Amoeba proteus

Amoeba : Introduction (YOUTUBE)

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Amoeba is the most popular, free-living available protozoan. It's regarded as the lowest form of animal, as its body consists of a mere speck of protoplasm. The body resembles a tiny blob of jelly, and yet it contains a l l the equipment required by the organism to perform all the vital functions of life, such as movement, nutrition, respiration, excretion, reproduction, etc. It serves as an interesting and suitable material for laboratory studies by the students because it is a large protozoan, very slow in locomotion and easy to obtain. *Amoeba* belongs to the superclass Sarcodina. There are several species of Amoeba, but most commonly studied, it the large freshwater species Amoeba proteus. This also a useful experimental animal.

The name *Amoeba proteus* has been derived from two Greek words -Amoeba from amoeba which means change, and proteus after the name of the mythical Greek sea- god Proteus, who could change into any shape. Thus, the interesting feature associated with this animal is that it has no shape, or rather, its shape is constantly changing. Amoeba was first described by Rosenhof in 1755. H.I. Hirschfield (1962) has given a comprehensive account of the biology of *Amoeba*.

Systematic Position

Amoeba: systematic position

Phylum	Protozoa
Subphylum	Sarcomastigophora
Superclass	Sarcodina
Class	Rhizopodea
Genus	*Amoeba*
Species	*Proteus*

Habits and Habitat

Amoeba: habits and habitats (YOUTUBE)

Amoeba proteus is widely distributed. It is commonly found on the bottom mud or on underside of aquatic vegetation in freshwater ponds, ditches, lakes, springs, Pools and slow-running streams. It is rarely found in, free water as it requires a substratum to glide on from place to place. It occurs in abundance in those waters which contain bacteria and organic substances such as aquatic vegetation, leaves and twigs. Sides of lotus ponds and water troughs are good places for their

collection. It moves and feeds with the help of false feet or *pseudopodia*, formed as a result of, streaming flow of cytoplasm. *Amoeba* has great power of *regeneration*. If an individual is cut into pieces, accidently or in a laboratory, every piece containing a part of nucleus grows into a complete amoeba.

Culture of Amoeba

Amoeba may be obtained for class study by scraping decaying vegetation from bottom of a pond. When the scraping is allowed to settle in a wide-mouthed container, amoebae of different kinds may be found in the sediment and sorted with the help of a fine pipette under a binocular microscope.

A temporary culture of amoeba can be prepared in laboratory by hay-infusion method. Decaying aquatic weeds or other organic substances such as hay, dry leaves, twigs seeds, etc., are taken and boiled with sufficient amount of fresh water. To prepare culture medium, tap water should not be used because it is usually chlorinated. After boiling for about IS minutes, water is filtered and the filtrate is allowed to cool. To this filtrate al few amoeba-rich' waler drops are added and the amoebae, are allowed to multiple for 2 or 3 days. A culture can also be maintained in laboratory by keeping amoebae in small covered petri dishes. containing a few boiled wheat grains. The latter serve as food' for bacterial growth on which other micro-organisms feed and which in turn serve as food for, amoebae., Not culture should be started from time to time by, pute together fresh wheat grains and a few amoebae from cultures.

Structure

Amoeba: structure (YOUTUBE)

1. Shape and size. Amoeba is a unicellular, microscopic animalcule and measures about 250 to 600μ (microns) in maximum diameter. To the naked eye, the larger Amoeba proteus is just visible as a whitish blob. Under the microscope in appears as an irregular, colorless and translucent mass of protoplasm, continually changing its shape by sending out and withdrawing finger-like processes, called *pseudopodia*. When it withdraws all its pseudopodia, it becomes spherical in shape.

Far from being shapeless, *Amoeba* is considered to have a definite polarity, *i.e.*, it has definite anterior and posterior ends. At the anterior end, the animal puts out pseudopodia, while the posterior end is marked by a wrinkled region, called *uroid*.

2. Pseudopodia. *Pseudopodia* or false feet (Gr.,' pseudo, false + podium, foot) are irregular blunt processes of the cell body. These are of variable size and are capable of protruded or retracted, often with considerable speed. These are formed as a result of liquefaction and flowing forward of the cytoplasm. As many pseudopodia are formed simultaneously A. *proteus* is a 'polypoidal' species. Its pseudopodia are large and broad with rounded tips. Such pseudopodia are called *lobopodia*. They move by 'pressure flow' mechanism and assist the animal in locomotion and food ingestion.

3. Plasmalemma. *Amoeba* possesses no pellicle or cell wall. The body is covered by a very thin, delicate plasma membrane or unit membrane, called *plasmalemma*. This membrane is selectively permeable, *i.e.*, water and some small solute molecules can pass freely through it and in both directions, but certain large molecules cannot pass. An unusual feature associated with plasmalemma is the presence of numerous fine,' ridge-like extensions on its outer. surface. Zoologists believe that these have adhesive properties and serve to bind the animalcule tot the substratum.

4.Cytoplasm. Inside the plasmalemma, there is a dense mas of cytoplasm containing several organelles. It is differentiated into two fairly distinct zones, an outer *ectoplasm* and an inner *endoplasm.*

(a). Ectoplasm. lying immediately beneath the plasmalemma, ectoplasm, teen clear and transparent. it is somewhat rigid, contractile and under tension. it is most clearly visible at the tip of the pseudopodium where it from Highline cap.

(b). Endoplasm. completely surrounded by ectoplasm the endoplasm forms the bulk of the animal. It is fluid-like granule and semi-transparent. As the ectoplasm is under tension, the endoplasm must also be under pressure of the ectoplasm.

According to mast, endoplasm occurs in to colonial states, the peripheral viscid original state is Tom, plasma jel under central flowing or sold state is termed plasmasol. The two colloidal states of endoplasm are inter-changeable. However, the electron microscope has not revealed the occurrence of two colloidal phases in endoplasm. It is believed that it is the ectoplasm which is in gel state, while the endoplasm is in sol state, According to De Bruyn, protoplasm can " be thought of as a "three-dimensional network" of protein chains, linked together by cross-linkages of side chains. Gel state is due to protein chains fully expanded and sol state is the result of contraction of such chains.

5. ENDOPLASMIC ORGANELLES: A number of organelles, visible under light microscope, are found within the endoplasm. These organelles comprise the nucleus, contractile vacuole, food vacuoles and water globules, etc.

(a). Nucleus: In A. *proteus*, nucleus is a single large flattened, discoidal and slightly biconcave disk like a human erythrocyte. It may be lying anywhere in the endoplasm. It may be difficult to "see the nucleus in a living animal, but it can be easily seen with the phase contrast microscope or after fixing and staining the amoeba in a drop of *methyl green acetic acid*. The nucleus is granular and refractive to light. It is bounded by a thin *nuclear membrane* which is double and intercepted by pores. A honeycomb-like lattice is found below the inner nuclear membrane. It probably. plays some part in maintaining the flattened form of the nucleus. The *nucleoplasm* is a clear, achromatic substance with scattered refringent *chromatin granules*. A few nucleoli are seen, in the nucleus of fixed and stained specimen, but they do not exist in the living animal.

(b). Contractile vacuole: The endoplasm, its posterior end container, single clear, rounded and pulsating contractile vacuole, filled with a watery fluid and enclosed by a unit membrane. surrounding this membrane is a region containing many tiny, feeder vehicles and mitochondria. It helps in the Osmoregulatory and excretory activities of the animal.

(c). Food vacuole: A number of spherical spaces, small and large containing water and food in various phase of digestion occur in the endoplasm. these are the food vacuole. these are formed when amoeba engulf for food with a drop of water. digestion take place inside this food. Wickets did disappear with the egestion of non-digestible food from the body.

(d) water globules: These are several small and spherical vacuoles is filled with a colorless fluid.

(e) Other organelles: In addition to these organelles, the endoplasm shows, in electron microscope, various inclusions characteristic of an animal cell. The *endoplasmic reticulum*, besides forming a network of tubules, occurs as vesicles. The *ribosomes* occur on some of the endoplasmic vesicles as well as scattered in the endoplasm. The *Golgi bodies* are present as several of sac-like tubes. The groups *mitochondria* are more or less oval and have *tubular cristae*. Plate-like or bipyramidal crystals and stored food abound in the endoplasm. The *lysosomes* are membrane-bound spherical bodies, scattered in the endoplasm. Thin filamentous microtubules abound in the endoplasm.

LOCOMOTION

Amoeba: locomotion (YOUTUBE)

Amoeba shows characteristic amoeboid movement by the formation of finger-like temporary processes, the pseudopodia. These are broad and with rounded tips and are called lobopodia.
These are formed as a result of flowing forward of cytoplasm. When moving, *Amoeba* may put out several pseudopodia but eventually progresses through just one broad anterior pseudopodium. Amoeba moves with an average speed of 1μ or one micron per second. Amoeboid movement is considered to be the most primitive kind of animal movement.

Theories of amoeboid movement

How the cytoplasmic flow is affected and the pseudopodia are formed is not clearly known.
Since the first observation of amoeboid movement by *Rosel von Rosenhof* in 1755, several theories, or hypotheses, have been proposed to explain the mechanism of *amoeboid movement*, but the evidence supporting them is unfortunately insufficient. A brief description d these theories is as under.

1.Contraction-hydraulictheory. Schultze (1875) was of the view that plasmagel (ectoplasm) undergoes contraction at the posterior end and causes protoplasmic currents to Now forwards, pushing the more fluid-like plasmasol (endoplasm) forward. This results in the formation of pseudopodium and propelling the body ahead.

2. Surface-tension theory. Berthold (1886) explained that the amoeboid movement is due to a difference in surface tension between the physical characteristics of body surface and substratum. According to this view, amoeboid movement is comparable with the movement of a fluid globule, like a mercury droplet. A pseudopodium is formed by an out flow of protoplasm (so-called fountain streaming) from a weak point where surface tension becomes reduced by external or internal factors. This theory had been supported by Rumbler and Butschli (1898), but it is not supported now-a-days. The theory assumes a liquid nature of body surface, but in majority of amoeboid forms outer body surface remains rigid and gelatinized.

3. Rolling movement theory. Jennings (1904), with his investigations on *Amoeba verrucosa*, explained that amoeboid movement takes place due to rolling movement of body surface comparable to rolling movement of a fluid-filled sac on a substratum. He observed in A. *verrucosa* that a carbon particle on amoeba's upper surface first passes forward and then turning downwards along the anterior tip, remains on the lower surface for a time as the body rolls forward, and then passes upward at the posterior end to repeat the cycle.

Jenning's finding may be correct for A. *verrucosa* which is devoid of pseudopodia, but it cannot be applied to A. proteus which moves with pseudopodia.

4.Walking movement theory. Amoeba: locomotion - walking movement theory (YOUTUBE)
Dellinger (1906) studied locomotion in A. *proteus* and came to the conclusion that a contractile substance present in the cytoplasm is mainly responsible for the amoeboid movement. According to this theory, the extended pseudopodia become attached to the substratum and then contract to pull the body forward. Seen in a profile, amoeba appears to walk on its leg-like pseudopodia.

5. Sol-gel theory. Amoeba: locomotion - sol-gel theory (YOUTUBE) This theory, first put forward by Hyman (1917) and later supported by Pantin (1923-26) and Mast (1925), is the most widely acceptable view, now-a-days. It attributes amoeboid motion to a change in the consistency of cytoplasm. Based on spontaneous sol-gel phenomenon of protoplasm, it offers the best explanation for amoeboid locomotion.

According to this theory, cytoplasm of amoeba is differentiated into a clear outer ectoplasm and a granular inner endoplasm. The latter is further distinguished into an outer stiffer and jelly-like region, the plasmagel, and an inner fluid region, the plasmasol (Mast, 1925).

According to the sol-gel or change of viscosity theory, amoeboid movement involves four processes occurring simultaneously: (i) The outermost thin, clastic in cell membrane or plasmalemma becomes substratum. (ii) There is a local partial liquefaction of the plasmagel at the anterior end. This causes the central plasmasol, under tension, to Now forward and force the plasmagel against this weakened area to produce a bulge, the beginning, of the pseudopodium. As plasmasol enters the newly formed pseudopodium, it rapidly changes into plasmagel around the periphery, thus forming a gelatinized tube within which the plasmagel continues to flow forward. (iii) Posteriorly, inner, surface of contractile plasmagel undergoes solation, so that a constant flow of plasmasol is maintained from behind forwards, in the direction of movement. (iv) The outer tube of elastic plasmagel, contracts and moves from in. front backwards, while the main bulk of, body, travels, forwards. The plasmagel thus exerts a squeezing motion; from the sides and rear of amoeba, forcing the plasmasol ahead. At the tip of pseudopodium, the endoplasm is changed to ectoplasm.

6. Folding and unfolding theory:

Amoeba: locomotion - folding and unfolding theory (YOUTUBE)

As already noted, protoplasm can be thought of as a three-dimensional network of protein chains linked together by cross linkages of side chains. According to Goldacre and Lorch (1950) and Goldacre (1952), the folding and unfolding of protein chains causes contraction and relaxation of protein molecules. They suggested that sol state of protoplasm is due to the folding protein molecules and gel state is due to the unfolding. When amoeba progresses, the cortical plasmagel at the posterior end contracts (folding). It is then liquefied to form plasmas which is forced through the central endoplasm to flow forward. At the anterior, end, the plasma is converted back into plasmagel (unfolding) which forms the advancing pseudopodium. For the folding [and unfolding processes, considerable amount of, energy is invested which comes from ATP (adenosine triphosphate).

7. Front or fountain-zone contraction, theory:

Allen (1961) suggests that, on the molecular level, amoeboid movement is a type of slow contraction, similar in many ways to muscle contraction. The endoplasm is believed 1 contain long protein chains, which undergo contraction at the anterior end of the body so that the amoeba is pulled forward. It visualizes the axial stream of endoplasm diverted in regular streamlines, thus creating a fountain zone; the endoplasm is constantly converted to ectoplasm anteriorly and ectoplasm to, endoplasm posteriorly.

8. Reversible gel-sol, transformation theory:
Advocated by Yagi (1961) and Marshland. (1964), this theory is the most accepted, explanation d amoeboid movement. This theory suggests the solation at the anterior end occurs into which endoplasm flows under pressure generated. contraction of the cortical, plasmagel at do posterior end. This results in propulsion amoeba.

NUTRITION

1.food and selection of food.
Amoeba is carnivorous and its mode of nutrition is holozoic, i.e., it feeds by phagocytosis, a mechanism in which food is engulfed in a solid form. The food consists of bacteria, diatoms, desmids, flagellates, ciliates and rotifers. Amoeba is able to select its food even in the absence of special sense organs.
It displays its preference for certain kinds of organisms whom it approaches, and avoids others. It is also able to distinguish organic food particles from inorganic sand particles.

2. Ingestion. Amoeba: ingestion (YOUTUBE)
Amoeba captures and engulfs its prey by means of pseudopodia. Pseudopodia are formed at the points, where the food comes in contact with the surface of the body.
According to Rhumbler (1930), Amoeba can ingest food in four possible ways, depending on the nature of food. 1) ft. Import. This method involves, the taking in of, food, such as an algal filament, on contact. The food passively sinks into the body by rupturing the plasmalemma" and ectoplasm at the point of contact/ 'The ruptured site soon heals up.
2. Circumfluence
When amoeba comes in contact with it less active or motionless organism, like bacteria, it extends its pseudopodia around the organism and envelops it completely into food vacuole within cytoplasm. The enveloping pseudopodia always maintain intimate u contact with the surface of prey.

3.Circumvallation.
By this method, amoeba engulfs an active prey like a flagellate or ciliate. Amoeba sends out pseudopodia around the prey forming a cup-like structure called food cup. The pseudopodia are not in intimate contact, with the prey during engulfment. The opening of food, cup constricts, leaving a pore which soon closes. In this way, a non-contractile food vacuole is formed with the prey in a considerable amount of water.

4.Invagination.

In this method the food is adhered by the toxic and sticky secretion of the ectoplasm. The food organism is sucked in, upon contact with the ectoplasm, by the formation of an ectoplasmic tube. This tube, upon engulfment, takes the form of a food vacuole.

5.Pinocytosis.

Pinocytosis is the 'cell drinking' phenomenon also, round to occur, in A, proteus. It assists in the ingestion of liquid food. It has been experimentally demonstrated that pinocytosis is induced by proteins, inorganic ions and certain dyes. When an amoeba, which has been starved for two days, is placed in one per cent sodium acetate solution; it becomes star-shaped with pseudopodia-like projections. Many of these projections show to contain pinocytosis channels running from the surface deep into the body it is thought that plasmalemma bound with colloidal material flows into the pinocytosis channels. From the inner ends of these channels, pinocytosis reticles of pinosomes, containing engulfed liquid material, become separated off. It has not yet been confirmed whether this phenomenon is one of the mean of ingestion of food in amoeba under normal conditions.

2. DIGESTION

The food vacuole order gastric vacuum formed by the extension and joining of the pseudopodia. That capture the prey is comparable to the gut of higher animals. Its membrane wall resembles in all respects the plasmalemma. Several such vacuoles, small and large, may be seen in an actively feeding Amoeba.

Lysosomes, containing digestive enzymes, fuse with the food vacuole and digestion of contained food organism slowly proceeds. It has been demonstrated that the reaction in the food vacuole is at first acidic and later on becomes alkaline. In acidic medium, the organism is killed and in alkaline medium, digestion of starch, proteins and fats takes place by the enzyme’s amylase, protease and lipase, respectively.

3. Absorption and assimilation.

As digestion goes on, the food vacuoles gradually shrink in size. The food vacuoles keep on moving in the endoplasm due to its streaming movement, called cyclosis. The digested food diffuses out into the endoplasm. Completion of digestion requires about 30 hours. The digested food is assimilated. to form new protoplasm.

4. Egestion.

Egestion of undigested residue takes place at any point on the surface of body. In Amoeba, there is no definite exit for this purpose. In the actively moving amoeba the much-reduced food vacuoles, containing undigestible residue, are shifted backwards and discharged at the posterior end, as the animal moves on.

RESPIRATION

Interchange of oxygen coming inwards and carbon dioxide going outwards forms the process of respiration. Amoeba has no special respiratory organs and no respiratory pigments but there is a free exchange of gases by diffusion through the general. body surface (plasmalemma) which permeable to the gases dissolved in water, Oxygen constantly diffuses into the cytoplasm for its concentration in water is always higher than in the cytoplasm. The oxygen brings about enzymatically assisted oxidation of carbohydrates, fats and even proteins and breaks them into simpler compounds. The energy liberated in the oxidation reactions is stored in the high energy bonds of adenosine-triphosphate or ATP, like that of any other cell. The oxidation of carbohydrates and fats results in the formation of metabolic wastes (carbon dioxide and water).
CO_2 diffuses out in the surrounding water as well as in the water discharged by the contractile vacuole.

EXCRETION

In the body, metabolism of fats and carbohydrates produces CO_2, whereas metabolism of proteins produces ammonia. Removal of nitrogenous wastes from body is called excretion. Amoeba is an ammoniotelic anima because it excretes nitrogenous wastes in the form of ammonia. As no special organelles are present for excretion, ammonia is excreted by diffusion from the general body surface in in surrounding water. Some amount of ammonia is dissolved in water which is discharge through the contractile vacuoles.

OSMOREGULATION

The protoplasm of A. proteus is of higher concentration than the freshwater of its environment. This causes the entrance of water into the body of amoeba by endosmosis through the semi-permeable plasmalemma. Not only does water enter in by endosmosis but also some water is formed within the cytoplasm as a result of metabolic activity and some gets in along with ingested food organisms. This necessitates to get rid of excess water to prevent swelling and rupture of amoeba's body. The mechanism which effects the water regulation is called osmo-regulation. It takes place through the contractile vacuole. The main function of contractile vacuole is osmoregulation, although CO_2 and nitrogenous waste substances are also excreted through it.

The exact nature regarding the working of contractile vacuole is not known. Amocha is hypertonic to the surrounding water, so that water is actively secreted into contractile vacuoles by endosmosis through vacuolar membrane. Tiny membrane-bound water-filled feeder vacuoles also get incorporated into contractile vacuole filling it with water. As water continues to fill the vacuole, it increases in size. When the vacuole becomes fully expanded, it comes to lie in the zone of related ectoplasm, where the ectoplasmic pressure results in its contraction and bursting.

This contractile vacuole disappears and a new one begins to form in the endoplasm. Due to force of contraction, the contents of contractile vacuole, that is H2O, CO2, ammonia, etc. are discharged to outside.

BEHEVIOUR

Amoeba: behavior

Behavior involves the manner in which an animal responds to the environmental conditions.
The responses to stimuli are called *taxes* (*singular, taxis*). A taxis may be either *positive*, in which the organism moves towards the stimulus, or *negative*, in which the organism moves away from the stimulus. *Amoeba proteus* shows both types of taxes, positive as well as negative, specifically to different stimuli. There are two views as to the effectiveness of the responses. According to one view, the response of *Amoeba* to a given stimulus is automatic or directed (*topotaxis*), that is, amoeba either moves towards the stimulus or avoids it, depending upon the nature of the stimulus. Another view holds that response to a stimulus is undirected (*phobotaxis*), that is, amoeba always avoids a stimulus and moves here and there to get a favorable environment.

Taxes are named according to the nature of stimulus. With respect to the kinds of stimuli, taxes are classified as follows:

1. Thermotaxis (response to heat). Amoeba responds negatively to both low and high temperatures. Optimum temperature lies between 20°C and 25°C. It ceases all activities at temperatures above 35°C

2. Phototaxis (response to light). Amoeba avoids both direct sunlight and total darkness. It responds positively to normal or weaklight.

3. Thigmotaxis (response to contact). A floating amoeba responds positively to those objects upon which it glides or rests. It will back away from contact with a foreign object or a probe while crawling or resting.

4. Chemotaxis (response to chemical substances).
Amoeba is negatively chemotactic to strong solutions of alkalies, salts and sugars. It also avoids sand particles or some other obstacles in the way. It responds positively to the food organisms.

5. Rheotaxis (response to current of air or water). Amoeba prefers to be drifted along the flowing water.

6. Galvanotaxis (response to constant electric current). When an electric current is passed through water, containing *Amoeba*, it stops moving. withdraws pseudopodia and becomes globular. In a weak electric current, it moves towards negative pole (cathode) and avoids positive pole (anode).

7. Geotaxis (response to gravity). The response of Amoeba to gravity is mostly positive as it drops to the bottom of container filled with water.

Amoeba does not have a nervous system and sense organs for the condition and perception of stimuli. The sensitivity is solely the function of the protoplasm.

REPRODUCTION

Amoeba proteus does not reproduce *sexually* by mating, that is, by the fusion of sex cells of gametes. Reproduction is essentially *asexual* and takes place by various methods such as binary fission multiple fission and sporulation.

1. Binary fission.

Amoeba: reproduction - binary fission (YOUTUBE)

It is the most common mode of reproduction. It results in the division of parent amoeba into two daughter amoeba. Division involves the nuclear division followed by cytoplasmic division. The animal divides by mitosis and involves the stages prophase, metaphase, anaphase and telophase.

(a) Prophase. In the prophase stage, amoeba withdraws its pseudopodia and becomes somewhat rounded, Cytoplasm loses its transparency to a large degree and contractile vacuole disappears. The honeycomb-like lattice underneath nuclear membrane first fragments and then disappears. The nucleoli disintegrate. A very large number (500 to 600) of very small chromosomes emerge in the central nucleoplasm.

(b) Metaphase. The metaphase stage is marked by the arrangement of chromosomes at the equator. Each chromosome splits longitudinally and becomes paired. Daughter chromosomes, on each side, become attached to the spindle fibers arising from multiple poles, situated within the nuclear membrane.

(c) Anaphase. In the anaphase stage, daughter chromosomes move towards opposite poles and constriction of nuclear membrane begins in the middle. Nuclear spindle, which was multipolar at metaphase, becomes unipolar at the end of anaphase.

(d) Telophase. During telophase stage, the constriction of nuclear membrane is completed and the nucleus is finally divided into two daughter nuclei. In each daughter nucleus the lattice is formed underneath the nuclear membrane and the nucleoli reappear.

(e) Cytokinesis. Next follows cytokinesis. Amoeba stretches and constricts in the middle. Large pseudopodia are formed at opposite poles, drawing both the daughter amoebae in opposite directions. It ultimately divides parent amoeba into two daughter amoebae which grow, and in their turn, repeat the same cycle of binary fission.

In *Amoeba*, reproducing by binary fission, the parent becomes wholly merged in the offspring. Thus, there exists a continuity of life, so that Amoeba is potentially immortal. However, death may come by starvation, accident or some other misfortune.

2. Multiple fission and encystment. According to some earlier workers, such as Scheel (1899) and Carter (1915), *Amoeba* forms a cyst and reproduces by *multiple fission*, during adverse environmental conditions. The animal secretes a three-layered, protective, chitinous cyst around it and becomes inactive. Inside the cyst, the nucleus repeatedly divides to form several daughter nuclei, which arrange themselves near the periphery. Each daughter nucleus becomes enveloped by a small amount of cytoplasm, thus forming a daughter amoeba, called amoeba or *pseudopodiospores*. When favorable conditions arrive, the cyst breaks off liberating the young pseudopodiospores, each with fine pseudopodia. They feed and grow rapidly to become adults and lead an independent life.

Multiple fission, preceded by encystment is no longer believed to occur in *Amoeba* by modern workers, some of them maintained A. *proteus* for 28 years without ever forming a cyst.

3. Sporulation. According to Taylor, during unfavorable conditions, A. *proteus* multiplies by sporulation without encystment. Nucleus breaks into several small fragments or *chromatin blocks*. Each block develops a nuclear membrane, becomes surrounded by a little cytoplasm and develops a *spore-case* around it. With the disintegration of parent body, about 200 such spores are liberated, each hatching into a small *amoeba* under favorable conditions. However, evidence has been lacking in support of sporulation in *Amoeba*.

4. Conjugation. Some observers have described a temporary fusion between two amoebae. After some time, they become separated again. It is said that this temporary union enables the two amoebae to lead a more active and vigorous life. This phenomenon is termed rejuvenation. However, it has not been confirmed by other workers.

Biological Significance of Amoeba

(1) Amoeba depicts organization of a protoplasmic mass o a single cell into a complete organism.
(2) Binary fission of Amoeba gives a clear-cut understands of the mitotic division of a cell.
(3) The taxes or responses of Amoeba represent the eat beginning of sensitivity in animals.
(4) Different organelles of amoeba give the first indicate of division of labour concerning vital activities.
(5) The great number of chromosomes (500 to 600) prese in the nucleus of Amoeba suggests the occurrence of isolated genes, which in higher animals are located chromosomes.

(6) Amoeba gives a faint idea regarding the anatomical structures of higher animals. For example, the food c is comparable to the buccal cavity. food vacuole 10 go. pseudopodia to legs, contractile vacuole to using bladder or kidney, and so on.

Question

» Long Answer Type Questions

1. Describe the habit, structure, physiology and behaviour of Amoeba.
2. Give an account of the structure of Amoeba proteus as seen under the electron microscope. How would you distinguish Amoeba for a typical animal cell?
3. Write detailed notes on:(i) Locomotion in Amoeba, (ii) Modes of reproduction in Amoeba, (iii) Nucleus of Amoeba, (iv) Osmoregulation in Amoeba,
4. Justify the statement that "binary fission in Amoeba is essentially an act of mitosis.?
5. Discuss the biological significance of Amoeba.
6. Write short notes on:(i) Amoeboid movement, (ii) Circumvallation, (iii) Contractile vacuole, (iv) Holozoic nutrition, (v) Lobopodia, (vi) Pinocytosis, (vii) Plasmalemma, (viii) Phototaxis.

» Short Answer type Questions

1.What is the mode of nutrition in Amoeba?
2. What is the function of contractile vacuole in Amoeba?
S. What are the pseudopodiospores in Amoeba and why they are essential in reproduction?
4. Explain the formation of pseudopodia basing on the sol-gel theory.
5. How Amoeba feeds on flagellates and ciliates?

6. Describe sporulation in Amoeba.
7. Who was describe Amoeba firs?
8. How are the culture of Amoeba in laboratory?
9. What is a hyaline cap?
10. Who was observed first to amoeboid movement?

»Multiple Choice Questions

1. The fresh water Amoeba and intestinal Amoeba are alike in:
   (a) the possession of single contractile vacuole (b) the absence of cilia
   (c) the structure of the cyst (d) their mechanism of dispersal

2. Amoeba is capable of regeneration. This is possible only from:
   (a) a nucleated bit of Amoeba (b) an anucleate bit of Amoeba
   (c) a young Amoeba (d) an old Amoeba

3. Name a digenic parasite from protozoa:
   (a) Entamoeba histolytica (b) Polystomella
   (c) Plasmodium (d) Copromonas

4. Amoeba was discovered by
   (a) Ross (b) Rosenholf
   (c) Lamble (d) Losch

5. During extreme heat a fresh water Amoeba living in a pond:
   (a) will form a gamete
   (b) will form a cyst
   (c) change to parasitic phase
   (d) will eliminate large parts of DNA
   (e) elimination of excessive food

6. The food capturing organelle of Amoeba is
   (a) food vacuole (b) contractile vacuole
   (c) pseudopodia (d) nucleus

7. Which is the most widely accepted theory of locomotion in Amoeba?
   (a) Walking movement theory
   (b) Rolling movement theory
   (c) Sol-gel theory
   (d) Surface tension theory

8. Which type of pseudopodium is found in Amoeba?

(a) Rhizopodium
(b) Actinopodium
(c) Reticulopodium
(d) Axopodium

9. Surface tension theory explains the theory of:

(a) amoeboid movement
(b) caterpillar movement of Hydra
(c) ciliary beat
(d) jerking movement of Euglena
(e) tension development on the surface during the movement of Paramecium in water

10. Many genera of foraminifera are dimorphic. What is meant by dimorphism:

(a) existence of an animal in many forms
(b) presence of two types of pseudopodia in foraminifera
(c) existence of an animal in two forms which differ in characters
(d) presence of different types of organelles in the same animal
(e) alternation of generation is known as dimorphism

11. Sol-gel theory was first given by:

(a) Pantin
(b) Hyman
(c) Mast
(d) Mast & Pantin

12. Pseudopodia are formed in an Amoeba

(a) when it comes in contact with a food particle
(b) by the movement of the surrounding water
(c) by exchange of salts with the medium
(d) by sol-gel transformation of the cytoplasm

13. Amoeba is placed in phylum Protozoa, because of

(a) presence of cell wall
(b) phagocytic mode of nutrition
(c) acellular body
(d) presence of contractile vacuole

14. Egestion of undigested food in Amoeba takes place through

(a) circumvallation
(b) a temporary rupture of its surface membrane
(c) the hyaline cap formed at its advancing end
(d) pinocytosis

15. Amoeba reacts

(a) negatively to both weak and strong light
(b) positively to strong light and negatively to weak light
(c) positively to both weak and strong light
(d) negatively to strong light and positively to weak light

16.’Amoeba is immortal', it can be explained by Germplasm theory of:
(a) Heitzman
(b) Schultz
(c) Berthold
(d) Weisman

17. Amoeba belongs to class Sarcodina, which is characterized by
(a) acellular body
(b) pseudopodia for locomotion
(c) uninucleate body
(d) presence of contractile vacuole

18. Normally Amoeba is not found
(a) crawling
(b) feeding
(c) secreting a cyst
(d) responding to stimuli

19. Body of Amoeba has permanent.
(a) shape
(b) organelle for locomotion
(c) anterior end
(d) food vacuole

20. A contractile vacuole is developed when
(a) fresh water Amoeba is placed in sea water bod
(b) fresh water Amoeba is placed in salt free water it all
(c) marine Amoeba is transferred in hypotonic medium
(d) sea water enters in body of marine Amoeba

21. Amoeba shows positive response for:
(a) dim and intense light
(b) solid objects
(c) cathode
(d) chemicals

22. Minimum number of daughter amoebae are produced, when surrounding water has
(a) no food
(b) less food
(c) plenty of food
(d) high temperature

23. Simplest mode of locomotion is:
(a) swimming
(b) creeping
(c) floating
(d) walking

24 Plasmalemma of Amoeba is

(a) impermeable
(b) least regenerative
(c) site for excretion
(d) not for respiration

25. If an Amoeba is kept in distilled water its contractile vacuole will
(a) disappear
(b) become swollen and full of water
(c) work faster
(d) have no effect

26. Regarding locomotion in Amoeba Hymen (1917) postulated
(a) theory of rolling movement
(b)surface tension theory
(c) walking movement theory
(d) sol-gel theory

27. If an Amoeba is put in medium A from water its contractile vacuole disappeared but when it is transformed to medium B contractile vacuole reppeared. What is the difference between medium A and B
(a) medium A is hypotonic
(b) medium B is hypertonic
(c) medium A is hypertonic
(d) medium A is isotonic

28. Nitrogenous wastes in Amoeba, are excreted through
(a) plasmalemma
(b) food vacuoles
(c) contractile vacuole
(d) none of these

29. When the prey is very active, Amoeba ingests it by
(a) circumfluence
(b) circumvallation
(c) invagination
(d) none of these

30. When Amoeba is subjected to weak and steady electric current
(a) it dies
(b) it remains at anode
(c) it moves towards the cathode
(d) it remains in the middle

31. Sol-gel Theory was proposed by
(a) Mast
(b) Hymen
(c) Pantin
(d) Mast & Pantin

32. Mode of nutrition in Amoeba is:
(a) holozoic
(b) mixotrophic
(c) saprophytic
(d) holophytic

33. Medium inside food vacuole of Amoeba is

(a) acidic
(b) alkaline
(c) I acidic then alkaline
(d) I alkaline then acidic

34. Amoeba respires through its:

(a) plasmalemma
(b) general body surface
(c) cytoplasm
(d) pellicle

35. Excretion in Amoeba occurs by:

(a) contractile vacuole
(b) food vacuole
(c) plasmalemma
(d) all of these

36. In Amoeba binary fission occurs when:

(a) food is abundant
(b) temperature is suitable
(c) both
(d) pond water dries up

37. Regarding locomotion in Amoeba Pantin supported:

(a) theory of rolling movement
(b) surface tension theory
(c) walking movement theory
(d) sol-gel theory

38. An Amoeba living in fresh water respires by means of

(a) nucleus
(b) food vacuole
(c) plasmalemma
(d) pseudopodia

39. A full grown Amoeba undergoes binary fission. The total surface area of one daughter amoeba soon after division is likely to be:

(a) slightly less than that of parent Amoeba
(b) equal to the half of that of the parent Amoeba
(c) slightly more than half of that of the parent Amoeba
(d) less than half of that of the parent Amoeba

40. What is common between an Amoeba and a leucocyte?

(a) contractile vacuole
(b) sporulation
(c) encystment
(d) pseudopodia

41. Locomotory organelles in Amoeba are

(a) lobopodia
(b) cilia
(c) flagella
(d) myonemes

42. Amoeba was discovered by

(a) Lancisi
(b) Leeuwenhoek
(c) Rosenhoff
(d) Ross

43. During digestion in Amoeba the medium is first:

(a) acidic
(b) highly alkaline
(c) neutral
(d) slightly alkaline

44. The function of the contractile vacuole in Amoeba is

(a) excretion
(b) osmoregulation
(c) none
(d) both

45. A 'lobopodia' is derived of:

(a) undulating membrane
(b) pseudopodia
(c) flagella
(d) cilia

46. Gel-sol transformation theory put founded by

(a) Yogi and Marsland
(b) Allen
(c) Hymen
(d) Jenning

47. Amoeba is

(a) ammoniotelic
(b) ureotelic.
(c) uricotelic
(d) all

48. Amoeba shows

(a) phototaxis
(b) chemotaxis
(c) thermotaxis
(d) all

49. Destruction of nucleus in Amoeba result in:

(a) no change
(b) Quick locomotion
(c) slowing down of metabolic
(d) immediate death

50. Nuclear DNA of Amoeba is:

(a) a double helix
(b) single stranded
(c) circular
(d) like a clover leaf

51. Pseudopodia Amoeba is composed of…

(a) ectoplasm
(b) endoplasm
(c) both
(d) none

ANSWER

1. (b) 2. (a) 3. (c) 4. (b) 5. (b) 6. (c) 7. (c) 8. (a) 9. (a) 10(c) 11. (b) 12. (d) 13. (c) 14. (b) 15. (d)16. (d) 17. (b) 18. (d)19. (b) 20. (b) 21. (C) 22. (C) 23. (b) 24. (c) 25. (b) 26. (d) 27. (c) 28. (a) 29. (b) 30. (c) 31. (b) 32. (a) 33. (c) 34. (b) 35. (C)36. (c) 37. (d) 38. (C) 39. (b) 40. (d) 41. (a) 42. (c) 43. (a) 44. (d) 45. (b) 46. (a) 47. (a) 48. (d) 49. (c) 50. (a) 51. (c).