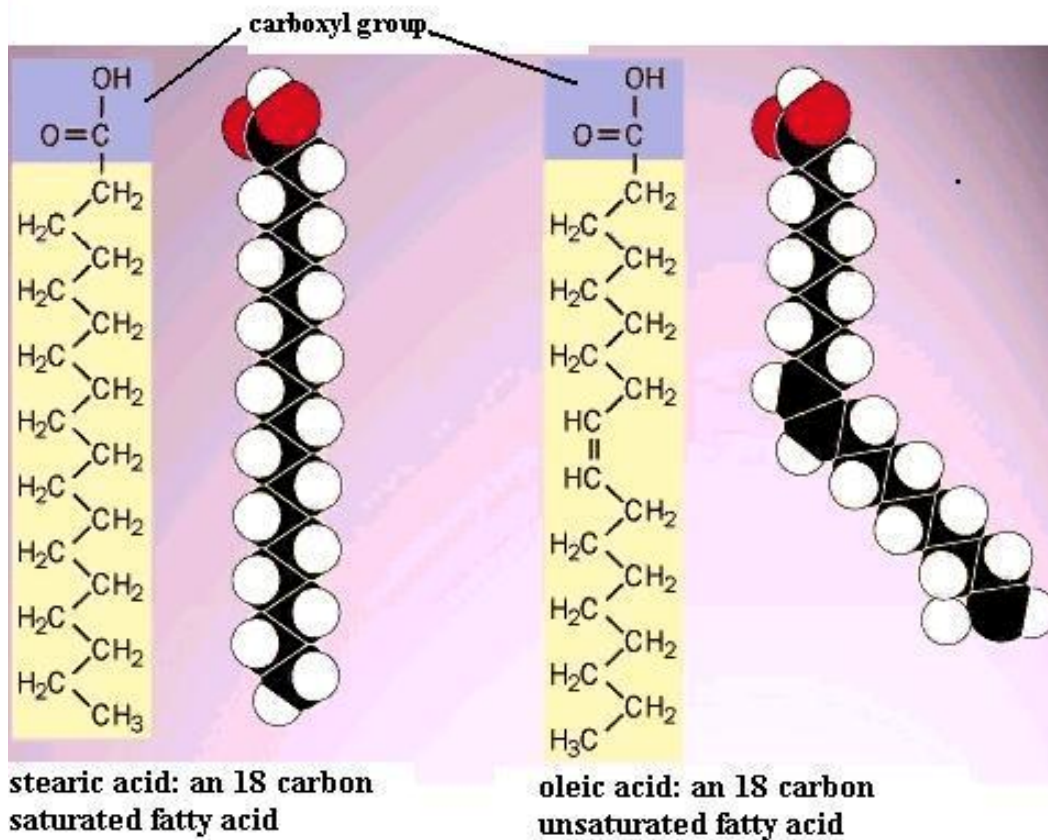


Lipids

- Lipids provide a concentrated source of chemical energy for the body
- Functions:
 - Chemical energy for the body
 - Absorb vitamins
 - Component of cell membranes
 - Insulation for the body
 - Hormones
- Ex: Fats and oils



- Triglyceride – made of a glycerol molecule bonded to three fatty acid chains
 - Saturated fats – meat fats, butter, lard
 - Unsaturated fats – fish oils, avocado
- Bonded by ester linkages



- Essential fatty acids – cannot be produced in the body and must be obtained from the diet
 - Omega-3 fatty acids are important in maintaining good health, preventing heart disease and arthritis
 - Found in oily fish (salmon, mackerel, herring and tuna), nuts, seeds and leafy green vegetables



OMEGA 3



OMEGA 6

- Steroids are lipid hormones
 - Testosterone – control development male sex characteristics
 - Estrogen – control development of female sex characteristics
 - Cholesterol – component of animal cell membranes
- Lipids should constitute no more than 30% of energy intake
- Excessive consumption of lipids can lead to heart disease and obesity

Summary

Macromolecule	Monomer	Bond/Linkage	Polymer
Carbohydrate	Monosaccharide	Glycosidic Bond	Polysaccharide
Lipid	Triglyceride	Ester Linkages	Fat
Protein	Amino Acid	Peptide Bond	Polypeptide

Water

- Body is made of 55%-60% water
- Body requires water for:
 - Chemical reactions
 - Digestion
 - Eliminate waste products
- Humans need to drink about 2L (8 cups) of water per day to replace water lost through urine, sweat and respiration

Vitamins

- Vitamin – an organic molecule that the body requires in small amounts as an essential nutrient
 - Regular cell functions, growth and development
- Classified as fat-soluble or water-soluble
 - Fat Soluble: Vitamins A, D, E, K
 - Water Soluble: Vitamins B and C

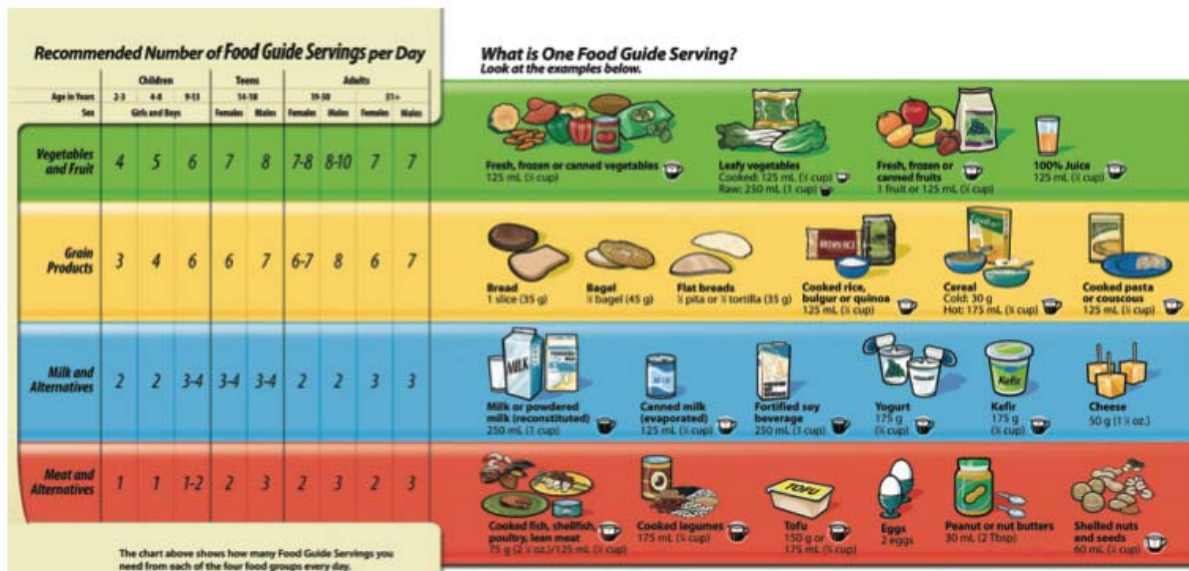
- Vitamins A, D, and K can be produced in the body

Vitamin A	Vitamin D	Vitamin K
<ul style="list-style-type: none"> • Body converts beta-carotene into Vitamin A • Beta-carotene is found in carrots, egg yolks and liver 	<ul style="list-style-type: none"> • Vitamin D is formed in the skin when the skin is exposed to sunlight • Bodies can produce vitamin D from 10-15min of sunshine three times a week 	<ul style="list-style-type: none"> • Synthesized by special bacteria found in the large intestine

Minerals

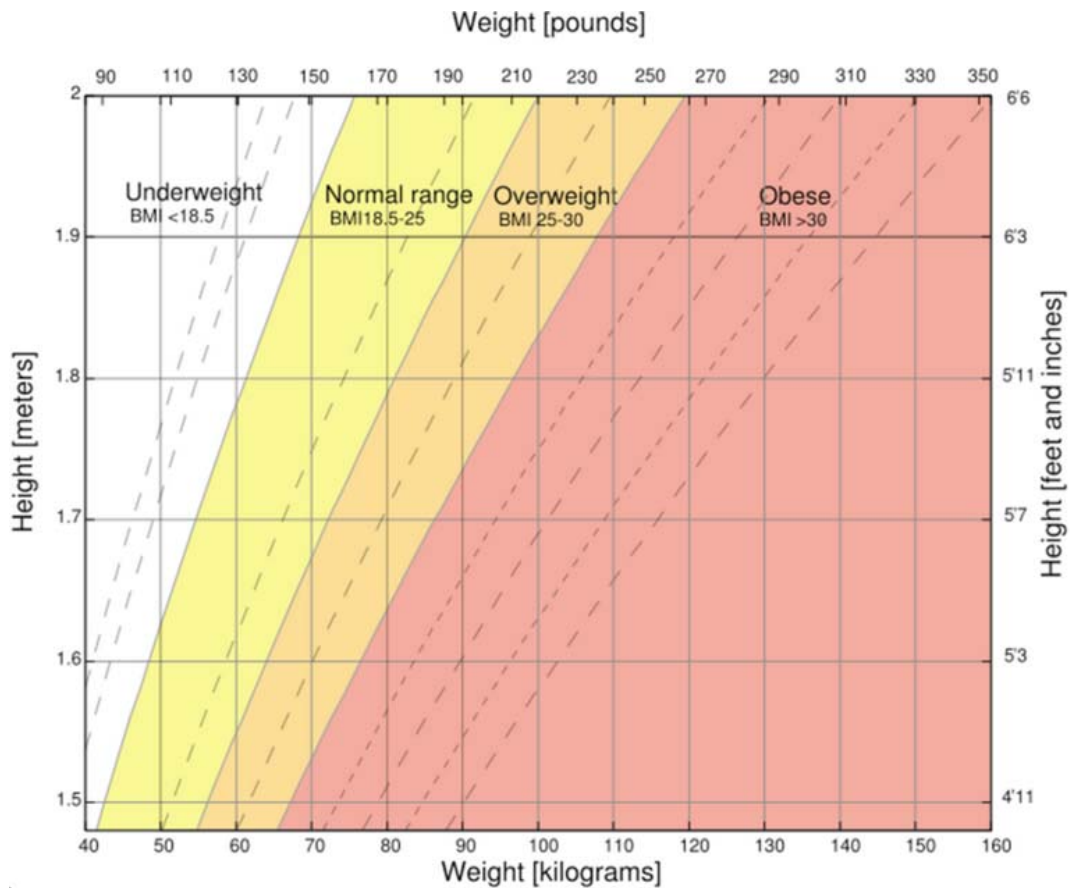
- Minerals – naturally occurring elements that the body uses to carry out metabolic processes
 - Calcium and phosphorus are important for bone formation
 - Sodium and potassium are important for nerve impulse transmission and muscle contraction
 - Iron is a key component of hemoglobin which is found in red blood cells

Healthy Eating



Overeating

- Obesity is when an excessive amount of body fat poses potential health risks
 - Genetics, inappropriate diet and inactivity can cause obesity
- Being overweight or obese can increase risk of heart disease, respiratory problems, diabetes, cancer, high blood pressure and joint problems



Anorexia Nervosa

- Psychological disorder that progresses to extreme dieting, excessive exercising, use of laxatives, diet pills and enemas to lose weight
- Laxatives – medications to cause food to pass through the intestines quickly
- Enema – flushing the bowels with liquids
- 10% of anorexia cases can lead to death; affects both men and women

Bulimia

- Psychological eating disorder which involves excessive eating followed by self-induced vomiting or laxative use to prevent weight gain
- Unlike people with anorexia, a person with bulimia recognizes their behavior is abnormal and may feel guilty
- Treatment involves behavioral and nutritional therapy