Hello students and welcome to this session. I'm Sheena Paul teaching at Government College of Arts, Science and Commerce, Quepem.

Today I'm dealing with the topic: fate maps and cell lineages Part 2, which is a component of the first chapter of the core paper developmental biology for semester 6.
The outline of this module includes the construction of the fate maps using artificial markings, fate maps of a chick embryo, cell lineages and outcomes of the cell lineage study.
At the end of this module, the students would be able to understand how to construct a fate map using artificial markers. They would be able to elucidate the main features of the fate map of a chick embryo. They would understand the concept of cell lineages and explain the outcomes of cell lineage study.
In the earlier module we had talked about the construction of fate maps using living embryos as well as using artificial natural markings.
In this module we shall be dealing with the construction of a fate map using artificial marking methods. All animal embryos would not be either transparent or show natural markings on their surfaces. In such cases, when we want to construct a faith map, we have to put to use artificial markers which can be used to construct the fate maps. Now the various types of artificial marking methods that are available in the construction of a fate map are vital style vital dye staining, Carbon particle marking and radio isotope markers. Let's take up the first one here.
The first method of construction of a fate map using the vital dye staining method. Now this method of construction of a fate map was first devised by W. Vogt in the year 1925. Vital dyes are dyes which will stain living tissues and embryos without causing any injury to the living cells. Some examples of vital dyes are Nile blue sulphate, Janus green, Neutral red and Bismarck brown. Now these dyes differ from the normal stains that we use in case of various practicals such as acetocarmine and methylene blue or methyl orange. Those stains are used to stain dead tissues, whereas vital dyes can be used without any harm or injury being caused to living tissues. Now how do we go about constructing a fate map using vital dyes? Vital dyes cannot be directly poured onto the living tissue, they have to be loaded onto what are called stain carriers, such as Agar Agar or cellophane. A small piece of the Agar Agar or the cellophane which has been loaded with the vital dye has to be cut out and placed on the surface of the embryo in the required position for a small period of time. Care should be taken that the vitelline membrane of the developing embryo is not damaged. The vital stain diffuses from the stain carrier, passes through the semipermeable membrane or the vitelline membrane and enters into the substance of the blastomere, which will then retain the dye for quite a long time. All the blastomeres and the tissues which developed from that initial blastomere which has taken on the vital stain, will retain the colour of the dye for a long time, thereby indicating the fate of that blastomere. Now different areas of a single blastula can be marked simultaneously by different vital dyes and the fate of each of these blastomeres can be studied.
The second method is carbon particle marking method. Now, this method of creating a fate map was first devised by Spratt in 1946. In this method, the surface of the embryo is marked with insoluble carbon particles which stick to the surface of the blastomeres and their movements can be studied over a period of time. The fate maps of the entire embryo can be constructed by a series of these experiments, one blastomere at a time.

The third method of construction of a fate map is by using radioactive isotopes such as tritiated thymidine or carbon 14 or phosphorus 22. These are the ones that are used as markers to track the presumptive organ forming areas. In this technique, the different blastomeres would be labelled with different radioactive markers and subsequently the fate maps can be constructed by studying the organs which showed the presence of those particular radioactive markers.

Let us take the example of the fate map of a chick embryo. Now in chick embryo the blastula comprises of a blastodermic wall which is bilaminar meaning it comprises of two layers, an outer layer which is the epiblast and an inner layer which is termed as the hypoblast. Both of these layers contribute to organ formation in the chick embryo. And the fate map of the chick blastula has been made for both the layers by using vital stains as well as carbon particle method. It has been seen that in chick embryo the epiblast is differentiated into the presumptive epidermal ectoderm, which forms the skin and the epidermis. The presumptive neural plate region which gives rise to the central nervous system and the sense organs. The presumptive notochord region, which lies in the mid dorsal line which will later on give rise to the notochord. The presumptive somite region which lies below the nautical region which develops into the musculature of the chick embryo and the posterior half of the epiblast will give rise to the ventral lateral mesoderm, which lines the body cavity as well as the extraembryonic membrane area, which will give rise to the four extraembryonic membranes that is the amnion, the chorion, the allantois and the yolk sac. Similarly, the inner layer that is the hypoblast of the blastula gives rise to the endoderm, which forms the lining of the digestive system as well as partly helps the formation of the notochord.

The fate maps are of great importance to understand the mechanism of gastrulation as well as the morphogenetic movements of cells and final position of these cells in the tissues of the embryo.

This is a diagram which shows the various presumptive organ forming areas offer chick embryo. One is the early stage and the second one is the fate map of a chick embryo just before the process of gastrulation.

The second concept that we have to discuss in this module is cell lineage or cytogeny. What does cell lineage mean? The observation and study of the developmental history of each blastomere is termed as cell lineage study or it's termed as cytogeny. Now cell lineage study can be done by using the vital staining techniques that we just talked about or using natural markings and then naming the blastomeres which are either stained with the vital dyes or showing the natural markings. Now in cell lineage study to understand the fate of each blastomere it becomes very necessary to name the early blastomeres and their progeny by certain names. Now in cell lineage study, this naming involves the use of the English alphabet as well as numbers. Let's just take an example over here.

If the zygote is made up of ABCD, in the first cleavage the zygote will divide into two blastomeres, one which is named as AB and the other which is termed as CD. In the next cleavage division, each of the blastomeres separate out and then they are called as A, B, C and D. In the next cleavage, the capital letter A divides into two blastomeres, which is then named using both alphabets as well as numbers in the naming process.1A1 and1a1. Similarly, the naming continues, in this pattern.

What are the outcomes or why is cell lineage study important? Cell lineage study helps in the establishment of phylogenetic relationships.

As a result of the study of cleavage patterns and lineages of three major invertebrate phyla, it becomes clear that Platyhelminthes, Annelida and Mollusca are closely related. Both annelids and molluscs, in their developmental history show the presence of a larval stage, which is called as the trochophore larva.
In both groups, the trochophore larva shares a common body plan, which indicates a close phylogenetic relationship. In both groups, the larval ectoderm arises from the first three micromere quartets, while the remaining micromeres give rise to the mesoderm. The macromeres in both groups give rise to the endoderm. Similarly, the ciliated bands which are present on the body of the trochophore larva, the heart, the formation of the nerve cord, and other main tissues occur in a similar manner in both groups, but beyond this the development in the two groups diverges from the common plan and unique structural adaptations such as the formation of this shell gland in molluscs and metameric body plan in annelids happens.
The cell lineage study also reveals that each blastomere undergoes a specific number of divisions before it differentiates into a larval structure, tissue or organ, and the ultimate position and division pattern of each of these blastomeres is set at the very early stages of development of the embryo. So that was the importance of cell lineage study.

These are the references that I have used in the formation of this module.

Thank you.