

## **TOPIC: TYPES AND PATTERNS OF CLEAVAGE-I**

LECTURE NO:03

BSC(HONS.) PART 1-PAPER II-GROUP B

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### **OBJECTIVES**

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To understand the Patterns of cleavage. To study control of cleavage patterns

To describe chemical changes during cleavage .To impart knowledge of significance of cleavage

To understand embryonic induction and concept of organizer

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### **INTRODUCTION**

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Fertilization results into the formation of zygote. The process of segmentation (cleavage) immediately follows fertilization or any other process which activates the egg. Cleavage consists of division of the zygote into a large number of cellular entities. The cells which are produced during segmentation are called blastomeres. The process

of segmentation prepares the groundwork for the future design of the embryo by producing adequate number of cells. The cleavage also establishes the fundamental conditions for the initiation of next developmental stage Gastrulation.

During embryonic development morphogenetic communication between cells and cell populations bring the exchanges of chemical and contact signals between groups of cells, which in turn alters the fate of cells. Such cellular interaction is called embryonic induction.

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## **CLEAVAGE**

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Cleavage or segmentation is a series of cell division of the fertilized egg through which it is converted into multicellular structure.

Cleavage can be characterized as that period of development in which no growth occur and chemical conversion of reserve food (yolk, glycogen) into active cytoplasm and the active cytoplasmic substances into nuclear substances like DNA, RNA and proteins.

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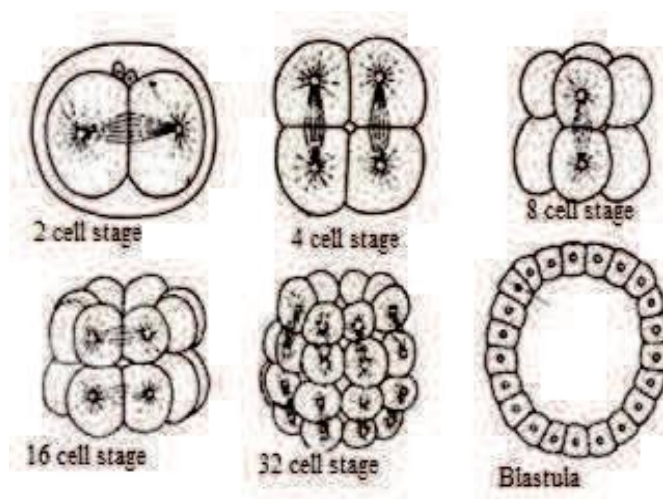
## PATTERNS OF CLEAVAGE

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The Pattern of cleavage due to Organization of egg may be of the following types

### (1) Radial cleavage:

When the cleavage planes cut the zygote in such a manner that there appears a radial symmetry in the resulting blastomeres, the cleavage is called a radial cleavage (Fig).



Radial changes in sea cucumber

For example, the frog's zygote divides by a vertical furrow into two equal blastomeres. The second cleavage furrow is also vertical but appears at right angles to the first. Thus four blastomeres are produced. These four blastomeres remain sticking together. A horizontal cleavage then appears above the equatorial region to cut

the four blastomeres into eight blastomeres with four smaller “upper” blastomeres and four bigger ‘lower” blastomeres. At this stage each bigger blastomere has a smaller blastomere sitting on its “head” and the blastomeres are arranged in four radial planes. A blastula produced by radial cleavage can be cut along any meridian to get into two identical halves. Radial cleavage is found in echinoderms.

## **(2) Biradial cleavage:**

When the first three division planes do not stand at right angles to each other, the cleavage is termed as biradial. Examples are found in polychaetes and ctenophora.

## **(3) Spiral cleavage:**

The spiral cleavage is found in those forms in which there is a rotational movement of cell parts around the North Pole to South Pole axis of egg, leading to a displacement or inclination of the mitotic spindles with respect to the symmetrically disposed radii.

Here, the cleavage planes are neither vertical nor horizontal but are slanting in relation to this axis. Moreover, each blastomere divides to form one bigger cell (macromere) and a smaller cell (micromere). In such a

cleavage the blastomeres of upper tier (micromeres) sits over the junction between each two of the vegetal blastomeres (macromeres).

This is due to oblique position of the mitotic spindles (Fig). Therefore it is also called oblique cleavage.

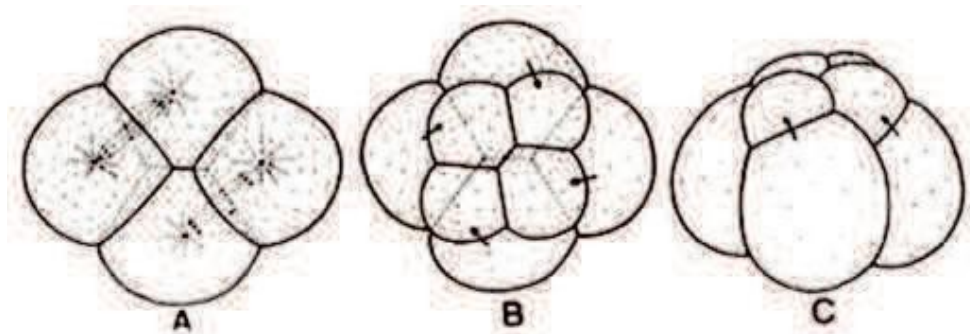


Fig. Spiral cleavage in *Mollusca* (a) Four cell stage, cell preparing for division (b) Eight cell stage, Animal pole view (c) Eight cell stage, Lateral view

In successive cleavages the mitotic spindles are arranged in a sort of spiral. The turn of spiral may lie in a clockwise direction (dextral cleavage—right handed) or anticlockwise direction (left handed—sinistral cleavage). Examples are found in *Turbellaria*, *nematoda*, *rotifera*, *annelides* and all the molluscs except *uphalopods*.

#### (4) Bilateral cleavage:

In bilateral cleavage, the blastula can be cut vertically only along one plane to get two identical halves, the right and the left. Cleavage activity on one side is mirrored by Activity on the other side. In most cases, the plane of bilateral symmetry is established by the plane of first cleavage furrow, which is bilaterally symmetrical (Fig. 3.3). Examples are found in tunicates, *Amphioxus*, amphibians, and higher mammals.

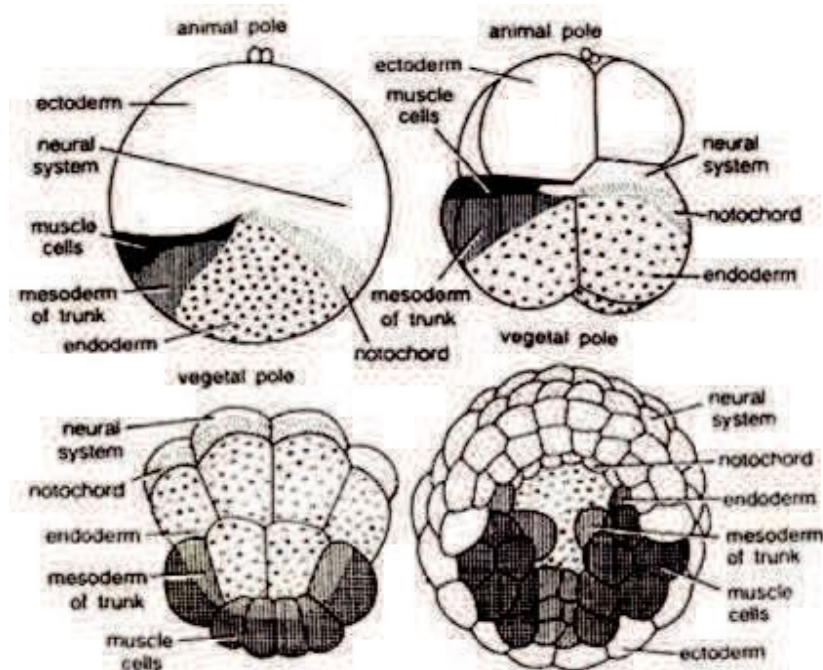


Fig: Cleavage of Ascidian egg showing bilateral cleavage

According to the concept of potency, which refers to the total range of developmental possibilities, that an egg or a blastomere is capable of realizing under any imposed conditions either natural or experimental, the following two types of cleavage have been recognized:

**Determinate:**

The fertilized egg forms all the parts of the embryo by repeated division. Some eggs or ova have, even before cleavage, different regions earmarked to form different parts of the embryo. For example, in the Ascidian eggs the region, which will form the endoderm, is fixed. If this region is dissected out from a fertilized egg, the embryo formed later will have no endoderm. Such eggs with predetermined regions are called mosaic (or determinate) eggs.

Cleavages in mosaic eggs follow a precise pattern and each blastomere has its characteristic position and unalterable fate. Here cleavage separate different organ forming regions and are called determinate or mosaic cleavage. Examples are of nematodes, annelids, molluses and ascidians, which show determinate type of cleavage.

**Indeterminate:**

In vertebrates the plan of cleavage is less rigid. Here the fertilized eggs do not have predetermined region. If the region which normally forms the endoderm removed from a fertilized sea urchin egg, the embryo formed later will still have the endoderm. Such eggs are called regulative or indeterminate eggs.

In these eggs, as there are no predetermined regions and the cleavages cannot separate such regions, they simply cut the eggs into segments which have the potential of forming any organ. This type of cleavage is called indeterminate or regulative cleavage. Eggs of some groups of invertebrates and of all vertebrates show indeterminate cleavage.

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