MINERAL ELEMENTS - 1.1.6

- Minerals may be classified according to :
  - o A : Macrominerals
  - o B : Microminerals.

A : MACROMINERALS

- Seven minerals that are present in the body in amounts greater than 0.01% of body weight are the macrominerals, or major minerals.
  - o Sodium (Na)
  - o Potassium (K)
  - o Chlorine (Cl)
  - o Calcium (Ca)
  - o Phosphorous (P)
  - o Magnesium (Mg)
  - o Sulphur (S) needed in organic form.

B : MICROMINERALS / TRACE ELEMENTS

- Minerals that are present in the body in extremely small amounts and are required in amounts less than 100mg per day are trace elements.
  - o Iron.
  - o Iodine.
  - o Manganese.
  - o Zinc.
  - o Fluorine

ELECTROLYTES

- Electrolytes are minerals in blood and other body fluids that carry an electric charge.
- For example, Calcium, Phosphorous, Potassium, Sodium.
- They affect the amount of water in your body, pH of blood, muscle function.

CALCIUM (Ca)

- Almost all the Calcium in the body ks found in the bones and teeth as calcium phosphate (calcium hydroxyapatite)
- A small amount is found in blood and body fluids.
- Macromineral

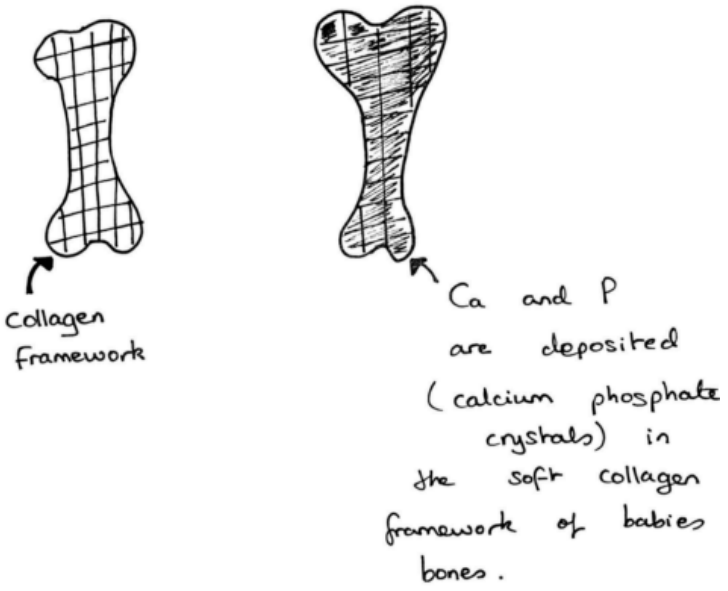
A : CALCIFICATION

- Calcification is defined as the laying down of calcium and phosphorous in the bones and teeth.
- It begins around week 13-14 of pregnancy and continues until peak bone mass is achieved around the age of 20-30 years old.
- During early childhood, calcification takes place more than any other time

Result: Hard Bone

Absorption of Calcium

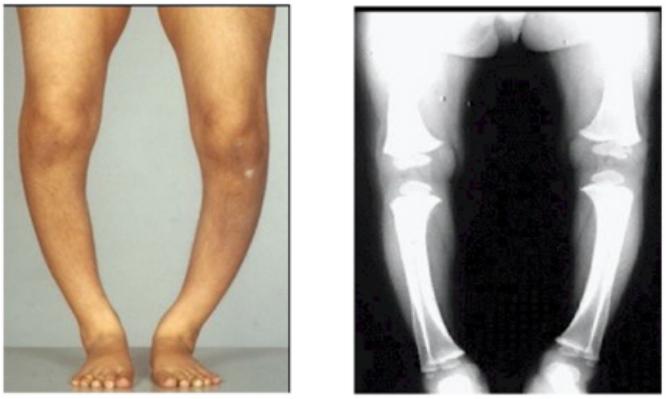
+	-
Vitamin D	Excess Fatty Acids
Phosphorous	Excess Protein
Parathormone	Phytic Acid
Protein	Oxalic Acid
Vitamin C	



B : RICKETS

- When something goes wrong with the calcification process during early childhood (ie) : inhibiting factors exist, the bones are soft and weak.
- When toddlers start to walk, the weight of their upper body puts pressure on the legs and they become curved (bow legs)

Figure 2. Photograph of a patient with rickets showing bowing of the legs (A) with classical radiological findings (B). of rickets.



(A) (B)

C : OSTEOMALACIA

- The condition may develop in women particularly (middle aged women)
- It is **a loss of bone density** (eg) : after a number of pregnancies, the foetuses may drain calcium from the mother's bones and this calcium may not be replaced in the diet.
- Also, during the menopause, the drop in the level of the female hormone oestrogen can accentuate the onset of osteomalacia.

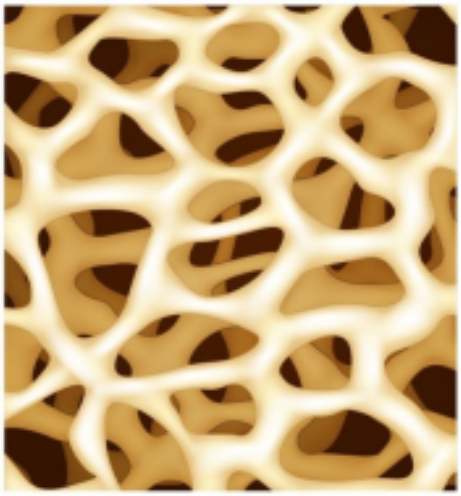
D : OSTEOPOROSIS

- This is a bone disease common in the elderly.
- It is caused by an excessive decrease in bone density.
- Particularly common in women (8 times more likely to occur in women then men) :

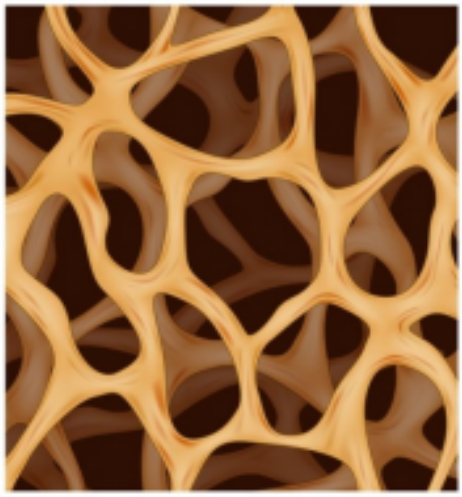
  1 : Women have a lower bone density.

  2 : Pregnancy can drain calcium supplies.

  3 : Low levels of oestrogen.
- Sometimes called brittle bone disease (Menopause)
- 75% of all cracks and fractures in old people's bones is due to osteoporosis.
  - More detail on osteoporosis in 'Diets'.



Normal Bone



Bone with Osteoporosis

CALCIUM (Ca)

Sources	Functions	Effects of Deficiency	RDA's
○ Dairy foods **(milk, yoghurt, cheese)** ○ Leafy Green veg **(Broccoli, kale, spinach)** ○ Fruits **(oranges)** ○ Beans/peas **(tofu, peanuts, baked beans)** ○ Fish **(salmon, sardines)** ○ Others **(fortified white flour)** NOTE: **only give** 2 **dairy sources on exam.**	○ **Calcification:** Calcium is deposited in bones and teeth from early pregnancy along with phosphorus in the form of calcium phosphate. This process begins during week 13-14 of pregnancy and continues until mid 20s – 30 years old. ○ Assists in normal **blood clotting along** with Vitamin K. ○ Helps maintain **proper nerve and muscle function/muscle tone.** ○ Regulates **heart rhythm** and helps lower blood pressure. ○ Reduces blood cholesterol levels.	○ Arm and leg muscle spasms/ joint pains. ○ Softening of bones due to (eg) osteomalacia (middle aged women), osteoporosis (elderly). It is also the cause of Rickets (bow legs) in children. ○ Because of Calcium's role in the movement of blood, deficiency can elevate blood pressure and cholesterol. ○ Messages from the nervous system to the brain can be affected resulting in nervousness, insomnia, depression and confusion.	**Children/Adult/Teen** 800mg **Teen Male** 1000mg **Pregnant and Lactating Mothers** 1000-1200mg

FACTORS THAT AFFECT CALCIUM (Ca) ABSORPTION

Help Absorption (+)	Hinder Absorption (-)
○ **Vitamin D** – causes protein to be made in the first part of the small intestine which in turn stimulates the reabsorption of excreted calcium in the kidney (Loop of Henle) ○ **Phosphorous** – Ca:P, 1:1.5. Phosphorous combines with calcium to form calcium phosphate. ○ **Vitamin C** (Ascorbic Acid) provides an acidic environment which helps the absorption of calcium. ○ **Parathormone** – secreted from the parathyroids in the thyroid gland helps control the level of calcium in the blood.	○ **Excess Phytic Acid** can combine with soluble calcium and form phytates and insoluble calcium. Phytic acid is present in plant derived foods (Seeds, Grains, Legumes, Nuts) ○ **Excess Oxalic Acid** can combine with calcium and form calcium oxalate (insoluble calcium). Oxalic acid is present in Rhubarb, Spinach, Kale, Cocoa Powder. ○ **Excess Protein** (eg) : Dukan diet, Atkins diet etc. Can increase excretion of calcium from the body in urine. ○ **Too many fatty acids** in the diet can combine with calcium and inhibit it's absorption.

SODIUM (Na) - (This is the only micronutrient measured in grammes)

Sources	Functions	Effects of Deficiency	RDA's
○ **Sausages** ○ **Smoked fish** ○ **Salted butter** ○ **Canned vegetables (peas/beans)** ○ **Bread** ○ **Convenience foods (frozen pizzas/ Pot Noodles)**	○ Necessary for the **transmission of nerve impulses.** ○ **Muscle contraction** including the beating of the heart. ○ Essential for the correct water balance of the body (osmoregulation) ○ Keeps blood and body fluid alkaline.	○ Muscular cramps ○ Loss of appetite ○ Low blood pressure ○ Tiredness/ Apathy	**Children 1-3 years** 500mg **Children 7-10 years** 1.2g **Adults** 1.6g

IRON (Fe)

Functions	Deficiency
○ Iron is needed to make the conjugated protein haemoglobin. ○ Iron is important in the neurological development of the human embryo. ○ Iron is an important part of enzyme systems and is necessary for out immune function. ○ The 'Haem' part of the haemoglobin has a special property which is its ability to pick up oxygen and form oxyhaemoglobin. Oxyhaemoglobin carries oxygen to cells and tissues of the body.	○ **Iron Deficiency Anaemia**: Low levels of haemoglobin (ie): low levels of iron in the blood therefore not enough oxygen can be picked up in the blood. **Symptoms** – paleness of skin, shortness of breath, fatigue, inability to exercise normally. ○ **Dry and damaged Hair and Skin**: This is because when your body is iron deficient, it directs it's limited oxygen to more important functions (eg): organs. When hair is deprived of oxygen it becomes dry and weak. Severe iron deficiency could lead to hair loss. ○ **Restless leg syndrome**: A strong urge to move your legs at rest, also possible itchy sensations.

RDA's	Excess Iron Intake	
Teen Male **8mg** Men **9-10mg** Women (from Puberty) **14-15mg**	**Nutritional Iron Overload** ○ Condition called Siderosis ○ Usually over 40mg of iron in diet per day. ○ Iron also in cooking pans **Symptoms: Diabetes, Heart disease, joint pain, constipation.**	**Genetic Iron Overload** ○ Condition called haemochromatosis ○ Genetic disorder ○ Caused by failure of iron to be absorbed in the small intestine. **Symptoms: Enlarged liver, grey pallor/ skin, Diabetes – Maybe death!**

DIFFERENTIATE BETWEEN HAEM AND NON HAEM IRON

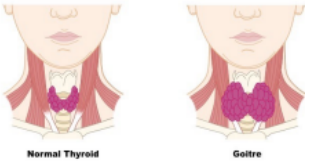
	Haem Iron	Non Haem Iron
State	Exists in the ferrous state	Exists in the ferric state
Absorption	Very easily absorbed by the body.	Vitamin C (reducing agent) is needed to remove a molecule of oxygen from ferric iron to reduce it to ferrous iron for absorption.
Food Sources	○ Red meat (Beef) ○ Offal ○ Black pudding ○ Fish (Mainly Animal Sources)	○ Eggs ○ Nuts ○ Dried fruits ○ Beans ○ Cereals ○ Green leafy vegetables (eg) : Cabbage. (Mainly Vegetable Sources

REVISE ! : **Pernicious Anaemia:** Lack of Vitamin B12, **Macrocytic Anaemia**: Lack of Vitamin B6, Lack of Folate/Folic Acid, **Iron Deficiency Anaemia:** Lack of iron.

FACTORS THAT AFFECT IRON (Fe) ABSORPTION

Help Absorption (+)	Hinder Absorption (-)
○ **Vitamin C** – helps absorption of iron. It acts as a reducing agent, capable of removing one molecule of oxygen from ferric iron to reduce it to ferrous iron. ○ **Combining Haem and Non Haem sources of iron together at the same meal**. Meat, Fish and Poultry, not only provide a good source of absorbable haem iron but can also stimulate the absorption of non-haem iron. Several studies have reported that the addition of Beef, Chicken or Fish to a cereal based meal (eg) : Brown Rice, can result in 2-3 times greater non haem absorption	○ **Excess Phytic Acid** (Phytic Acid can be found in large amounts in Peanuts, Kidney Beans, Oats, Bran). Phytates are formed when excess phytic acid combines with iron which can inhibit iron absorption. ○ **Excess Oxalic Acid** (Oxalic Acid can be found in large amounts in Kale, Spinach, Beetroot, Rhubarb). Oxalates form when combined with iron, this can inhibit iron absorption. ○ **Polyphenols** are major inhibitors of iron absorption (found in Cocoa, Coffee and some Herbs). **Tannins are water soluble polyphenols** found in Teas, Coffees, Cocoa, Walnuts, Apples, Raspberries, Blackberries and all have the ability to inhibit iron absorption by as much as 60%.

IODINE (I)

Sources	Functions	Effects of Deficiency	RDA's
○ Cod Liver Oil. ○ Seafood (eg) : Salmon, Herring, Cod. ○ Milk. ○ Milk Products. ○ Vegetables grown near the sea. ○ Seaweed	○ Iodine is needed to make the hormones thyroxine and tri-iodothyronine. ○ Helps to regulate metabolism. ○ Essential for brain development in the womb/early childhood	○ Goitre – enlargement of the thyroid gland. ○ Lack of energy. ○ Cretinism – mental backwardness. ○ Weight gain due to underactive thyroid gland.  Normal Thyroid Goitre	**Children** 100 µg **Teenagers** 130 µg **Adults** 140 µg **Pregnancy** 140 µg

ZINC (Zn)

Sources	Functions	Effects of Deficiency	RDA's
○ Oysters. ○ Meat. ○ Milk. ○ Bread. ○ Legumes. ○ Cereal Products	○ Zinc is a constituent of many enzymes, particularly an enzyme found in red blood cells. ○ Maintenance of health. ○ It is necessary for protein and carbohydrate metabolism. ○ Forms part of Gustin, the zinc protein found in saliva.	○ Not known in healthy people. ○ Those suffering from alcoholism, senile dementia, diabetes may lack zinc. - Poor digestion. - Delayed healing of wounds	**Children** 4 - 7 mg **Teenagers** 9 mg **Adults** 7 - 9 mg **Pregnancy** 13 - 15 mg

SAMPLE QUESTIONS

2006 B) HIGHER LEVEL (18 MARKS)

(a) State:
(i) **four** possible ill-effects of a diet deficient in calcium;
(ii) the recommended dietary allowance (RDA) of calcium for (a) adults and (b) pregnant women. **(18)**

(i) 4 Points @ 3M each = 12M

- Softening of bones due to decrease in bone density (eg) : Osteomalacia (middle aged women), Osteoporosis (elderly).
- Because of its role in the movement of blood, Calcium deficiency can elevate blood pressure and cholesterol levels in the blood.
- Arm and leg muscle spasms/joint pain.
- Messages from the brain can be affected resulting in nervousness, insomnia, depression and confusion.

(ii) 2 Points @ 3M each = 6M

- RDA Male Adult : 800mg.
- RDA Pregnant Women : 1200mg.

2010 Q1(B) HIGHER LEVEL (21 MARKS)

(b) Meat makes an important contribution to the intake of micronutrients such as iron. Give an account of iron and refer to:

- sources in the diet
- biological functions
- recommended daily allowance (RDA) for adults. **(21)**

(i) 3 Points @ 3M each = 9M

• Haem Iron Sources

o Offal (Liver)

o Red Meat.

• Non Haem Iron Sources

o Eggs.