
CHAPTER

19

GROWTH AND DEVELOPMENT

*Animation 19: Homeostasis
Source & Credit: Wikispaces*

In the course of its life cycle an organism changes from a fertilized egg into an adult. As development proceeds, all sorts of the changes take place. The most obvious change is growth. The progressive changes which are undergone before an organism acquires its adult form constitute embryonic development. Growth is the permanent and irreversible increase in size that occurs as an organism matures.

GROWTH AND DEVELOPMENT IN PLANTS

In plants growth and development involve cell division, elongation and differentiation of cells into tissues and then organs. Growth is an irreversible increase in size and development is a programmed series of stages from a simpler to more complex form. As development proceeds, cellular differentiation of structure and function takes place.

A plant has a growth pattern called **open growth**. Throughout life, the plant adds new organs such as branches, leaves and roots, enlarging from the tips of roots and shoot but the rate of growth is not uniform throughout the plant body. At the beginning, the growth is slow, but gradually it becomes rapid, attains a maximum, then gradually slows down. In vascular plants, growth occurs through the activity of meristems. Meristems are young tissues or group of cells that retain the potential to divide. In lower plants, the entire plant body is capable of growing, but in higher plants, the entire plant body is not capable of growing but growth is limited to certain regions known as growing points. These growing points consist of groups of cells which are capable of division, these growing points are called meristems. These meristematic cells are located at the stem and root and they are of the following types.

(i) Apical Meristems

The apical meristems are found at the tips of roots and shoot and are primarily concerned with the extension of plant body. These are perpetual growth zones found at the apices of roots and stems. They are responsible for increase in the number of cells at the tips of roots and stem, so they play important role in primary growth (Fig 19.1).

Animation 19.1: Apical Meristems
Source & Credit: Animated Abstarct

(ii) Intercalary Meristems

These are the parts of apical meristem which get separated from apex by permanent tissues. They are situated at the bases of internodes in many plants. They play important role in the production of leaves and flowers. These are of temporary nature.

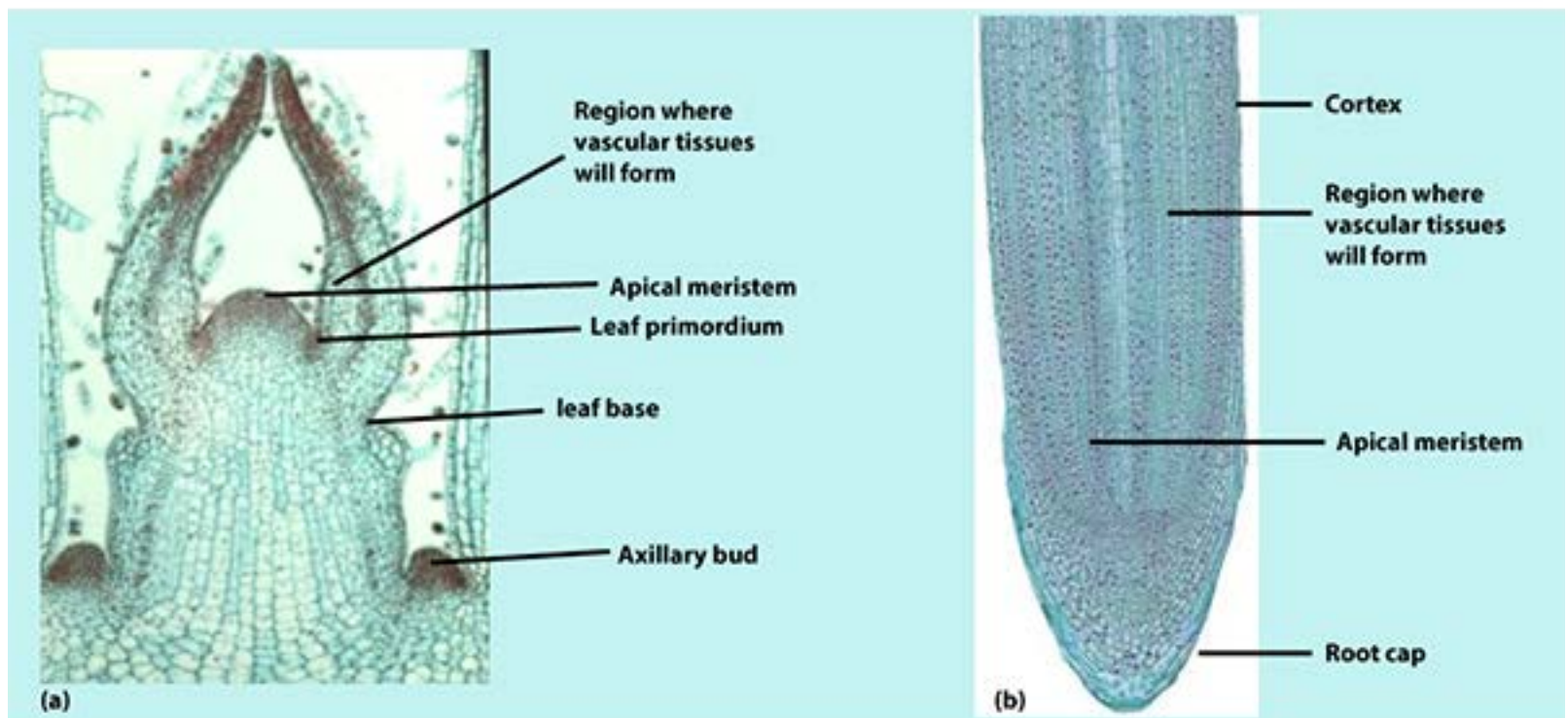


Fig. 19.1 Photomicrographs of the apex of a shoot (a) and a root (b).

(iii) Lateral Meristems

Lateral meristems are cylinders of dividing cells. They are present in dicots and gymnosperms. Vascular and cork cambium are the examples of lateral meristem. They play an important role in the increase in diameter of stem and root and in secondary growth are determinate i.e. they grow to certain size and then stop e.g. leaves, flowers and fruits; while others are indeterminate i.e. they- grow by meristems that continually replenish themselves, remaining youthful e.g. vegetative root and stem.

Types of Growth:

(i) Primary Growth : Primary' tissue is added by the apical meristem

(ii) Secondary Growth : Secondary tissue is added by the intercalary or vascular cambium leading to increase in thickness.

Phases of Growth : Growth of multicellular plant is divided into four phases, cell division, elongation, maturation and differentiation.

During **cell division**, the number of cells increase by mitosis. It occurs at the tip of root and shoot where cells are small, have spherical nuclei lying in the center of cytoplasm, which is non-vacuolated. As a result of cell division, each daughter cell proceeds to enlarge. Synthesis of cytoplasm and cell wall material also takes place in this zone.

A little distance from apex of root and shoot lies the **zone of elongation** and is only of few millimeters in length. During elongation the cell volume increases upto 150 fold due to uptake of water. Plasticity of the cell wall increases and wall pressure is reduced. Synthesis of new cytoplasm and cell wall material proceeds on.

During **maturation**, the final size of a given type of a cell is attained. The cells which develop into pith, cortex and certain other tissues do not elongate further along the axis, while other cells like fibers and tracheids elongate lengthwise more than in other direction.

When the cell enlargement ceases, the process of **differentiation** starts. During this growth phase the walls of cells become thicker, the walls of many kinds of cells and tissues become pitted; thickening appear on the walls of xylem vessels, cells of various tissues differ in spatial dimensions and many new structural features develop. (Fig 19.2)

Conditions of Growth

The growth rate is influenced by number of factors both external and internal. External factors are temperature, light, oxygen, carbon dioxide, water, nutrition etc. while internal factors are hormones, vitamins etc.

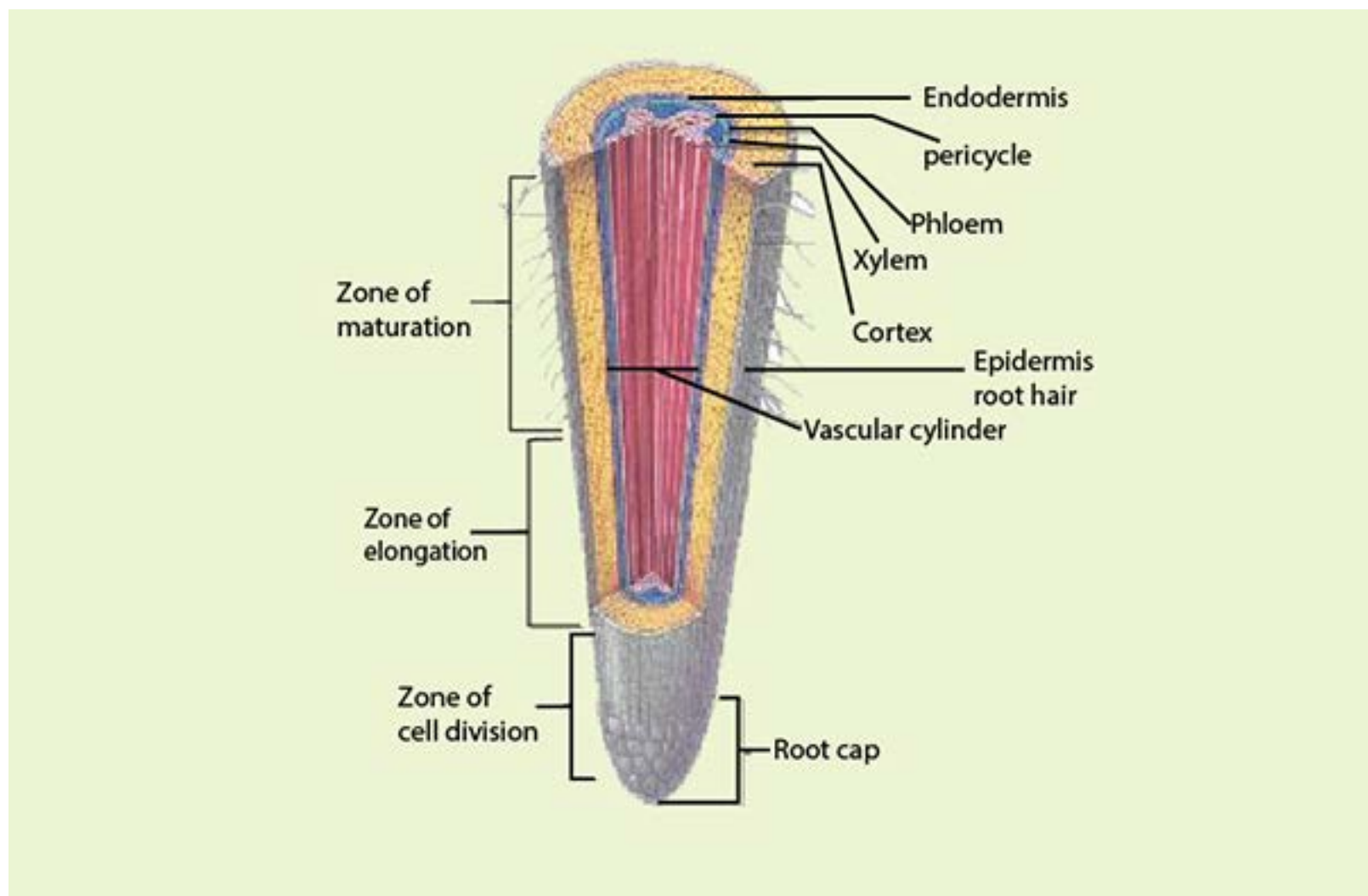


Fig. 19.2 The root tip is divided into four zones.

(A) External factors

(i) Temperature : Temperature influences the rate of growth within a certain range (0-35°C). Normally rate of growth increases with rise of temperature and decreases with decrease in temperature. For maximum growth, the optimum temperature is 25-30°C and it is least at 5-10°C. But at a very high temperature (35-40°C), the rate of growth stops and the plant may die.

(ii) Light : Light plays very important role in the growth of plants. By light, we mean the fractions of light, which is absorbed by plant during photosynthesis. Generally, light influences growth in three ways; intensity, quality and duration.

The increase in intensity of light increases the number of cell divisions. The red light favours elongation of cells and blue light enhances cell division but retards cell enlargement. Similarly, ultraviolet rays also retard cell elongation. Duration of light affects the growth of vegetative and reproductive structures. It also plays a role in inducing or suppressing flowering. The phenomenon is termed as **photoperiodism**.

(iii) Oxygen : For successful growth, regular supply of oxygen is necessary. Without oxygen, no metabolic activity is possible and no growth takes place. A very high supply of oxygen however, inhibits growth.

(iv) Carbon Dioxide : We know carbon dioxide is essential for carrying out normal process of photosynthesis but a very high concentration of it can retard growth.

(v) Water : By absorbing water, the cells elongate. The plant growth ceases in the absence of water.

(vi) Nutrition : Nutrients supply energy to growing plants. With the increase in nutrition, growth increases, whereas decrease in nutrition causes retardation of growth.

(B) Internal Factors

(i) **Hormones** : Plant hormones also influence growth e.g. Indole-3-acetic acid / (IAA) causes elongation of cells.

(ii) **Vitamins** : Vitamins are organic compounds synthesized within the plant bodies in the presence of light. If the plants are grown in dark, the vitamin deficiencies are induced and growth of plant body ceases.

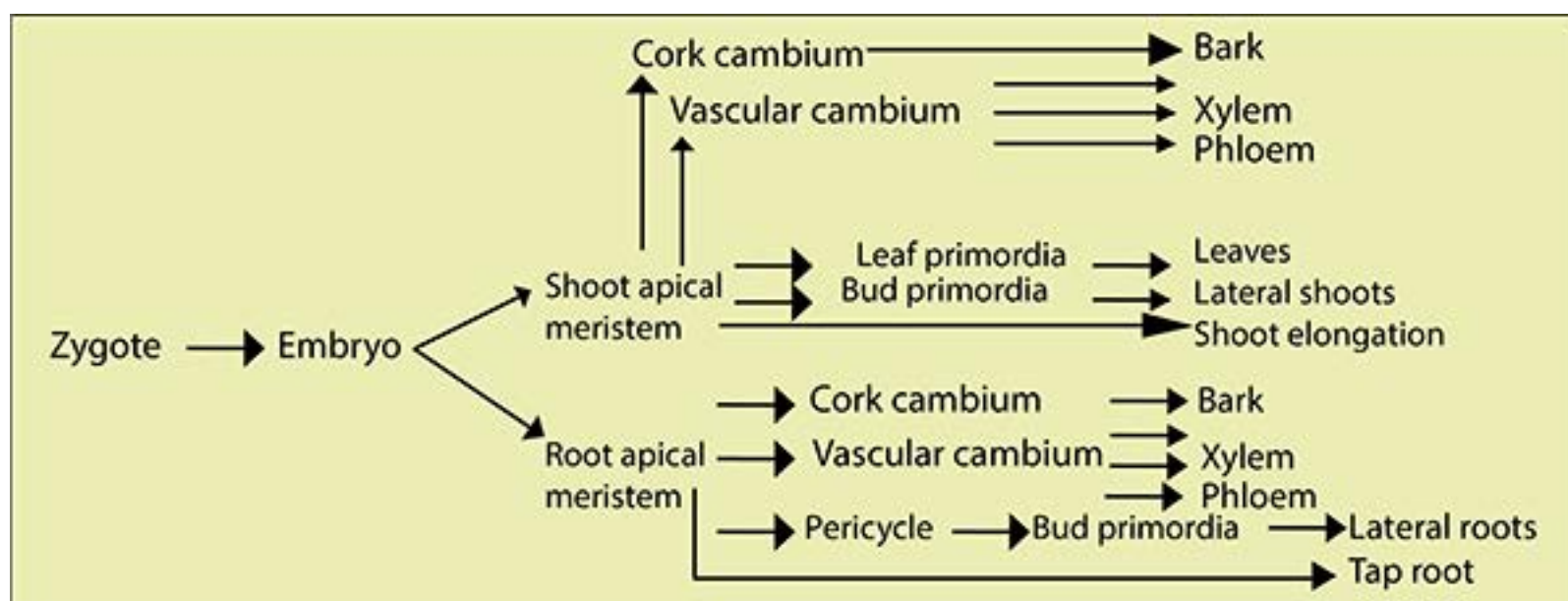


Fig. 19.3 Graphic representation of growth and differentiation in plants

Differentiation

As you have studied, once a seed has germinated, the plant's further development depends on the activities of the meristematic tissues, and we know that shoot and root apical meristems give rise to all cells of the adult plant. Differentiation is the formation of specialized tissues, which can be considered to occur in plant in five stages (Fig 19.3).

Stage 1 Represents the formation of embryo.

Stage 2 Within the embryo, shoot and root apical meristems are recognized.

Stage 3 Cambium is recognized, it is responsible for secondary growth.

Stage 4 There is production of leaf primordia (these are the cells committed to become leaves, shoot or roots). Root primordia develop from the root cambium, called pericycle. Leaf and shoot primordia develop directly from apical meristematic cells.

Stage 5 Fully differentiated tissues and structure are formed including xylem, phloem, leaves, shoots and roots.

Growth Correlations

The development of a plant is usually correlated with its growth and different organs growing at different rates in different directions and the development of different parts takes place. Such reciprocal relationship is known as **correlation**.

One of the most important correlative effect in plants is **apical dominance**. In many plants, only apical bud grows while growth is suppressed in lower axillary buds. In an experiment, when apical bud was removed, the growth in the lower buds was inhibited. So active shoot apex controls the development of lateral buds. Thus, the auxin of the terminal bud is responsible for inhibiting the growth of lateral buds by a phenomenon known as apical dominance (Fig 19.4). Later Thimann and Skoog in 1934 performed experiments and showed that **apical dominance** was caused by auxin diffusing from the apical bud which inhibited the growth of lateral shoots is called **inhibitory effect**. The removal of apex releases the lateral buds from apical dominance. It is called **compensatory effect**.

Research has also indicated that not only auxin causes apical dominance, cytokinins also play important role in apical dominance and in many cases if cytokinins are applied directly on the inhibited bud, it allows lateral buds to be released from apical dominance. It is also seen that those plants that have dense growth of lateral branches, have very little apical dominance. As far as practical application of apical dominance is concerned, it plays an important role in tap root development, and the inhibition of sprouting of lateral buds (eyes) in potato tuber by applying synthetic auxin. In the later case, the sprouting of eyes is prevented and storing period is increased from one to three years (Fig. 19.4).

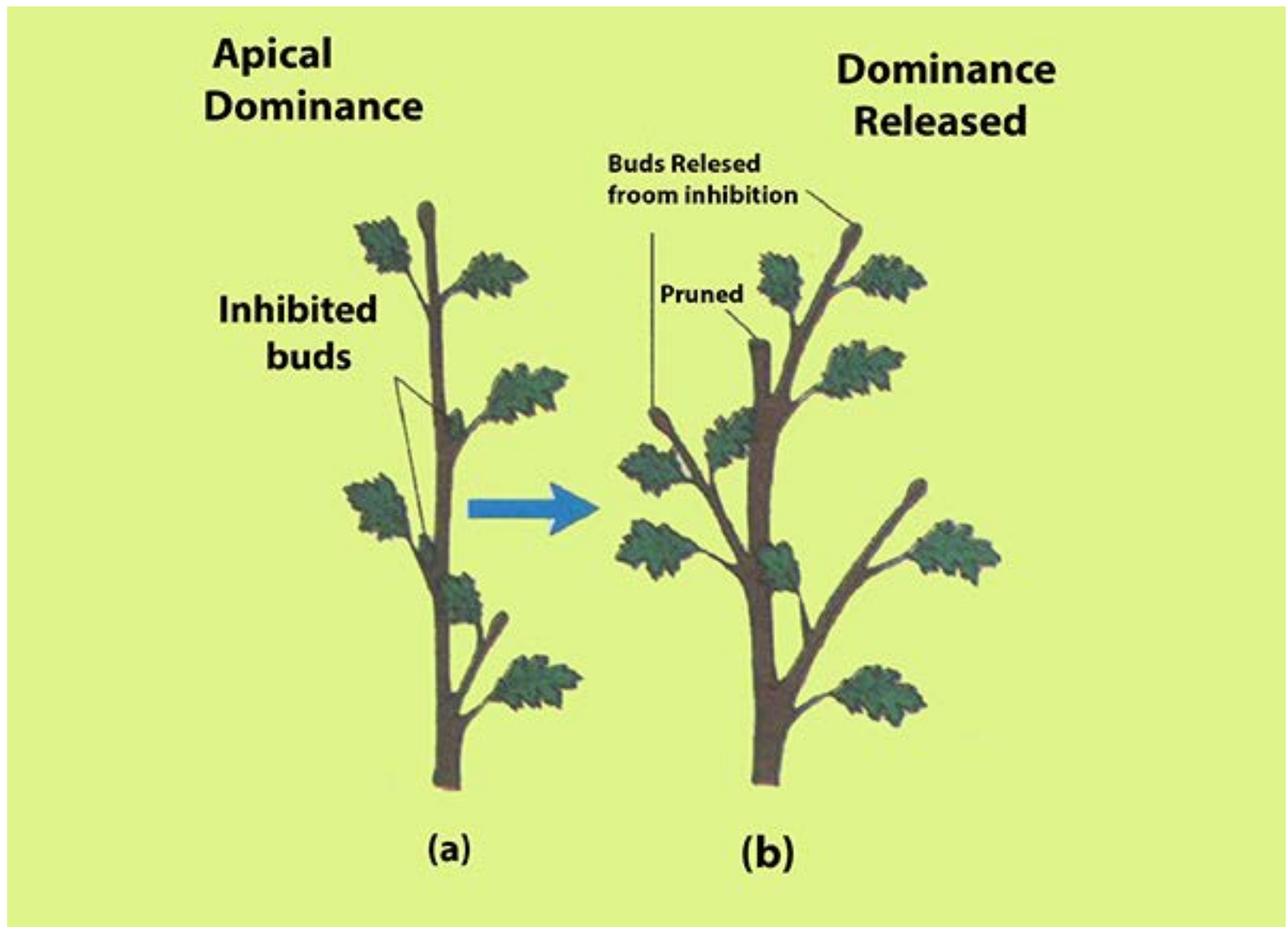
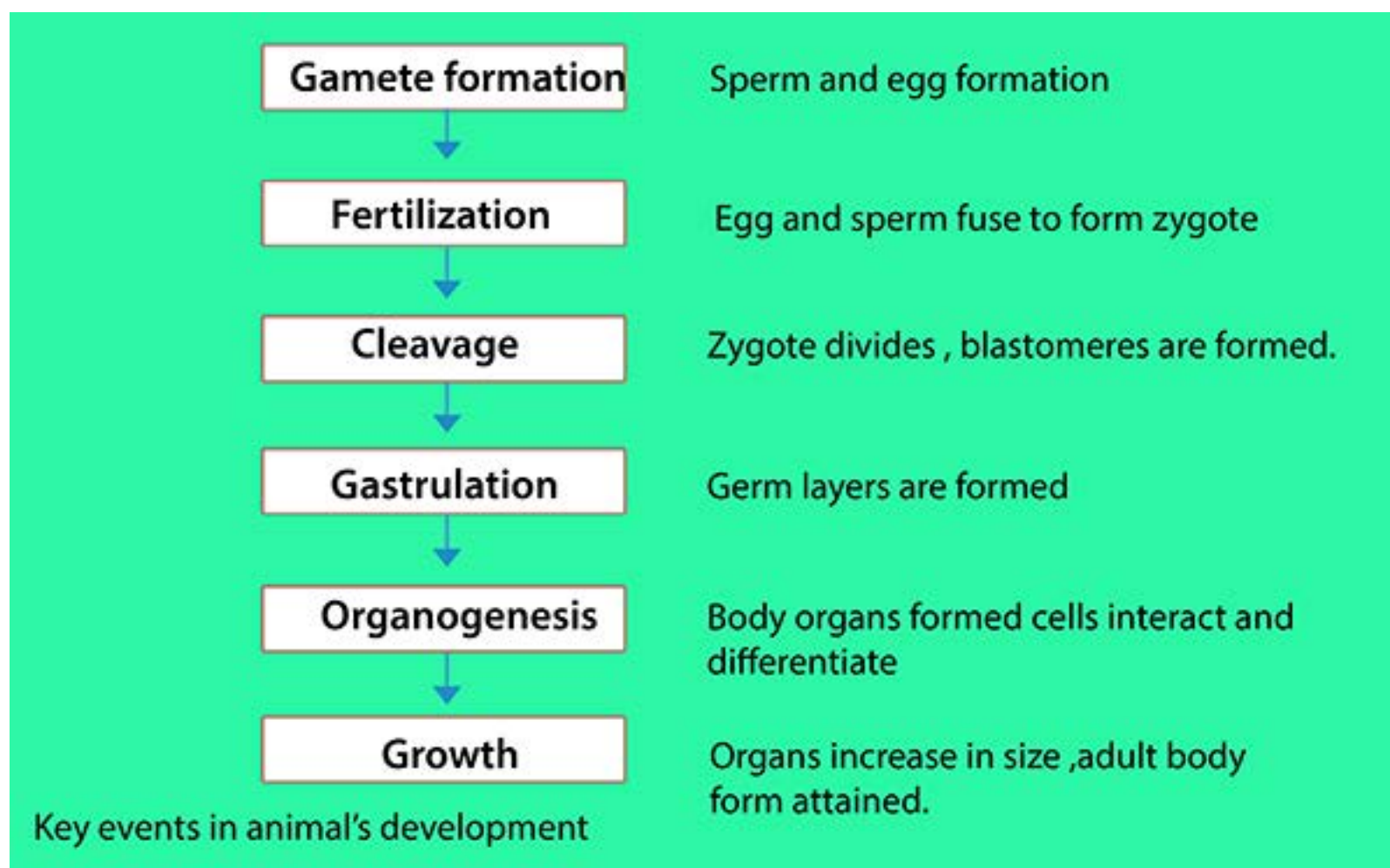


Fig. 19.4 Apical Dominance : The Influence of Auxin

GROWTH AND DEVELOPMENT IN ANIMALS

Embryology is the study of growth and differentiation undergone by an organism in the course of its development from a single fertilized egg into a highly complex and an independent living being like his parents.

Development is an ordered sequence of irreversible steps, with each step setting up the necessary conditions for the next step. Since all animals are somehow related through the process of evolution, there are some similarities in their various forms of development. Here, we will see a broad outline of the early stages of development. This can be described in terms of several stages, depicted below:



Development of Chick

The development of chick has been taken as a basic scheme of development. It will provide basis for understanding the early differentiation of the organ systems and the fundamental process of body formation, which is common to all vertebrates.

Fertilization and Incubation : The chick egg (called the yolk) is surrounded by various accessory coverings secreted by the female reproductive tract.

Fertilization is internal and normally takes place just as ovum is entering the oviduct. The shell is secreted as the egg passes through the shell gland (the uterus).

When an egg has been laid, the development ceases unless the temperature of egg is kept nearly up to the body temperature of the mother. In incubating eggs artificially, the incubators are usually regulated at temperature between 36-38°C. At this temperature, the chick completes development and is hatched on the twenty first day.

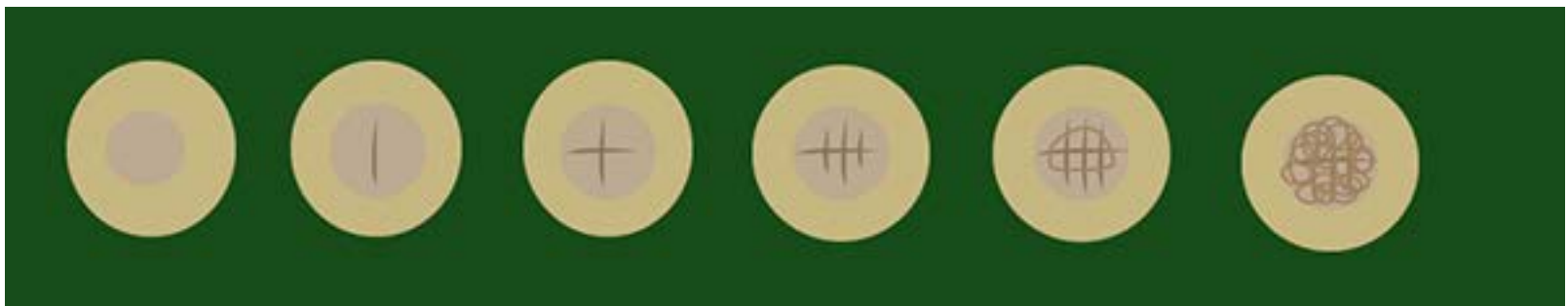


Fig. 19.5 Cleavage stages in chick

Animation 19.2: Development in Chick
Source & Credit: Backyard Chicken

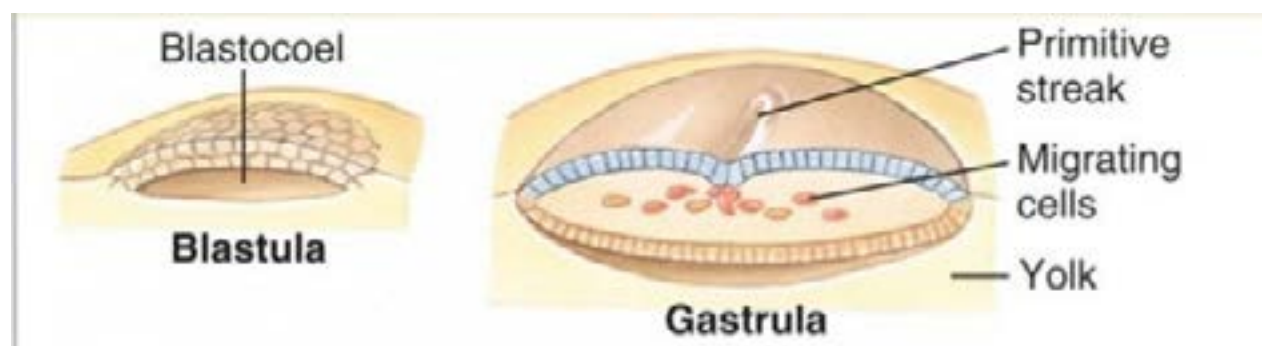
Cleavage :

Immediately after fertilization, the egg undergoes a series of mitotic divisions, called cleavage. In bird's egg the process of cell division is confined to the small disc of protoplasm lying on the surface of the yolk at the animal pole. This type of cleavage is referred as discoidal cleavage. The cleavage furrows start in the clear cytoplasmic region (Fig 19.5). The first two cleavage planes are vertical while the third runs horizontally parallel to the surface and thus cuts underneath the cytoplasm and separates it from the yolk. The successive cleavages become irregular and number of cells increase.

Morulla : Cleavage results in the formation of a rounded closely packed mass of blastomeres. This is morula, it consists of a disc shaped mass of cells two or more layers in thickness (blastoderm) lying close to the yolk. In the center of the blastoderm, the cells are smaller and completely defined while those at the periphery, are flattened, and larger.

Blastulla :

The morula stage is short-lived and soon changes into blastula and is characterized by the presence of a segmentation cavity or blastocoele. The discoidal cap of cells above the blastocoele is called **blastoderm**. The marginal area of the blastoderm in which the cells remain undetached from the yolk and closely adherent to it is called the zone of junction (Fig 19.6).



19.6: Blastula and gastrula stages in embryo of chick

Gastrulation : It is characterized by the movement and rearrangement of cells in the embryo. During gastrulation, the blastoderm splits into two layers: an upper layer of cells called **epiblast**, and a lower layer of cells called **hypoblast**. The epiblast is mainly presumptive ectoderm and mesoderm (Fig 19.7). The hypoblast is mainly presumptive endoderm because hypoblast cells grow outward over the surface of the yolk, then downward around it to form the endodermal lining of a yolk sac. At this stage, the central cells of blastoderm can be separated from the yolk, under these central cells a pool of fluid develops, raising them off the yolk and giving the area a translucent appearance - the **area pellucida**, while the peripheral part of the blastoderm where the cells lie unseparated from the yolk is termed as area opaca, the white area that transmits light. The upper layer of the blastoderm consists of the presumptive mesoderm and ectoderm.

Notochord and Mesoderm Formation

In the chick, the mesodermal cells do not invaginate as in amphibians, but migrate medially and caudally from both sides and create a mid line thickening called primitive streak (which grows rapidly in length as more and more presumptive mesodermal cells continue to aggregate in the middle. All this results in the change of shape of blastoderm, (it changes from circular to pear shaped).

Animation 19.2: Mesoderm Formation
Source & Credit: UNSW Embryology

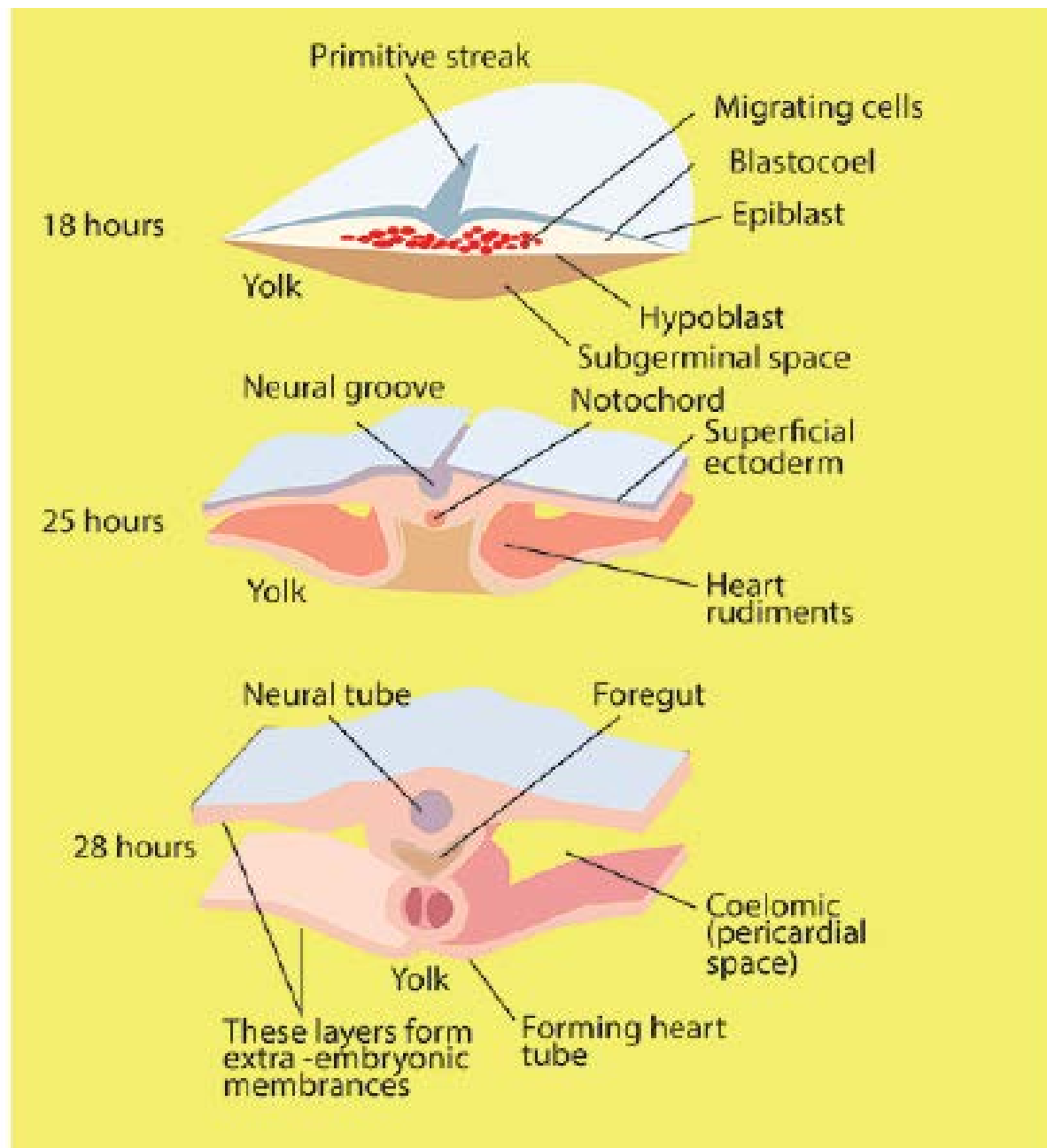


Fig. 19.7 Gastrulation in the chick

The anterior end of the primitive streak is occupied by an aggregation-the . primitive node or notochordal cells while rest of cells are mesodermal cells. Thus primitive streak represents the dorsal and both lateral lips of blastopore.

The continuous migration of cells takes place between epiblast and hypoblast and results in the formation of groove along the whole length of primitive streak. This is named as primitive groove, marked on either side by thickened margins, the primitive ridges.

At the cephalic end of primitive streak, closely packed cells form a local thickening known as Hensen's node. The Hensen's node however, mark the site of a somewhat special type of invagination.

Shortly, after the primitive streak has been formed and the endoderm was well established, cells begin to push in from the region of Hensen's node to form the rod like notochord in the midline beneath the ectoderm. In chick embryo of about 18 hours, notochord is one of the few prominent structural features. In sections of embryo incubated from 18-20 hours, it is seen that ectoderm has spread and become organized into a coherent layer of cells merging peripherally with the yolk and the marginal area where the expanding germ layers merge with the under lying yolk is known as germ wall and the cavity between the yolk and the endoderm which has been called gastrocoele is now termed as primitive gut.

From Hensen's node, dorsal mesoderm is formed and is organized into somites. The lateral plate mesoderm is splitted into two sheet like layers viz somatic mesoderm and splanchnic mesoderm, with a space between them. The cavity formed between somatic and splanchnic mesoderm is coelom. Somites are seen in 25-26 hours embryo, these are compact cell masses lying immediately lateral to neural folds.

Neurulation :

On the dorsal surface of gastrula, over the notochord, presumptive neural ectoderm is present in the form of a band. As gastrula elongates, the band thickens to form a neural plate. In chicks of 18 hours, neural plate was seen as a flat, thickened area of ectoderm. In embryos of 21-22 hours, a longitudinal folding has occurred, establishing the neural groove in the mid dorsal line, on either side of neural folds. In 24 hours embryos, the folding of neural plate is clearly visible. The embryo is now termed as neurula. The anterior end of the neural groove is widest and forms the future brain and rest of portion is future spinal cord. In the meantime, the neural plate sinks and the neural folds grow toward one another and meet in the middorsal line, fuse and convert the neural groove into neural tube. At each end of neural tube, a small opening called anterior and posterior neuro-pores are also seen, which close later on. With the formation of neural tube, there is formation of central nervous system and the cavity enclosed is known as neurocoel. This whole process is named as **neurulation**.

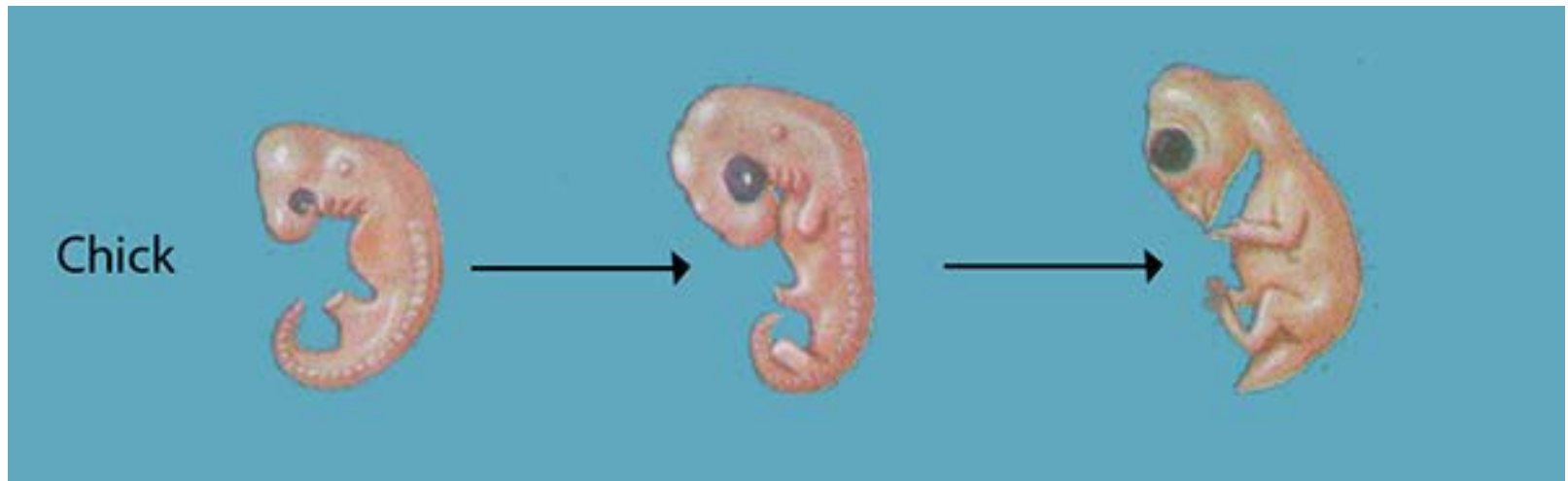


Fig:19.8 Early chick embryos

Mechanisms of Development

We know that from a single celled zygote, multicellular individual is formed and zygote contains complete information in the form of genome which has come in the form of chromosomes from the eggs and sperms. During cleavage, zygote divides into many cells. Each cell has full set of chromosomes and gets complete instructions from the parents. During differentiation however some genes remain active, while others switch off. The importance of nucleus and cytoplasm during development is revealed from the following experiments.

1. In 1892, Hans Dietrich, took sea urchin egg at two-cell stage, shook it apart and separated it into two cells. Later on, it was seen that both half embryos developed into normal larvae. Dietrich concluded that both these cells contained all the genetic information of the original zygote.
2. contained all the genetic information of the original zygote.

Another experiment was performed by Spemann. He took salamander zygote, and with the help of minute ligature of human hair divided the zygote into two equal halves. The nucleus was present in one half, but the other half had no nucleus. When the developmental process continued, it was seen that cleavage was completed in the half containing nucleus but the anucleate half was not seen dividing. Eventually, when nucleated side had reached a 16-cell stage, one of the cleavage nuclei crossed the narrow cytoplasmic bridge to the anucleate side. Immediately this side started dividing.

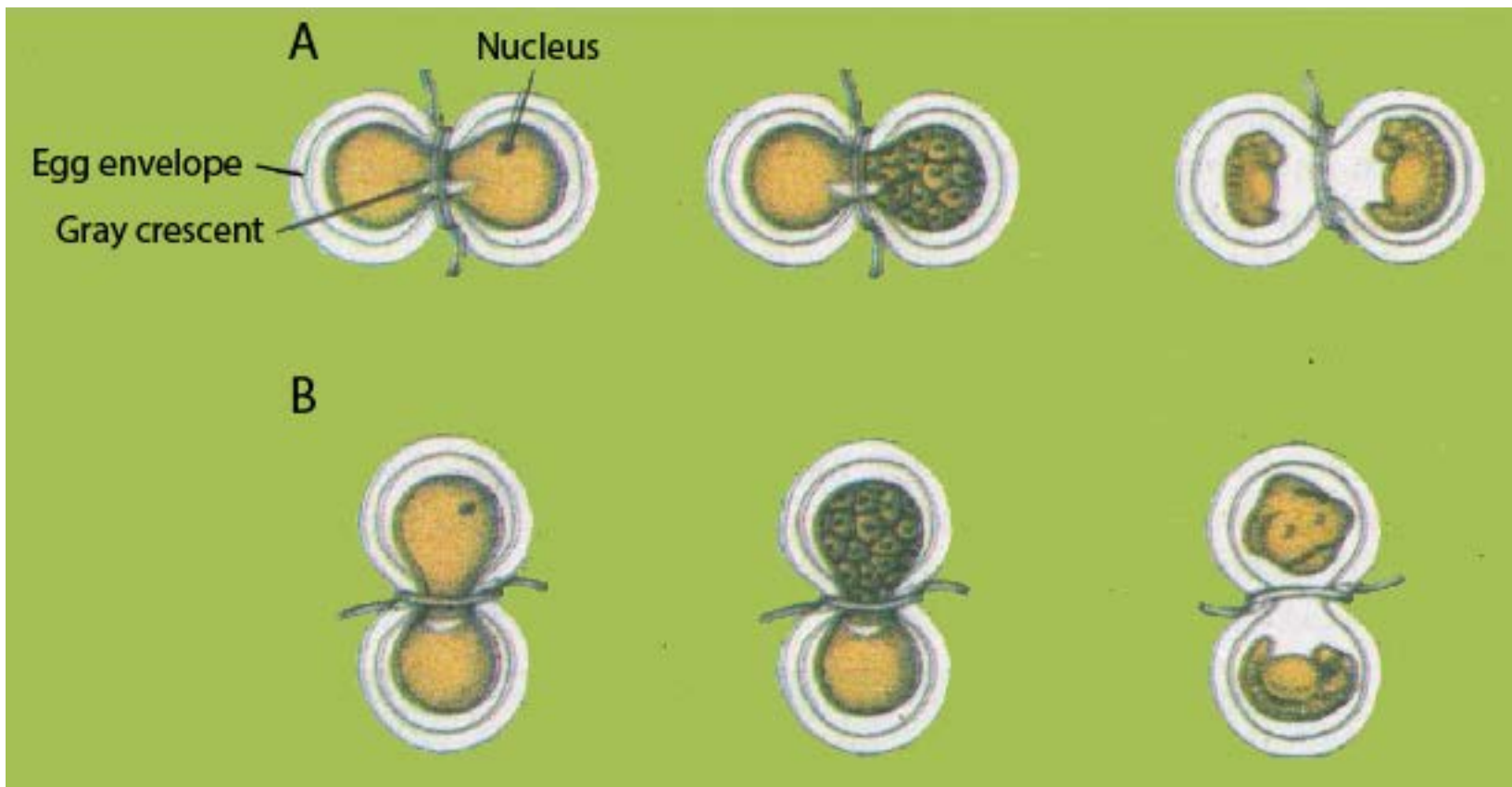


Fig. 19.9 Spemann's delayed nucleation experiments. Two kinds of experiments were performed. A, Hair ligature was used to constrict an uncleaved fertilized newt egg. Both sides contained part of the gray crescent. The nucleated side alone cleaved until a descendant nucleus crossed over the cytoplasmic bridge. Then both sides completed cleavage and formed two complete embryos. B, Hair ligature was placed so that the nucleus and gray crescent were completely separated. The side lacking the gray crescent became an unorganized piece of belly tissue; the other side developed normally.

3. Spemann also performed another experiment. He separated the two halves of embryo; both of them contained nuclei. Both these halves developed into complete embryos. He also observed that from a 16-cell embryo even, if a single cell is separated, it contains a complete set of genes and form a complete embryo. Through series of experiments, Spemann also observed that sometimes it may happen that the nucleated half can develop into abnormal ball of cells. Later studies revealed that development depends on the position of gray crescent. Gray crescent is the pigment free area that appears at the time of fertilization. So in the half lacking gray crescent, no further development can take place.

On the basis of above experiments, Spemann made two conclusions.

- i) All cells contain the same nuclear information.
 - ii) In the gray crescent area, cytoplasm contains information essential for development.
- Next question is, if all the cells contain same nuclear material, what causes the cells to differentiate. There are two ways by which cell undergo differentiation and become committed to particular determinative molecules.
1. During cleavage, cytoplasmic segregation of determinative takes place.
 2. Induction or interaction with the neighboring cells takes place.

Role of Cytoplasm in Development

It is known that different cytoplasmic components contain different morpho genetic determinants that are responsible for cell differentiation. These determinants are present in blastomeres. The fertilized egg of an ascidian contains cytoplasm of five different colours that is segregated into different blastomeres.

1. **Clear cytoplasm.** It produces larval epidermis.
2. **Yellow cytoplasm.** It gives rise to muscle cells.
3. **Gray vegetal cytoplasm.** It gives rise to gut.
4. **Grey equatorial cytoplasm.** It produces notochord and neural tube.

Role of Nucleus in Development

Most gene controlled substances, which can easily be identified are found in the cytoplasm, and are probably produced in it. Through experiment, it is found that production of developmentally active substances by the nucleus itself, or its immediate neighborhood, is, however available in some cases. One of such example is in the multicellular alga, *Acetabularia*. It consists of rhizoid, which is attached to the ground, from which arises a long stalk with an umbrella shaped cap at its top. On the basis of structure and shape of the cap, two species of *Acetabularia* have been identified; *Acetabularia mediterranea*, which has regular shaped cap, and *A. crenulata*, which has irregular shaped cap.

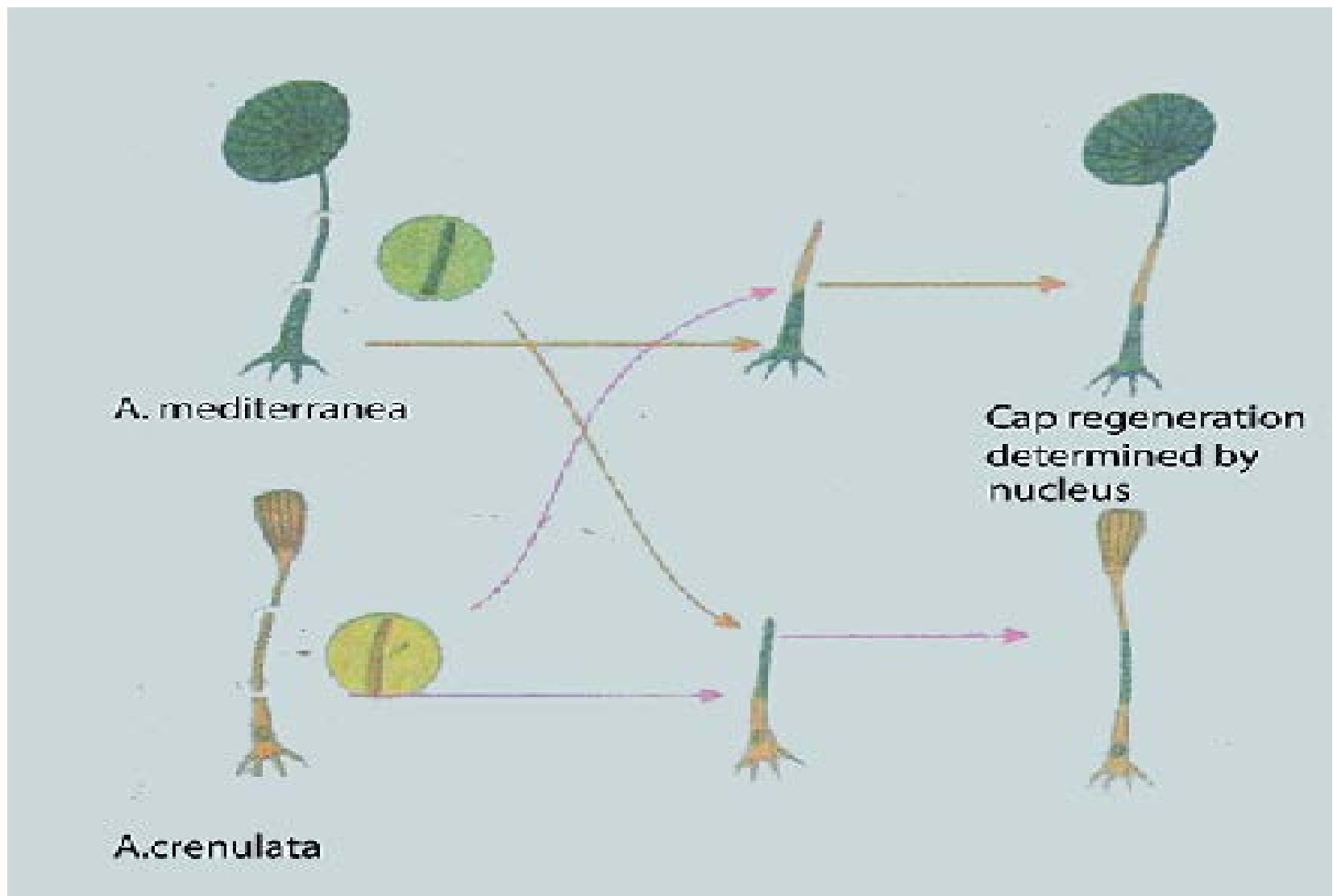


Fig. 19.10 Nuclear control of cap structures in two species of *Acetabularia*.

There is only a single nucleus, although they may attain the size of several centimeters or more. Haemmerling showed that if the cap is removed, a new one is regenerated. He cut off the nucleus containing rhizome from an alga of one species (*A. mediterranea*) and grafted a similar piece containing the nucleus of another species (*A. crenulata*). When the cap was now removed, it was seen that the new regenerated one had the characters of *A. crenulata*. So nucleus lying at the base of the alga and not the stalk to which the regenerate was attached determined the structure of cap. It means that irrespective of the fact to which species the cytoplasm belong, the genes were able to express according to the type of nucleus

From all these experiments , it was concluded that both gene and cytoplasm play important role in development . Nucleus contain all gene, which determine the characteristics of the individual, while cytoplasm plays the role of selection of genes.

Concept of Differentiation:

A fertilized egg contains cytoplasmic components that are unequally distributed within the egg. These different cytoplasmic components are believed to have morphogenetic **determinants** that control the functioning of a specific cell type. This is now called differentiation. Zygote contains complete information for the development of an individual but it is difficult to see, how these cells differentiate.

In order to understand the concept of differentiation, Spemann performed a series of experiments on amphibian embryo.

He took out piece of ectoderm from frog's embryo and grew it in a separate dish. The embryo from which the piece of ectoderm was removed , was unable to form normal nervous system but has a defective nervous system. Similarly , the isolated piece did not develop any structure even though it was active and healthy . In another experiment , he separated the mesoderm underlying ectoderm and folded the flap of ectoderm to its original piece . The frog did not develop any nervous system. So it was proved that mesoderm had some effect on the ectoderm to simulate the ectoderm cells to form nervous system.

Embryonic Induction

The capacity of some cells to evoke a specific development response in other is widespread phenomenon in development. Work on embryonic induction was reported by Hans Spemann and Hilde Mangold in 1924. They took two embryos of salamander at the gastrula stage and removed a piece of dorsal blastopore lip from one embryo, and transplanted it into a ventral or lateral position of another salamander gastrula. It invaginated and developed a notochord and somites. It also induced the second embryo to form neural tube and a complete nervous system was formed where the dorsal blastopore lip was placed. The developing embryo had both the grafted tissue and induced host tissue. Later on, it was seen that only cells from the dorsal lip of blastopore were capable of inducing a complete embryo. This area corresponds to the presumptive area of notochord, somites and prechordal plate. Spemann designated the dorsal lip area the **primary organizer** because it was the only tissue capable of inducing development of secondary embryo in the host. This was called **primary induction**

AGING

Aging is an inevitable process and despite all the efforts to inhibit or stop it aging process goes on. It can be defined as negative physiological changes in our body. We identify the adult individual by the following signs of old age, all of them need not be present e.g. loss of hair pigment, development of small pigmented areas in the skin of face and arms, dryness and wrinkling of skin, loss of agility, increased weight due to fat, poor vision and forgetfulness, general weakness and decreased body immunity.

Degeneration of organ and tissue may also take place e.g. in joints, arthritis arises from the degeneration of cartilage, degeneration and disappearance of the elastic tissues in the tunica media of the blood vessel result in arteriosclerosis, blood clotting in the coronary arteries.

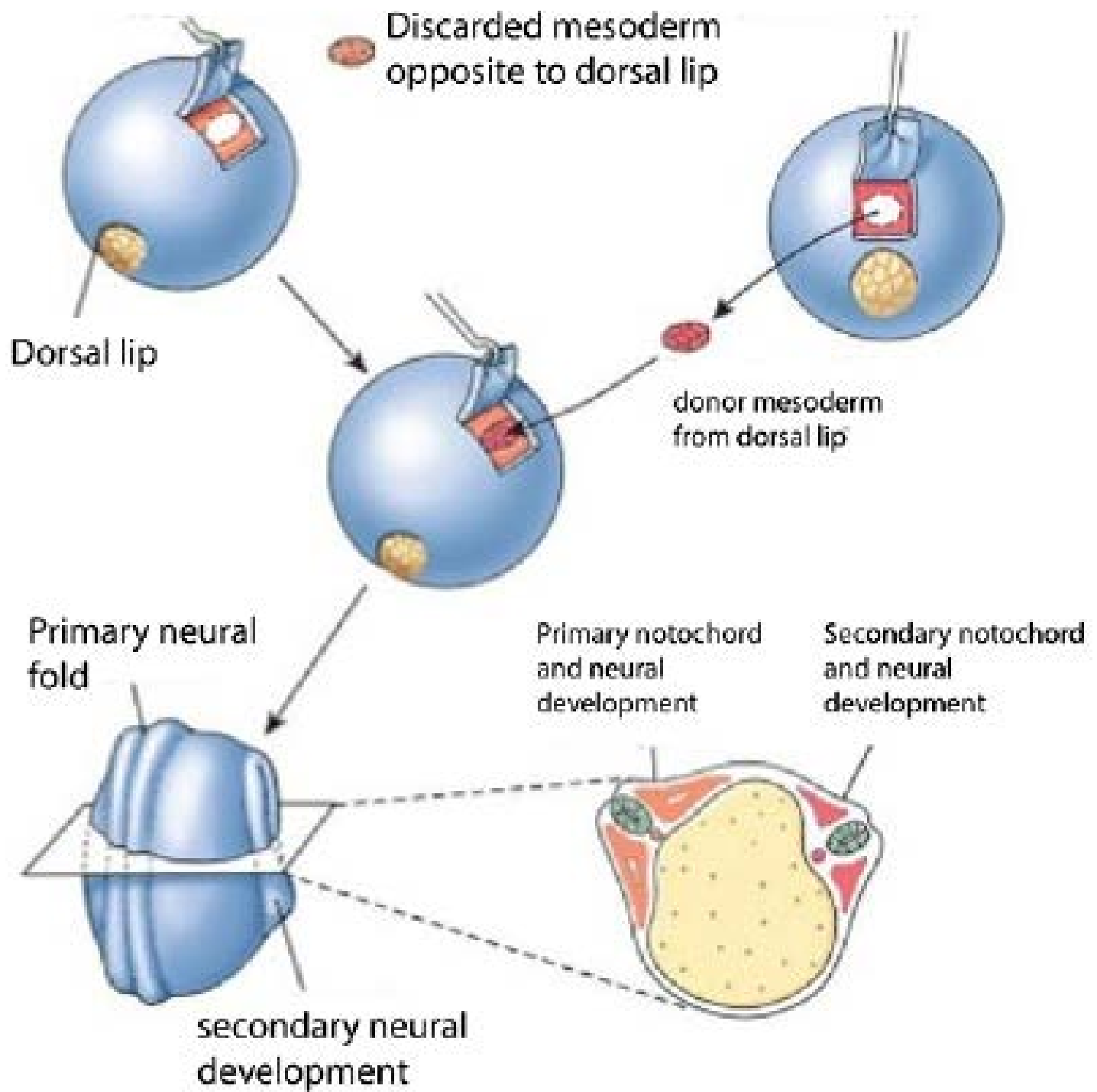


Fig. 19.11 The spemann primary organizer experiment

The exact process of aging is still unknown , but the following points are worth consideration.

1. The cells of tissues have only a finite number of mitotic division and hence the cells may have reached their finite number by the time tissue or organ is fully grown. For example in the case of nervous system, mental activity and memory deteriorate and there are fewer nerve cells in old age.

2. Changes in intracellular substances take place during aging . For example, collagen acquires increased cross linkages in its protein molecules , while elastic tissues loss their elasticity with the passage of the time . There is also hardening and loss of resilience in dense connective tissues and cartilage.

3. Spontaneous mutation may result in loss of cells and degeneration of tissues . The process of aging can be slowed down by better nutrition and improved living conditions e.g. regular meals, regular exercise ,adequate sleep ,abstinence from smoking and maintaining ideal weigth can prolong life by an average of 11 years.

Today, there is a great interest in gerontology, the study of aging. The number of older individuals are expected to rise. In the next half century, the number of people over age 75 will rise from the present 8 million to 14.5 million ,and the number of over age 80 will rise from 5 million to 12 million. The human life span is judge to be maximum of 120-125 years. The present goal of gerontology is not necessarily to increase life span but to increase health span.

REGENERATION

The ability to regain or recover the lost or injured part of the body is called **regeneration**. In sponges due to simple organization sponges possess greater power of regeneration. These not only replace the parts lost during injury, but any piece of the body is capable of growing into a complete sponge. The process, is however, very slow and requires months or years for the complete development.

If a lobster loses its pincer claw a new claw regenerates. If a starfish breaks off portions of their arms into pieces till the central disc completely devoid of arms is left, the central disc in almost all cases and also the arms in some cases are capable of developing into separate individuals. If the head of an earthworm is removed, a new head regenerates. Limb regeneration has been studied mostly in salamanders of various ages. In these forms, the limbs are readily regenerated throughout life, more rapidly when the amphibian is young and small. Besides limb, other parts of the body also have considerable regeneration capacity e.g. tail in the larva of amphibians and in lizards. For example, a lizard can easily discard its tail but tail can be regenerated by special features of its tail.

Healing of fracture and repair of a skin wound are some other examples of regeneration.

In plants, regeneration is the basis of plant propagation. Almost any part or even a very small fragment of a plant e.g. a piece of stem or leaf or even a single tissue cell may develop into a full plant. A part of the stem with a few leaves may be taken from many kinds of plants and when planted in soil form a complete plant.

*Animation 19.3: Regeneration
Source & Credit: Giphy*

In the process of regeneration, many of the various cell types which were present in the missing part of the body are replaced by the differentiation of cells e.g. in flatworms, and planaria the unspecialized cells, neoblasts, which are always present in the body of adult are mobilized and migrate to the site of amputation, where they differentiate into specialized cell types. But in other organisms like salamanders or newts some of the specialized tissue cell types in the stump of an amputated limb apparently dedifferentiate (become less specialized) and then proceed to differentiate into the same and probably different types of cells.

Asexual reproduction: fission followed by regeneration

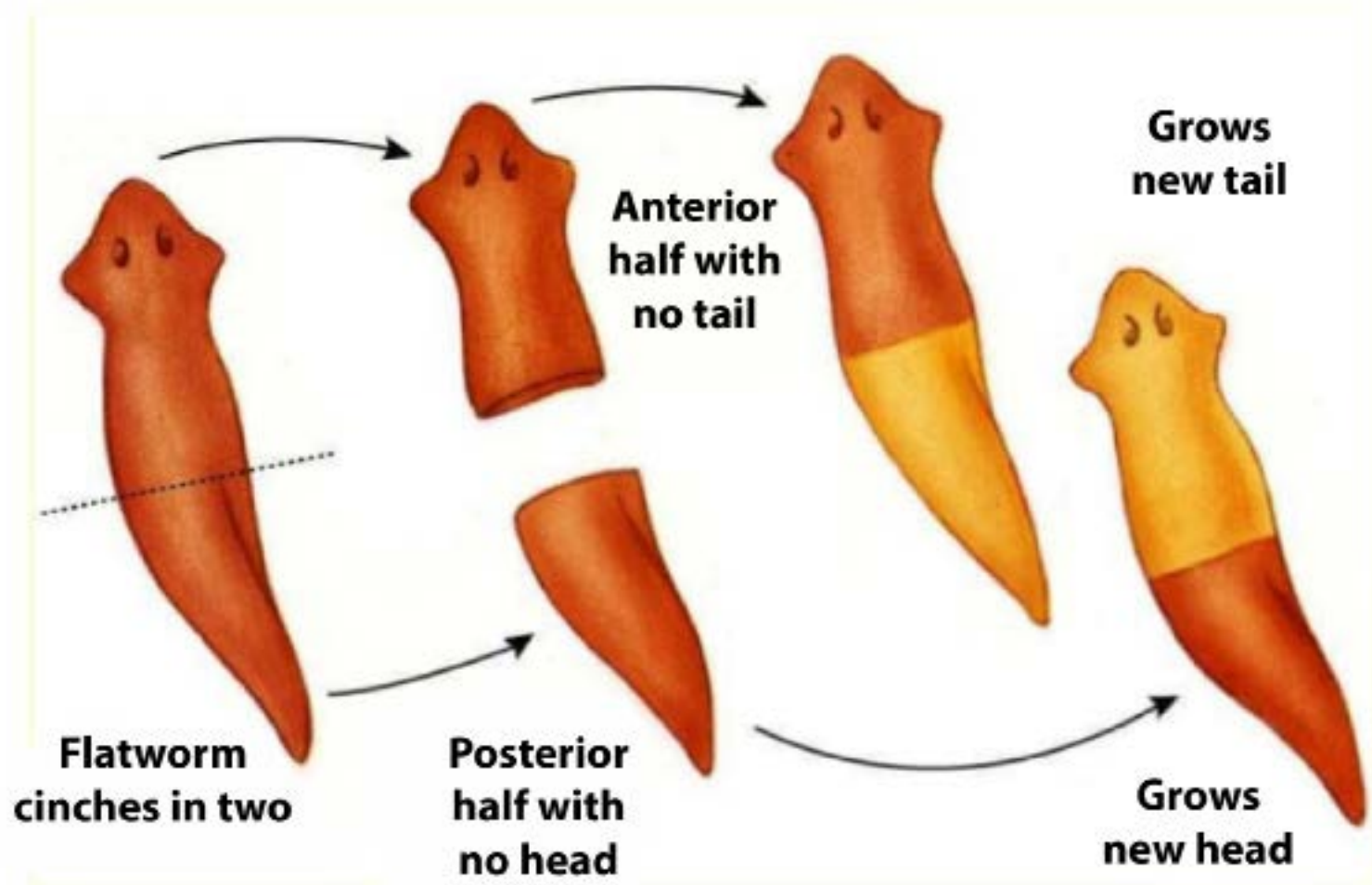


Fig:19.12 Regeneration in (a) Starfish (b) Planaria

ABNORMAL DEVELOPMENT

Sometimes, under unfavourable conditions, some parts of the body show abnormal development. Teratology is the branch of biology, which deals with these abnormal developments and causes for such developments. Anything which interferes with the normal process of development is the factor causing abnormalities.

The normal process of development is disturbed by abnormalities inherited from parents, abnormalities due to chromosomes or genes, environmental factors or metabolic defects.

Abnormalities are inherited from parents through abnormal or defective gene(s). Abnormality of development is also related to the presence of defective gene on sex chromosomes e.g. in haemophilia only males suffer from this disease. It again, depends whether the gene is dominant or recessive, homozygous or heterozygous.

Chromosomal abnormalities result when one of the sex chromosomes (x or y) is missing or extra and these abnormalities lead to syndromes. Kline-felter's Syndrome (xxy) is an example of trisomy of the sex chromosome while Turner's Syndrome (xo) is the condition in which one of the sex chromosomes is missing. Another condition, xyy leads to tallness, aggressiveness, mental defect and antisocial behavior. These abnormalities arise during the formation of gametes, when these gametes unite to form zygote.

Environmental factors causing or contributing to abnormal development are grouped together as teratogens. Ionizing radiations (e.g. x. rays) are well known for their teratogenic action. Because, they often have their effect on the developing ovum or spermatozoan, causing damage or changes (mutations) in the genes. Nutritional deficiencies, absence of certain substances (e.g. vitamins and trace elements), toxins and drugs even ingested by mother, effect the differentiation of every tissue in the foetus. If such deficiency is high, a cell may cause death of foetus.

Metabolic defects lead to structural deviations from the normal. During organogenesis, when various body organs are formed, sometimes, one organ or its part is missing or it is repeated and it can result into abnormal organs or body parts and the individual born are malformed.

In microcephaly, the individuals are born with small skull. Individuals with cleft palate have their upper lip folded or the individual has harelip. In conditions of the fingers in hand or feet are more or less than five.

EXERCISE

Q1. Fill in the blanks.

- (i) The influence of notochordal cells on the ectodermal cells to become nervous system was called_____.
- (ii) _____is a condition in which individuals have small skull.
- (iii) Growth is accompanied by two factors.
(a) by increase in _____(b) increase in_____.
- (iv) _____are the regions where growth is initiated by the proliferation **of cells**.

Q.2 Write whether the statement is true or false and write the correct statement if false.

- i). Primary growth leads to increase in length, while secondary growth leads to increase in width.
- ii). The plants in which flowering is not at all effected by the day length are called day neutral plants.
- iii). The somatic mesoderm soon splits in the middle to form two layers
(a) Outer parietal layer (b) Inner visceral layer
- iv). In the clear cytoplasmic area, cytoplasm contains information essential for development.
- v) The phase of cell movement and rearrangement is called cleavage.

Q.4 Short questions.

- (i) What is organizer and inducer substance?
- (ii) What is differentiation?
- (iii) Define embryonic induction.
- (iv) Differentiate between growth and development.
- (v) What is meristem?

Q.5 Extensive questions.

- (i) What is aging. How will you explain this process.
- (ii) What is regeneration? Why it is so effective in some animals and missing in others?
- (iii) Describe in detail the developmental processes of chick.
- (iv) What is growth, discuss different phases and condition for growth?
- (v) What is development, describe the principles of development in detail?