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Role of Calcium in Blood Coagulation

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I. INTRODUCTION

During the last decade it became the subject of much attention by both scientists and the general public that in the biological system like many other inorganic elements calcium is the most important element. The central role of calcium is in mammalian bones and other mineralized tissues were recognised immediately after its discovery as an element by the scientist Davy in 1808. The insight arrived much later that calcium 2^+ ions could play a very important role in other tissues as well.

Nowadays, Ca^{2+} ions are widely recognised as central to a complex intracellular messenger system that is mediating a wide range of biological processes such as muscle contraction, secretion, glycolysis and glycogenesis, iron transport, cell division and growth [1–11].

In the case of mammals, the blood plasma in the Ca^{2+} Ion concentration exceeds the intracellular by factor of about 104 Ca^{2+} ions are instrumental in joining certain proteins in the blood clotting system with membrane surfaces of circulating cells.

The stable isotopes of calcium are 40 Ca, 44 Ca, 42 Ca, 43 Ca, amid all 40 Ca is most abundant [12]. There are two main groups of experimental techniques for the measurement ofCa^{2+}ion namely 1) Measurement of free calcium concentration. 2) Measurement of total calcium concentration.

Approximately 1 kilogram of calcium is present in the human body of which more than 99% deposit is in the bone in the form of calcium phosphate [1].

The distribution of calcium 2^+ Ion throughout the organism is demanded and should be made available where needed. In human beings, the blood plasma level of total calcium is kept constant (=2.45mM) within the narrow limits. On a cellular level the basal cytoplasmic calcium 2^+concentration, at least in eukaryotic cells, is very low that is on the order of 100 nM. Whereas, at the same time the concentration of Ca^{2+} in certain organelles such as endoplasmic reticulum or mitochondria may be considerably higher [2,13]. Ca^+ channels are regulated by chemical signalling, perhaps by hormones acting directly on the channel by small molecules released intracellularly when a hormone is attached to a membrane- bound receptor [lipard].

More than 99% of the calcium in the human body is in the bones and teeth. In bone, calcium provides the structural strength that allows the bone to support the body's weight and anchor the muscles. Bone calcium also serves as a reservoir that can be tapped to maintain extracellular calcium concentration regardless of intake. Calcium differs from most other nutrients in that the body contains a substantial store, far in excess of short-term needs, but at the same time that store serves a critical structural role. Thus, the effects of calcium deficiency may escape notice for a considerable time, until they manifest as skeletal weakness or fractures. Deficiency of calcium bones becomes interstitial or brittle and osteoporosis gradually develops.

II. DEFICIENCIES

In the growing child the deficiency of calcium causes rickets. Provides the structural strength to the bone, which supports the body's weight and anchors the muscles. The deficiency of calcium manifests as skeletal weakness for fracture.

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III. Dietary Intake Recommendation

The recommended Dietary Allowances (RDA) for children is 700 mg/d age between 1-3 yrs., for children is 1000 mg/d age between 4-8 yrs., for adolescents is 1300 mg/d age between 1-3 yrs., for younger adults is 1000 mg/d age between 1-3 yrs., for women is 1200 mg/d age over age 51 y, and for men and women is 1200 mg/d over the age 70y.

3.1 Sources of Food

Dairy Products-Milk, Buttermilk, cottage cheese, ice-cream or ice milk, sour cream cultured, soy milk, calcium fortified, yogurt. However, many non-dairy are also a source of calcium which includes seafood, leafy greens, legumes, dried fruits, tofu and various fortified foods.

IV. Discussion: Role of Calcium in blood Coagulation

Prevention of Blood coagulation outside the body: Although blood removed from the body and held in a glass test tube normally clots in 6 minutes, blood collected in *siliconised containers* often does not clot for 1 hour or more. The reason for this delay is that preparing the surfaces of the containers with silicone prevents contact activation of platelets and Factor XII, which are the two principal effects that initiate in-trinsic clotting mechanism. Conversely, untreated glass containers allow contact activation of platelets and Factor XII, with rapid development of clots.

Heparin can be used for preventing coagulation of blood outside the body as well as in the body. Heparin is especially used in surgical procedures in which the blood must be passed through a heart-lung machine or artificial kidney machine and then back into the person.

Various substances that decrease the concentration of calcium ions in the blood can also be used for preventing the blood coagulation outside the body. For instance, soluble oxalate compounds mixed in very small quantities with a sample of blood cause precipitation of calcium oxalate from the plasma and thereby decrease the ionic calcium levels so much that blood coagulation is blocked.

Other calcium- deionizing agents used for preventing coagulation are sodium, ammonium, and potassium citrate. The citrate ion combines with calcium in the blood to cause an un-ionised calcium compound, and the lack of ionic calcium prevents coagulation. Citrate anticoagulants have an important advantage over the oxalate anticoagulants because the oxalate is toxic to the body, whereas moderate quantities of citrate can be injected intravenously. After injection, the citrate ion is removed from the blood within a few minutes by the liver and is polymerized into glucose or metabolized directly for energy.

Consequently, 500milliliters of blood that has been rendered incoagulable by citrate can ordinarily be injected into a recipient within a few minutes without terrible consequences. But if the liver is damaged or if large quantities of citrated blood or plasma are given too rapidly (within fraction of a minute), and the citrate can, under these conditions, greatly depress the level of calcium ion in the blood, which can result in tetany and convulsive death.

General Mechanism: All research workers in the field of blood coagulation agree that clotting takes place in three essential steps

1. In response to rupture of the vessel or damage to the blood itself, a complex cascade of chemical reactions occurs in the blood involving more than a dozen blood coagulation factors. The net result is formation of a complex of activated substances collectively called *prothrombin activator.*
2. The *prothrombin activator* catalyses the conversion of *prothrombin into thrombin.*
3. The thrombin acts as an enzyme to convert fibrinogen into fibrin fibres that enmesh (catch) platelets, blood cells, and plasma to form clot.

Mechanism by which the blood clot itself is formed, beginning with conversion of prothrombin to thrombin.

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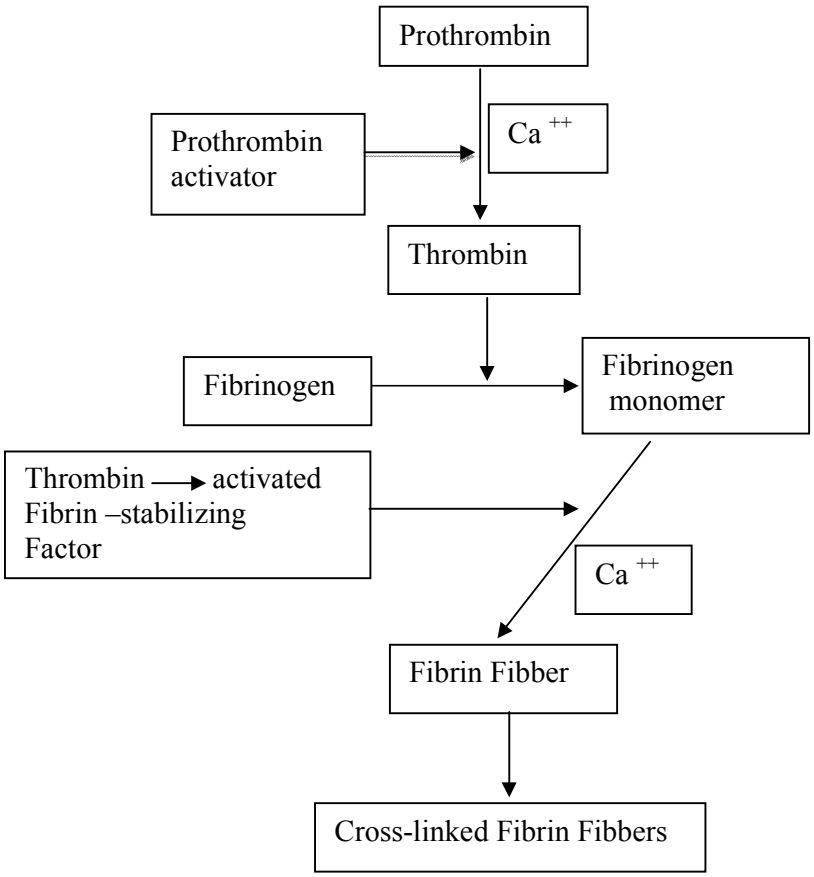

Note -1

1. When blood vessels are cut or damaged, the loss of blood from the system must be stopped before shock and possible death occur. This is accomplished by solidification of the blood; a process is called coagulation or clotting.
2. The coagulation initiated by the platelets.
3. It consists of a network of insoluble fibrin molecules.
4. Calcium ions required for the promotion or acceleration of blood clotting pathways.
5. Clotting cascade occurs through two separate pathways.
   a. Intrinsic pathway
   b. Extrinsic pathway
6. The platelets produce substances that combine with calcium ions in blood to form thromboplastin, which in turn converts protein prothrombin into thrombin in a complex series of reactions.
7. Thrombin, a proteolytic enzyme, converts fibrinogen, a protein substance, through a series of reactions into cross linked fibrin.
8. An insoluble protein that forms an intricate network of minute threadlike structure called fibrils and causes blood plasma to gel.
9. The blood cells and plasma are enmeshed in the network of fibrils to form clot.

Note -2

1. Calcium 4 is clotting factor.
2. It helps in activating many other clotting factors.

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V. CONCLUSION

From the above chemistry, it can be concluded that blood collected in *siliconised containers* often does not clot for 1 hour or more. Heparin can be used for preventing coagulation of blood outside the body as well as in the body. Soluble oxalate decreases the concentration of calcium ions in the blood can also be used for preventing the blood coagulation outside the body. Other calcium- deionizing agents' sodium, ammonium, and potassium citrate is used for preventing coagulation. In all these processes the role of calcium is very crucial.

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