B.Sc First year Zoology (Honours)

Paper-1

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Pearl formation

Meaning of Pearl:

The word 'pearl' is derived from the Latin word pirula which means pear, that is in accordance to the pear shape of the pearls. The beauty of pearl is an object of adoration and a barometer of wealth. Pearl is counted among the nine gems and needs no cutting or polishing to bring out its lustre. All over the world, pearl has been a subject of folklore and is also a subject of one of the most modern sciences — genetic engineering.

The credit for the production and development of modern pearl culture goes to Japan. The initial success was achieved in 1893 by Kokichi Mikimoto, who is considered as the 'Pearl King' and the Father of Pearl Culture industry. From the initial success the technique of pearl culture was developed and perfected.

Types of Pearls:

(a) Natural pearls:

Natural pearls may be formed within the oyster or mussels by either accidental entrance of a solid or accidental wound within the shell muscles or tissues. Pearls so produced are called natural pearls and are very rare because of their accidental origin.

(b) Cultured pearls:

Cultured pearls are produced by human interference, when the pearls are produced through the process of culture of pearl producing oysters or mussels.

(c) Artificial pearls:
Such pearls are cheap imitations made of plastics, glass, fish scales, etc. with an artificial luster.

Pearl Producing Molluscs:

Any mollusc, which has the mother-of-pearl layer on the inner surface of its shell, is generally capable of producing a pearl. However, pearl as a jewel is only produced by a few species, which are listed below.

Pearl oysters:
Pinctada fucta, Pinctada margaritifera and Pinctada maxima are the three prime species of pearl oysters and produce superior quality pearls.

Formation of Pearl:
(a) Natural pearl:
Pearl is formed due to secretion of the mantle tissue. The nacreous layer of the pearl is secreted by the outer epithelial layer of the mantle. This layer has the capability to rearrange and regenerate itself and remain viable when disturbed and also when transplanted in other tissues of the animal. The inner epithelium and the connective tissue, on the other hand, would disintegrate when transplanted.

A natural pearl is formed by the following way:
(1) The outer epithelial layer of the mantle accidentally falls into the body of the pearl oyster.

(2) It regenerates a sac consisting of a single layer of cells, thus forming the pearl sac.

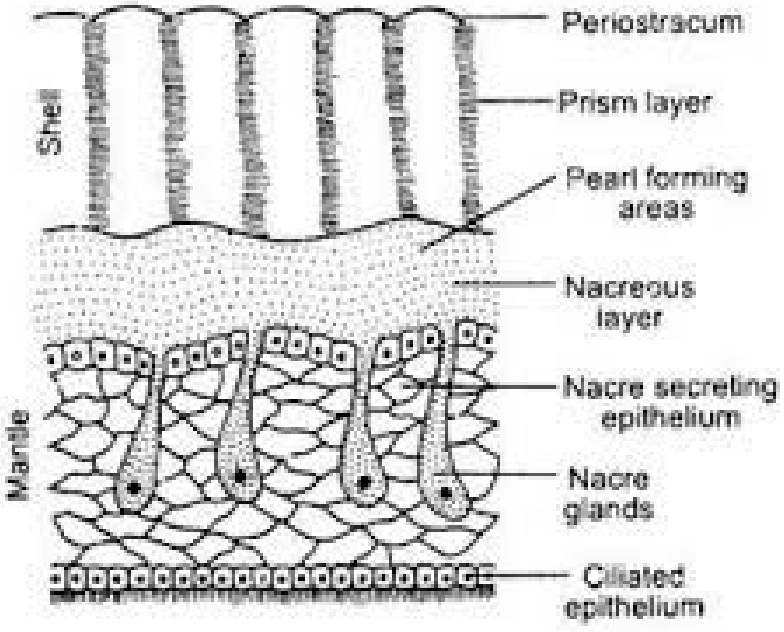
(3) Sometimes a foreign body accidently enters into the body of the oyster, when the shells remain open, and gets trapped between the shell and the mantle. The outer epithelium of the mantle invaginates and form the pearl sac.

(4) Inside the pearl sac, as a result of secretion of nacre, a natural pearl grows.

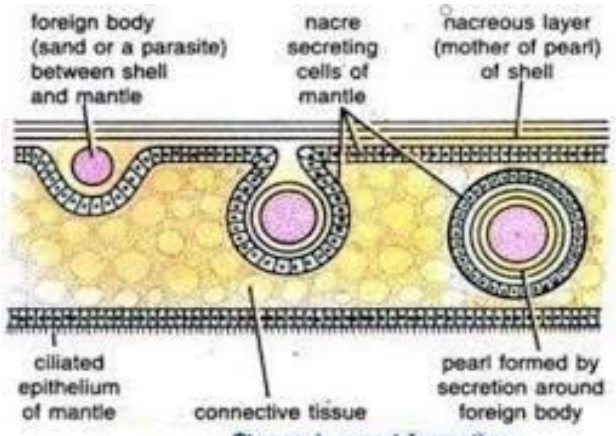
(5) The secretion of nacre continues till the end of life of the pearl oyster, thereby forming/producing a beautiful, natural pearl.

From the figure it is to be noted that every pearl has a nucleus (however tiny it may be) at its core. However, 'pearl without nucleus' may rarely be formed and would obviously be a contradiction.

Such possibility occurs when a few decayed blood cells or epithelial cells might provide the basis for pearl formation, which subsequently disintegrates totally. When such a pearl is cut, it reveals no nucleus and appears to be formed entirely of mother-of-pearl layers.



Nacreous layer and nacre glands of pearl oyster.



Stages in pearl formation.

(b) Cultured pearl:
The technique of the formation of natural pearl is manipulated in the cultured pearl formation process.

Here for the formation of pearl, the two pre-requisites are:
(1) The outer epithelium of the mantle lobe and

(2) A core substance or nucleus.

(i) Formation of pearl sac:
Here, a small piece of mantle from a donor oyster is grafted skillfully into the gonad of the recipient oyster along with a nucleus. The outer epithelium of the grafted mantle piece regenerates itself around the implanted nucleus and forms a pearl sac.

This pearl sac secretes and deposits nacre or mother-of-pearl around the nucleus, thus resulting into a pearl. As this pearl is

produced through manipulation (surgery) in the oyster and by further cultivation of the seeded oyster, it is thus called the cultured pearl. The half- pearl is produced by inserting the nuclei on the nacreous face of the shell at appropriate sites.

(ii) Secretion of pearl forming matters:

Initially, after the formation of pearl sac, its internal part is alkaline and the secretion contains organic substances such as Keratin. The secretion is due to the prismatic layer containing calcites. The internal part of pearl sac later becomes acidic and subsequently neutral. The secretive matter ultimately becomes pearl forming material.

(iii) Calcium absorption and formation of calcium carbonate:

The main ingredient of pearl is calcium carbonate (calcite and aragonite). In pearl oysters the main source of calcium is food. However, the gill, mantle and fool can directly absorb calcium from water.

In case of the gills, the calcium absorption power is strong and its rejection capacity is meagre, while, in the mantle both absorption and rejection of calcium are very strong. Thus, the gills are considered to be the most ideal organ for absorption and storing of calcium in pearl oysters.

Calcium absorbed through food and from water slowly moves into the pallium through blood. The carrying of calcium in the body depends mainly upon the role played by alkaline phosphatase present in the epithelial cells of the connective tissue and mantle of the pearl sac. Alkaline phosphatase combines with the calcium ion (Ca^{+2}) to form phosphate and other salts.
The calcium ion in the presence of phosphatase gains energy and passes through the mantle to be absorbed by its epidermal cells. This is then carried to the connective tissue of the pearl sac.

In the course of its passage the Ca^{+2} also unites with the cartilaginous sulphate (a compound protein of acidic nature). It further induces the calcium ion to become active and is transported to the cytoplasm of nacreous layer and ultimately excreted by the epidermal cells.
The excreted calcium then under the activity of carbonic acid releasing hydrase combines with the carbon dioxide (released by the body of the mussel due to metabolic activity) and ultimately forms calcium carbonate.

It has been reported that the concentration of carbon dioxide determines the nature of crystal formation. In the presence of increased CO_2 in the aquatic environment calcium carbonate forms sleek-like crystals, while it takes the shape of calcite when CO_2 decreases in the environment.