Metamarism

Meaning of Metamerism:

Metameric segmentation or metamerism is an architectural body plan in some animals in which the similar body segments and organ systems are serially repeated one after another. The similar body segments are called metameres or somites.

The animals which exhibit such features called metamerically segmented. Structurally each meta-mere or somite is constructed on the basis of some fundamental plan and usually possesses a part of almost all the body systems.

In all respects the segments forming an individual are identical in structure and the organs they contain or in other words, the individual is formed by rhythmic repetition of segments which are similar both exter-nally and internally. This repetition is often disturbed by simplification, by coalescence of segments or by .differentiation between the segments.

Occurrence of Metamerism:

Metamerism is first seen in annelids in animal kingdom. Each segment usually con-tains appendages, muscles, nerves, blood vessels, excretory organs and a pair of coelomic sacs which are repeated in almost all segments. It is also seen in kinorhynchs, arthropods and most chordates.

A recent view is that the cestodes are metamerically segmented but the metamerism of these animals is of different type. Most of the scientists believe that metameric segmenta-tion appears independently at least three times.

These are:

(i) Annelid and arthropod line,

(ii) Chordate line and

(iii) Cestode line.

Characteristic Features of Metamerism:

1. Metamerism is always confined to the intermediate (trunk) segments except the anterior acron (head) and a poste-rior pygidium or telson.

2. Each metamere represents a mirror image of the other.

3. Segmental structures are interdepend-ent on each other.

4. They are integrated into a single func-tional unit.

5. All the segments of body work in co-ordination.

Types of Metamerism:

The metamerism in different groups is divided into the following types:

1. True Metamerism:

The true metamerism is one in which the segmentation of the body develops by the segmentation of the mesoderm. It occurs in annelids (Fig. 17.14), arthropods and in most chordates. The body of annelids consists of a number of segments and the number re-mains constant in a particular species except in certain cases of asexual reproduction. New segments are not added to the body after maturation.

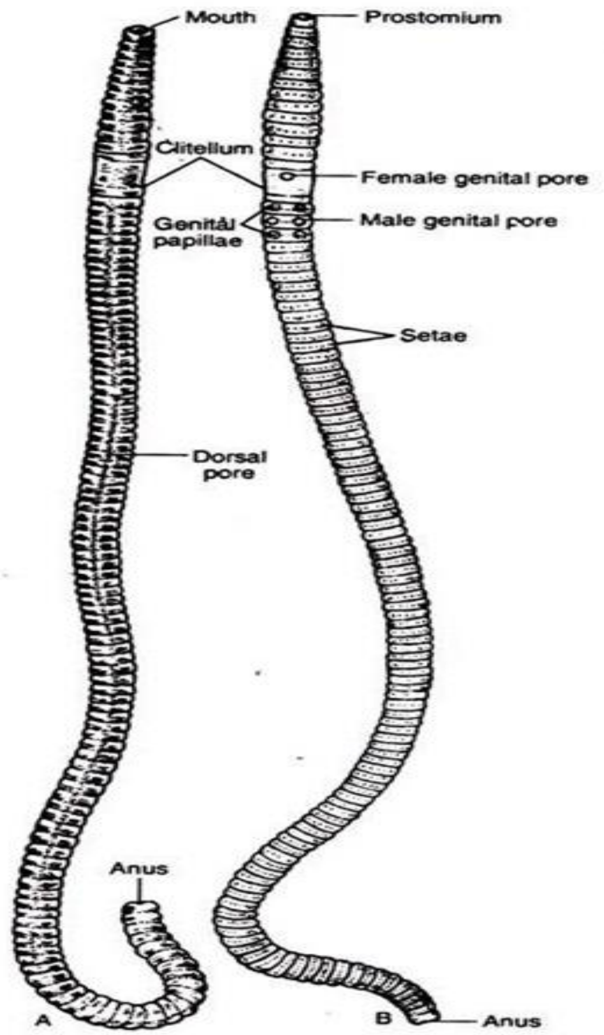

Fig. 17.14: Dorsal (A) and Ventral (B) views of earthworm *(Pheretima)*.

That means after the embryonic stage all the segments become the same age. Moreover, the segmental structures are inter-dependent and integrated so that the indi-viduality of the body is preserved. New segments arise at the posterior end in front of the pygidium. Hence, newer segments occur at the posterior end and older seg-ments remain just behind the head.

2. Homonomous Metamerism:

If the segments or somites of the animal are all alike, the' segmentation is called homonomous metamerism. It is seen in annelids (Fig. 17.2). Each metamere contains segmental blood -vessels, nerves, nephridia and coelomoducts. This is a primitive type of segmentation and is not found in any exist-ing animal because a few anterior segments are specialised to form the head which is called cephalization.

A well-defined and well-organised head is lacking in annelids. However, formation of a ‘head’ is suggested in polychaetes by anteriorly placed struc-tures and their association with parapodial cirri.

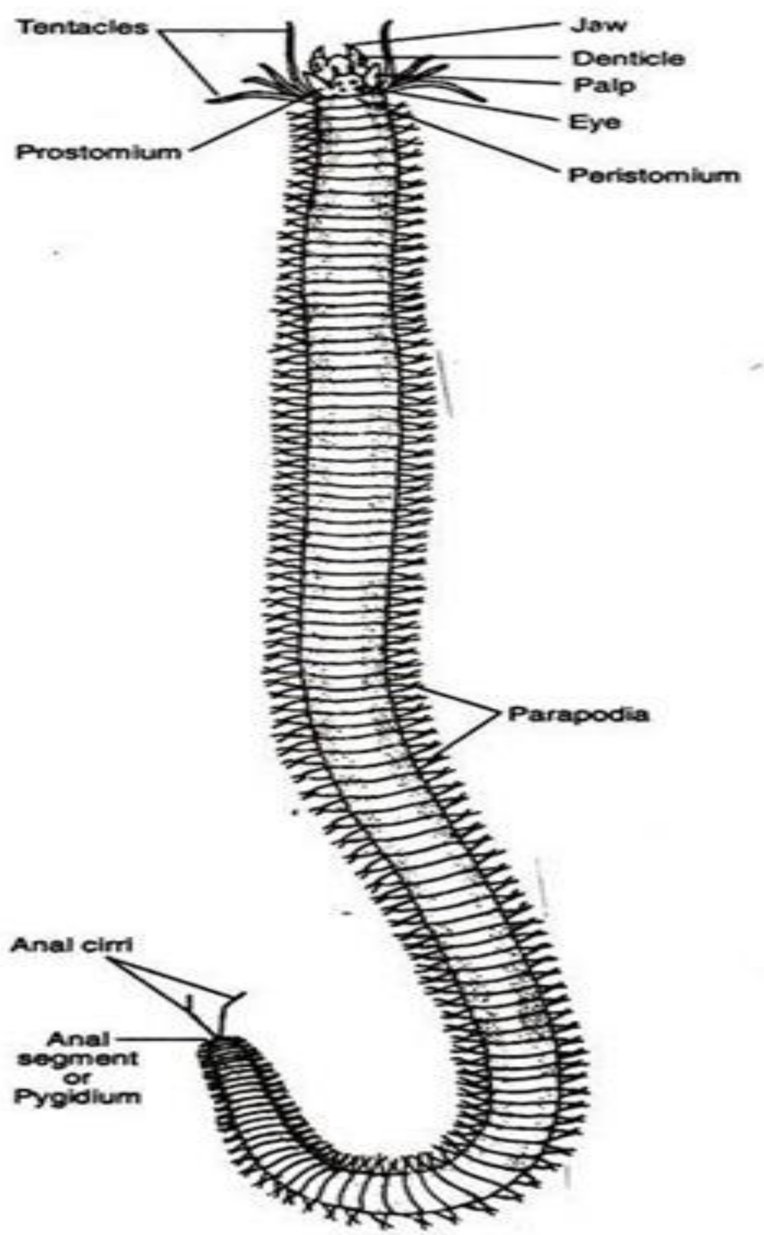

Fig. 17.2: External features of *Nereis*—dorsal view (after Bloom and Krekeler).

In some polychaetes transformation of one or two post-oral segmental parapodia into protostomial cirri has occurred. This transformation is accompanied by a shift of these post-oral segments and their ganglia anterior to mouth (pre-oral), resulting some sort of a brain formation. Cephalization in true sense is absent in annelids.

3. Heteronomous Metamerism:

In arthropods and chordates the seg-ments of the body are dissimilar in different body regions and restricted only to certain organs. This type of metamerism is called heteronomous metamerism (Fig. 17.49).

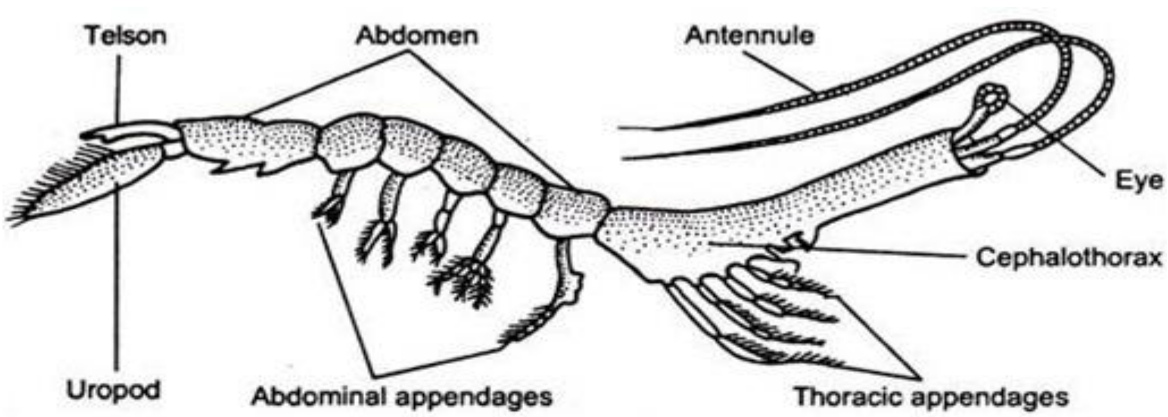

Fig. 17.49: A crustacean showing the heteronomous segmentation.

4. External Metamerism:

In arthropods, the metamerism is exter-nal. Internally the segments are not marked by partitions.

5. Internal Metamerism:

In vertebrates there is internal metamerism, seen in the embrayos and confined to the muscular, skeletal (vertebrae and ribs) and nervous system.

6. External and internal Metamerism:

In Annelids, the metamerism is clearly visible both externally and internally. Exter-nally it is marked by the constriction on the skin of the body and internally it is marked by the partitions (septa).

7. Complete Metamerism:

When the segmentation is seen practi-cally in all systems, the metamerism is called complete metamerism. It is seen in annelids.

8. Incomplete Metamerism:

When the segmentation is not seen in all the organs, the metamerism is called incom-plete metamerism. It is seen in arthropods and chordates.

9. Pseudo-metamerism or Strobilization:

In contrast to true metamerism, pseudo-metamerism or strobilization is seen in tapeworms (Platyhelminthes) where segmentation of the body takes place by the segmentation of the ectoderm. The body consists of a number of segments or proglottids which varies in different individuals of the same species.

New segments are added to the body throughout life. The proglottids or segments differ in the degree of development. The segments or proglottids are functionally independent or self-con-tained units and new segments are always formed and there is no cooperation between the segments. The new segments are formed at the anterior end, just behind the scolex.

Origin of Metamerism:

There are several conflicting views re-garding the origin of metamerism.

Such as:

1. Pseudo-metamerism Theory:

   This theory postulates that the metamerism evolved sec-ondarily as a result of repetition of body parts whose ancestor was acoelomate and un-segmented, and contained the various systems or organs which had serially spread out along the entire length of the body (pseudo-segmentation).

   This is supported by the fact that Turbellarians contained tes-tes, yolk glands, transverse connectives of two nerve cords which are serially repeated along the length of the body, and these organs were separated by the development of septa producing metamerism. The metameric segmentation was linked with the evolution of coelom.

   Pseudo-metamerism:

   1. Segmentation of the body is related to the segmentation of the ectoderm.
   2. New segments are formed at the anterior part of the body (behind the scolex).

3. Segments work as an independent unit.

4. No co-ordination among the segments e.g., tapeworms (Platyhelminthes).

Metamerism:

1. Segmentation of the body is related to the segmentation of the mesoderm.

2. New segments are formed at the posterior end of the body (in front of the anal segment).

3. Segments work as different units.

4. Segments work in co-ordination with all other segments e.g., Annelida, Arthropoda, Chordata.

2**. Cyclomerism Theory**:

This theory was proposed by Sedgwick in 1884 and sup-ported by Remane in 1950 and 1963. This theory is the corollary of the enterocoelous theory of coelom origin and is associated with the origin of metameric segmentation.

It is assumed that the origin of coelom took place from the gastric pouches of some an-cestral anthozoan coelenterates. The gastric pouches are separated from the main gastric cavity and arranged in linear fashion. These pouches are transformed into coelomic pouches in the protocoelomates.

First four gastric pouches are developed in ancestral medusoid coelenterates. Further division of two pouches resulted into three pairs of coelomic cavities, viz., protocoel, mesocoel and metacoel in the protocoelomates.

Loss of protocoel (anterior pouch) and mesocoel (lateral two pouches) leads to the formation of un-segmented coelomates, such as mol-luscs and sipunculans. Later subdivision of metacoel (posterior pouch) produces seg-mented annelids (Fig. 17.50A-G).

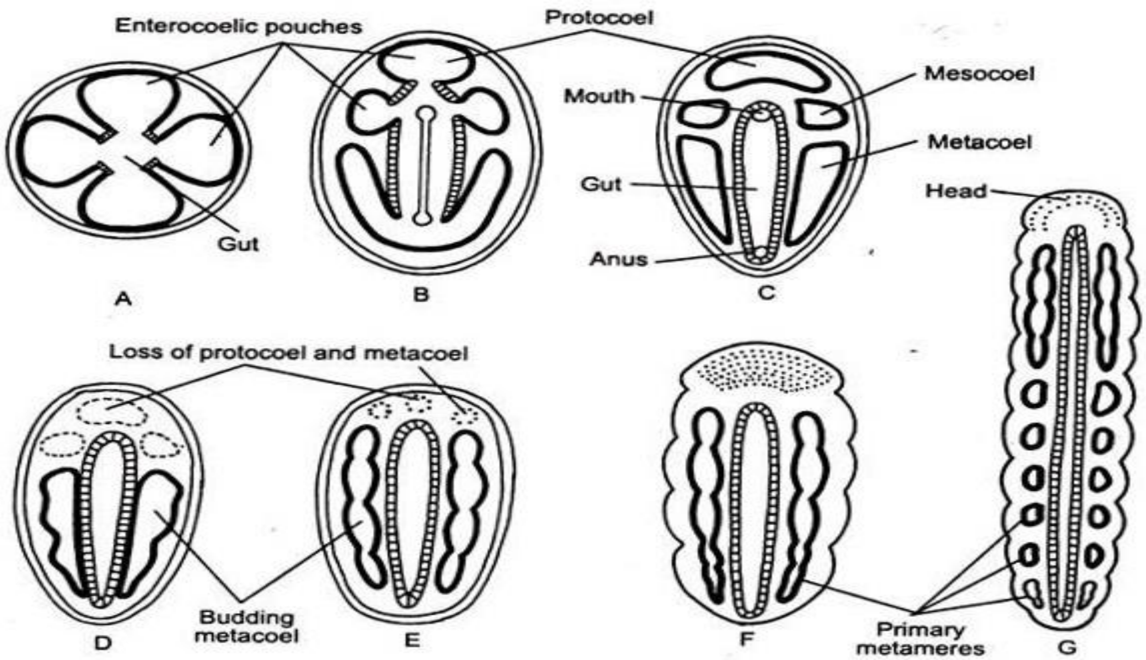

Fig. 17.50: Diagrams illustrating the cyclomerism theory of metamerism.

3. **Corm or Fission Theory**:

According to this theory, the metameric segmentation re-sulted due to incomplete separation follow-ing the repeated transverse divisions of a non-segmented ancestor or by asexual repro-duction producing a chain of sub-individuals or zooids. These zooids are united end to end. Such events occur in scyphozoan strobilae and in platyhelminthes.

Remarks:

The chief objection of this theory is the sequence of zooid formation in platyhelminthes and scyphozoans is never serial with terminal fission. An-other objection is that the reproduction by fission is usually confined to sessile animals where the ancestors were prob-ably free-swimming (Fig. 17.51).

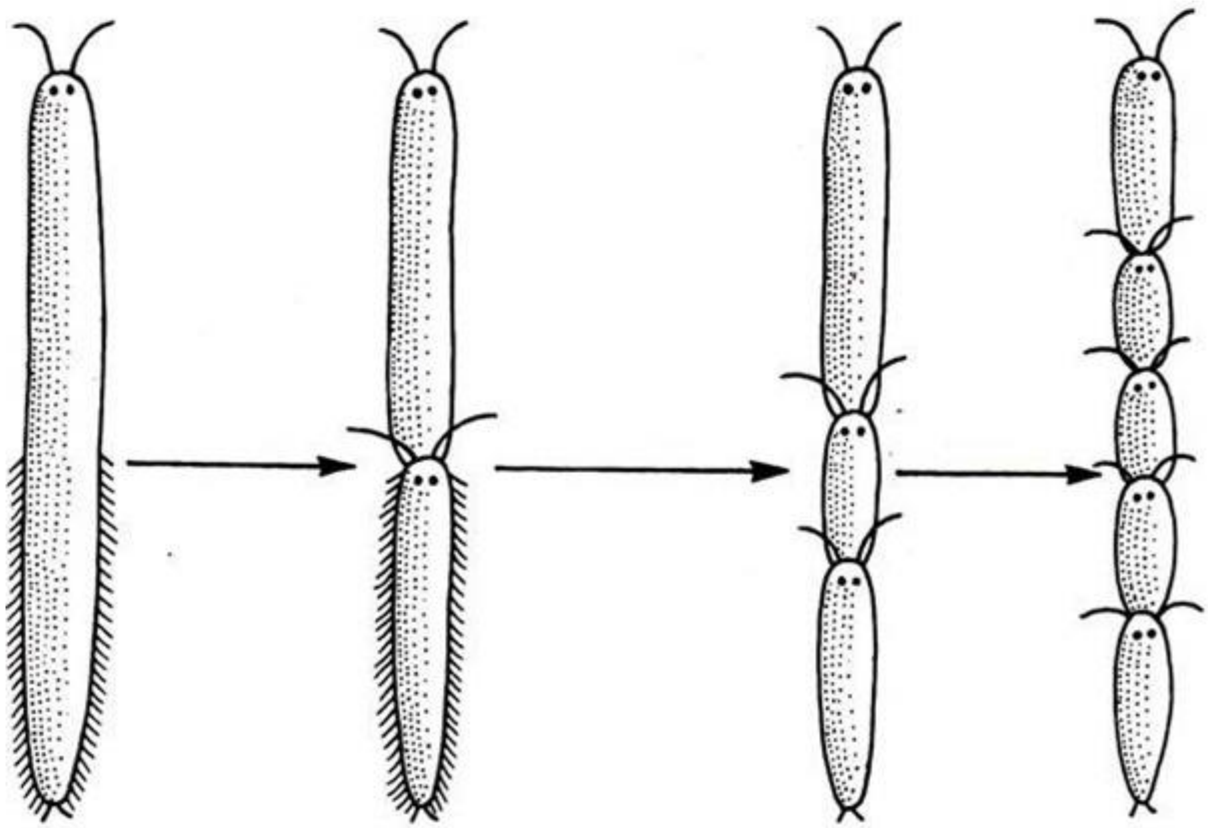

Fig. 17.51: Diagrams illustrating the origin of metamerism by fission.

4. Locomotion theory:

R. B. Clark (1964) proposed the locomotion theory to explain the origin of metamerism. According to this theory, metamerism evolved in annelids as an adaptation to the peristaltic locomotion and for burrowing, and in chordates meta-merism is associated with the strong undulatory, serpentine swimming.

In annelids, peristaltic locomotion in-volves shortening and lengthening of body by circular and longitudinal muscles which act against each other. As coelom is filled with coelomic fluid which acts as hydro-static skeleton to facilitate the locomotion, but peristaltic movement is not possible until it is compartmented by the develop-ment of septa.

With the development of compartmented coelom the fluid pressure main confined to a particular region of the body and it does not affect the whole body. The septa and metameric segmentation to-gether allow the part of the body to contract and other parts in the longitudinal axis relax.

This enables a strong peristaltic wave to propagate down the body. For burrowing the animals need a hard skeleton but they lack such structure and the coelomic fluid, and inter-segmental septa act as hydraulic skel-eton.

In chordates the metamerism evolved independently for locomotion. Metamerism allowed the tail muscles to be arranged segmentally for the undulatory movement of the body.

Significance of Metamerism:

1. It helps in locomotion, not only in burrowing but in all other types of locomotion.
2. Metamerism offers division of labour.