INTRODUCTION

You will study how various processes occur in the development of mature male and female gametes, called sperms and ova (or eggs) respectively in vertebrates. You will also become familiar with the events that occur prior to and during the period of fertilization (union of sperms and ova) which results in the formation of a single celled zygote that consists of genetic material from both parents. This zygote through various stages and cell processes develops into a multicellular organism that is capable of functioning, growing, reproducing and completing its life cycle. The process of development of the zygote from a single celled entity to a multicellular embryo is long. In humans as you may be aware the duration of development of the zygote into a fully developed foetus, ready to be born is approximately nine months.

In the present unit you will study about the principles of development which are common in all organisms both nonchordates and chordates. You will also come to know about the emergence of the field of embryology and how it progressed into the modern and vast discipline of Animal Developmental Biology, due to newer and better biological techniques and the advent of newer biological sciences like molecular biology, genetics etc.

This unit will also focus on the various nonchordate and chordate animal models that have been used in the past and are being used in the present study of embryology and animal developmental biology. These animal models have been used in order to understand how animals develop both at the observable, morphological, experimental level and at the level of underlying molecular biology and genetics. You will be able to understand the reasons for choosing a particular animal model in order to study a particular process of development

Developmental biology addresses some of the big questions that arise from the study of embryological processes such as: how does a single cell-the fertilized egg- give rise to a multicellular organism in which there are a multitude of different cells that give it form? How do the various cell types –

muscle cells, blood cells, skin cells, neurons etc., - form and get differentiated from one another? How do these cells then get organized into functional organs in the animal body and what can influence these pathways of development? Along with this you will learn about some crucial experiments that gave the developmental biologists insight into these processes.

DEVELOPMENT STAGES COMMON TO ALL ANIMALS

The blueprint of development of an organism from a fertilized egg to an adult is encoded in (i) genes present in the zygote and (ii) some special clues in the form of cytoplasmic determinants present in the cytoplasm of the zygote.

During the course of development, the developing cells of the zygote differentiate into many cell types that communicate and coordinate the various developmental activities and then subsequently get organized to form an integrated functional organism.

A development principle common to all higher organisms is that, the fertilized egg or zygote will develop progressively during several stages that last for different periods in order to form an integrated functional organism.

The stages of development that occur between fertilization and the birth of an organism (Fig.10.1) are collectively known as embryogenesis. It is during embryogenesis that the genotype (genes of the developing organism) of the organism determines the morphological appearance (phenotype) of the organism. Each animal whether it is a fruit fly or earthworm or frog, or bird or a mammal undergoes the same basic stages of development which include:

i) **Fertilisation –** involves the fusion of mature male and female sex cells or gametes. Each gamete has only half the complements (set) of the chromosomes of the adult organism and union of the male and the female gamete to form the zygote restores the full genetic complement. The full genetic complement of the zygote instructs the zygote to develop in a similar manner to the parents and to produce an organism similar to the parents.

ii) **Cleavage or rapid cell division –** is the stage in which the zygote is divided into numerous small cells known as blastomeres. During cleavage cells do not grow between each division and so with successive cleavage cells the **blastomeres become** smaller. These smaller blastomeres develop into early stages of development called **morula and blastula** stages.

iii) **Gastrulation –** is the stage during which the cell division slows down and cells of the blastula undergo dramatic movement and rearrangement causing **cellular diversity** and formation of the three germ layers namely, ectoderm, mesoderm and endoderm. These three layer interact to form the organs of the body**.**

iv) **Morphogenesis –** is the process **of cellular differentiation in the embryo**. Morphogenesis gives the embryo its shape.

v) **Organogenesis –** is the process in which organ formation is completed so that the embryo becomes functional. A fully developed individual organism can then be distinctly seen as a member of a particular species at this stage. The embryo then, takes birth as a formed individual that lives on, till its death.

In many species a group of cells are set aside and do not participate in the formation of the embryo. These are known as germ cells and are used to produce the next generation. All other cells of the body are known as somatic cells. The germ cells migrate in the embryo to form the gonads and give rise to gametes in the adult organism. However, the process of development does not stop at birth, it is seen as metamorphosis and regeneration in some animal groups and finally as aging or senescence.

In Figure 10.1 we have shown the life cycle of frog as an example depicting all the above mentioned stages of development.

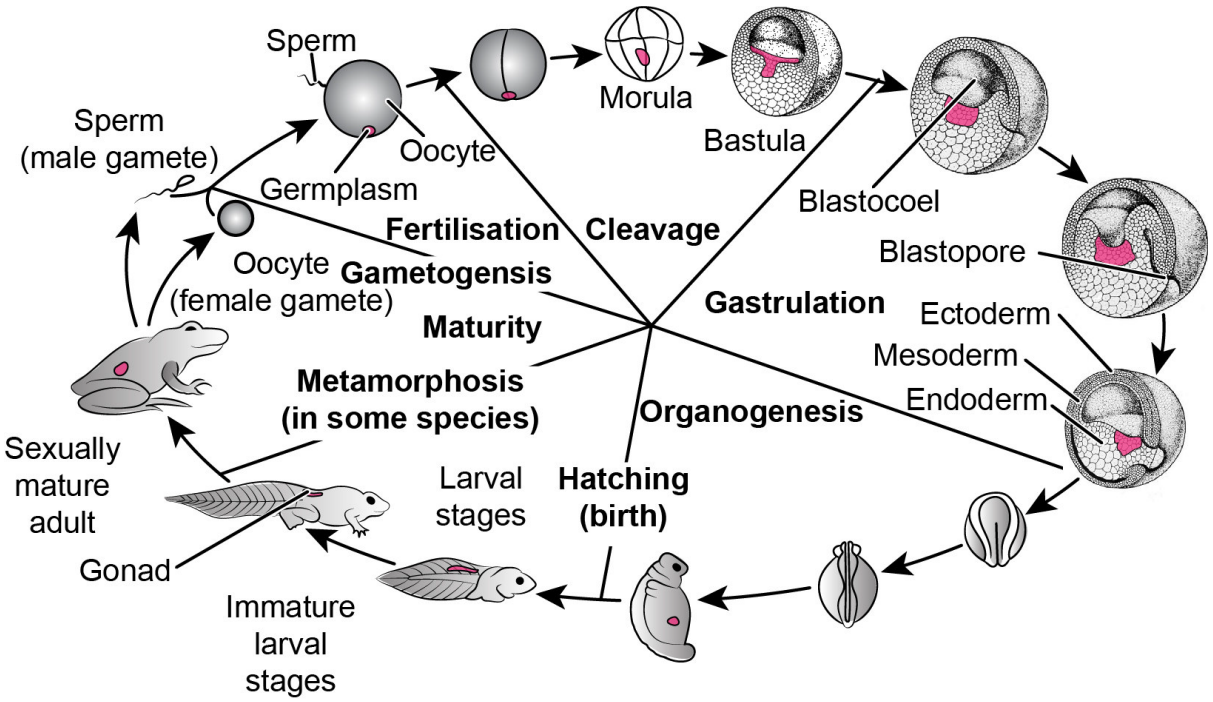

Fig : Life cycle of a frog, showing, the various stages from fertilisation and embryogenesis. In the frog the egg hatches as a larva (tadpole) and completes the rest of development through steps of metamorphosis; finally emerging as the adult frog capable of starting another generation.