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characteristics of fungi

Small, generally microscopic,

Fungi are, eukaryotic, usually filamentous, branched, spore bearing organisms that lack chlorophyll. Fungi have cell walls that contain chitin and glucans (but no cellulose) as skeletal components. A group of fungal like organisms, the oomycota, usually refered to as oomycetes, untill about 1990 were considered to be true fungi.

Filaments of the fungi are called mycellia (sing. mycellium). These mycellia are composed of microscopic, tubular thread like hyphae (sing. hypha). The body of the fungus is called soma, comparable to vegetative as in plants. The entire body of the fungi is called thallus. Soma is general term may be used for single part of the fungi like, reproductive part, morphological organ etc.

The storage carbohydrate of fungi is ~~ethel~~ glycogen rather starch.

Fungi are heterotrophic and have absorptive -ve nutrition. Absorptive nutrition means that they do not ingest food, instead first break down large and relatively insoluble molecules such as carbohydrates, proteins, and lipids into smaller and more soluble molecules that they can be absorbed. Without water, fungi can't bring out normal metabolism. Fungi have the ability to utilize almost any carbon source as food.

Aside from the availability of a suitable food source, examples of other factors

that influence the growth of fungi are moisture, temperature, pH, and oxygen

Fungi have the ability to grow both under water and water deficient conditions. The most optimum temperature for fungi is 25-30°C with lower and upper limits of 10 and 40°C. However, certain thermophillic forms have optima above 40°C, even some may grow above 50°C. On other hand, there are some cold loving or psychrophillic which may grow below freezing temperature. most fungi seem to grow best at pH levels of 4-7.

Many fungi are of course, saprobes (Gr. sapros = rotten + bios = life) and obtain their food by attacking dead organic matter. Whereas considerable number of species live as parasites (Gr. parasitos = eating beside another) on plants, animal and in some cases even on fungi. Those fungi which live on living source only are called obligate parasites. These fungi can not be grown on artificial synthetic medic. Those fungi which have the ability to grow both on living and non-living may be called as facultative parasites and facultative saprobes.

As mentioned previously, fungi have the filaments, called mycellium. But, there are some fungi which do not produce filaments (mycellium) but exist in single cell and reproduce by budding or fission.

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these are commonly known as yeasts. Still, there are fungi which may exist both in mycellium and single cell form, these fungi are known as dimorphic.

Dimorphism is common in fungi causing diseases on animals and humans.

The hyphae of the mycellium have cross-walls, these are technically called as septum (septa-pl) However, there are hyphae which do not have cross-walls and are called as aseptate non-septate or coenocytic. In most complex fungi the septum wall near the central pore is swollen or inflated to form a barrel-shaped structure. This type of septum is called dolipore septum.

cell wall of the fungi performs different functions; it maintains the turgor pressure, confers shape to hyphae, act as filter against many compounds that are dangerous to fungi and also protect the fungi from the harsh environment. Further, the functions of cell wall are making associations with other fungi and other organisms. Also role in the reproduction of fungi.

Fungal walls and Hyphal tip growth

The fungal cell wall is the dynamic structure that subject to change and modification at different stages in the life cycle of a fungus. It is composed basically of a skeletal or micro-fibrillar component located to the inner side of the wall and usually embeded in an amorphous matrix material that extends to the outer surface of the wall. The skeletal component consists of highly crystalline, water insoluble materials that include B-linked glucans and chitin, while matrix consists of mainly polysaccharides that are mostly water soluble. Miscellaneous components that may be present in cell wall of fungi include lipids, melanins, D-galactosamine polymers, and polyuronids. cellulose is not present in the cell wall of true fungi.

Life is present in the apex of the fungal hyphae. This means that fungal germ tubes and hyphae grows from their tips. The basic question is that how the hyphae grows because it is rigid to

maintain the shape of Hyphe. There are two hypotheses which explain, how the hyphe grows from its tips.

① Steady-state Hypothesis :-

According to this hypothesis the hyphal tip is viscoelastic which means that it can expand. After expansion, the non-crystalline chitin and β-glucan subsequently cross-links and again form the rigid hyphae.

② Lysis synthesis Hypothesis :-

This suggests that the wall is inherently rigid, but during hyphal growth lysis of the tip occurs and tip become expanded, after that, synthesis of that portion occurs that resulted in rigidity of the hyphae and in this way Hyphe grows. What so ever, the way is, but hyphal growth needs energy for their growth, this energy comes from enzymes which are present in membrane bound ~~organe~~ vesicles.

Transmission electronmicroscope (TEM) have shown that there are two types of vesicles at the apex of hyphae. These include microvesicles and macrovesicles. microvesicles are <100 nm in diameter while macrovesicles are > 100nm. These vesicles are tightly packed with other structures to form a unique and dynamic structure called Spitzenkörper. Presence of Spitzenkörper in the hyphal apex is guarantee of hyphal growth while its position determine the direction of the hyphal growth, filament-Spitzenkörper is the supply center for the vesicles involved in the hyphal growth. The role of microvesicles in hyphal tip growth is, it transfer chitin synthase enzyme through the ~~cytoplasm~~ plasma membrane at the apex where it catalyzes the formation of the microfibrils of the chitin-skeleton of the fungal wall.

Macrovesicles present in hyphal tips appear to be secretary vesicles that contain enzymes and perform polymers that are used to form amorphous matrix of the fungal cell wall. These secretary vesicles obtain these enzymes and wall polymers from the golgi cisternae which come to macrovesicles via endoplasmic reticulum.

On the surface of cell wall, small thin fibrils are present, these are similar to pili of bacteria. Germ tube, hyphae and even spores of some fungi are surrounded by an extracellular matrix. These extracellular matrix are composed of musciloginous materials, and mostly found in pathogenic fungi. These extracellular matrix protect the plant fungi from desiccation and toxic polyphenolics produced from the plants during infection. Further, these also help the fungi to adhere with plant to infect it. It has also been reported that these polysaccharides inhibit spore germination.

Hyphae are usually unnoticed because of their smaller size and usually present inside the tissues. But sometime, these hyphae clustered together and form hard resting bodies to protect themselves from harsh environment. The example of these structure is Stroma and Sclerotia. These structures can be seen with naked eye.

Stroma :- (pl. Stromata; Greek. Stroma = mattress) A stroma is a compact, somatic structure much like a miniature mattress or a cushion on which or in which fruiting bodies usually are formed

Sclerotia :- (Sing- sclerotium; Greek. skleros = hard)- These are also hard resting structures. e.g., Ergot of rye caused by clericeps purpurea in which rye seeds are replaced by sclerotia and these sclerotia have ergot shape which can be seen through naked eye.

Hyphae of fungi also form thick strands called mycelial cords or rhizomorphs (Gr. rhiza = root + morphe = shape). In all structures i.e. stroma, sclerotia and rhizomorph hyphae loose its individuality.

Pathogenic fungi fall into three categories.

Perthotrophs :- Also known as nectrotrophs, first produce toxins and enzymes to kill the host in advance of their hyphae and then grow between and into dead and dying cells.

Biotrophs :- Are ecologically obligate parasites and in vivo obtain their nutrients, only from living cells. The hyphae of the most biotrophs grow primarily between host cells and give rise to specialized hyphal branches that penetrate the host cells and give rise to specialized hyphal branches that penetrate the host cell wall and then invaginate the host cell plasma membrane without killing the cell. These branches are known as haustoria (Sing. haustorium; Latin. haustor = drinker), these structures are involved in taking nutrients from the host. e.g rusts, smuts, powdery mildews, downy mildews.

Hemibiotrophs :- These initially require living host cells but soon cause the death of the host cells in ~~host~~ advance of their hyphae. e.g., Anthracnose fungi (colletotrichum lindemuthianum).

Also important to mention appressoria (Sing. appresorium), these are specialized infection structures formed at the tips of germ tubes or hyphae on the outside of the host. Appressoria adhere to the host surfaces and form a penetration pegs

that enter the host surfaces either by growing into stomatal openings or by directly penetrating the host epidermis. The actual purpose of the appressorium is, it exerts tremendous turgor pressure which keeps the infection peg to penetrate into the host tissues. In the wall of the appressorium, melanin is present which makes its colour dark and also keeps the appressorium walls not to break, because melanin gives rigidity to the hyphae.

Fungal organelles :-

The hyphae of fungi almost invariably contain large numbers of nuclei. In aseptate forms, nuclei generally appear to be distributed randomly throughout the cytoplasm of an actively growing hyphae. In septate forms, individual hyphal compartments may, depending upon the species involved and the phase of the life cycle examined, routinely contain one, two, or many nuclei. Nuclei of fungi are small, generally spherical to ovoid in shape. Nuclei have nuclear membrane, micro-tubules and nucleolus. Meiosis and mitosis clear occur in these nuclei. Different number of chromosomes are found in different phyllum of fungi (from 3 to 900 chromosomes). Numerous mitochondria are found in the hyphae. Other cytoplasmic components of fungi are, endoplasmic reticulum, vacuoles, lipid bodies, lysosomes, multivesicular bodies and micro-filaments. microfilaments form the fungal cytoskeleton. Woronin bodies are also found in certain types of the fungi and are associated with septal pores. Two types of proteins are found in cytoskeleton of fungi, include tubulin and actin. Number of vacuole is also variable in hypha and are granular in shape.

Reproduction and spores

Sexual and asexual reproduction takes place in fungi. In asexual reproduction karyogamy

does not take place. Karyogamy (Gr. Karyon = nut + Gamos = marriage), the fusion of nuclei and meiosis. while during sexual reproduction fusion of nuclei occurs and follows meiosis. The benefit of sexual reproduction is it brings many recombinations and formation of many new forms. This enables fungi to adapt readily to a multitude of environmental conditions. For sexual reproduction, there is need of sexual organs or reproductive organs. In the formation of reproductive organs either sexual or asexual, if the whole body is converted into one or more reproductive structures, so that somatic and reproductive phases do not occur together in the same individual, this type of pattern is called thalocarpic (Gr. holos = whole + Karpos = fruit). However, in some fungi, some part of fungi is converted into reproductive structure while remainder continues its normal activities i.e. somatic, this type of pattern is called eucarpic (Gr. eu = good + Karpos = fruit).

Fungi may produce both sexually and asexually while some fungi produce only sexually or asexually. Two terms are used to describe sexual and asexual stages. Teleomorph is used to discribe sexual stage while anamorph is used for asexual stage. The term Holomorph is used to describe the whole fungus in all its facets, forms and potentialities. More recently there has been proposed to replace these terms with meiosporic fungus (teleomorph) and mitosporic fungus (anamorph).

The common methods of asexual reproduction in fungi are;

① Fragmentation:-

Fragmentation of some, each fragment growing into a new individual.

② Fission

Fission of somatic cells into daughter cells, common in yeasts.

Budding :-

Budding of somatic cells or spores and each bud producing a new individual

Production of mitotic spore :-

Production of mitotic spores, each spore usually germinating to form a germ tube that grows into mycellium. The term diespore is used to represent both sexual and asexual spores. The spores produced through asexual reproduction, if cover themselves with thick wall are called chlamydospores.

Pseudomycellium :- The small buds when join together and form short branches, these are called Pseudomycellium.

The most common method of asexual reproduction in fungi is through spores. Spores are variable in their morphology. Spores may be thin or thickwalled, transparent in colour (hyaline), size is from minute to large and shape is from oval, oblong and needle shaped.

All types of asexual spores are produced in a sack like structure called sporangia (sing. sporangium) and the spores are named as sporangiospores. Sometimes, spore are produced at the tips or sides of hyphae, then these spores are called conidia (Gr. Konis = dust + idium = dimin, suffix). Sporangiospore are non-motile and are called aplanospores, but if they move i.e. motile then these are called planospores. The sporangiaspore of virtually all true fungi are non-motile (aplanospore) Planospores (motile) spores are only produced in the phyllum chytridiomycota. Motile spores have flagellum or whiplash flagellum. The flagellum is attached to the posterior end of the spore and devides into two parts.

Sexual reproduction is the union of two nuclei and consists of three distinct phases;

1- Plasmogamy :- Union of two protoplast, to bring the nuclei close together (Gr. Plasma = a molded object i.e; a being + gamos = marriage, union)

2- Karyogamy :- The fusion of two nuclei (Gr. Karyon = nut + gamos = marriage). It may occur just after plasmogamy or its time may charge with space and time.

As a result of plasmogamy new cell is formed containing two nuclei from each parent, this is called DIKARYON. Two nuclei take considerable time to unite.

3- Meiosis :- After long time, two nuclei of dikaryon unit together, and follows meiosis (Gr. meiosis = reduction), which again reduces the number of chromosomes to the haploid and constitutes the third phase of sexual reproduction. Sexual spores are named as oospores, zygospores, ascospores and basidiospores.

It is important to mention that true fungi exist in haploid, in dikaryon condition while diploid phase comes at the point of zygote formation. However diploid phase remain throughout the life cycle of phyllum Chytridiomycota. In phyllum chytridiomycota, haploid stage alternates with diploid stage throughout the life cycle. This process is generally known as alternate bearing. Sometimes nuclei of same or different genotypes co-exist in same mycellium and in the same

hypha, this phenomenon is called Hetero-karyosis (Gr. Heteros = different + karyon = nucleus). Heterokaryosis may last for an indefinit period or only long for or up to karyogamy. In heterokaryon, each nuclei is independent from each other, however hypha or mycellium is controlled by genes of nuclei.

Heterokaryosis may originate in fungal thallus in four ways;

1- By germination of heterokaryotic spore.
2- By introduction of different nuclei in homokaryon.
3- By mutation in multinucleate homokaryotic structure
4- fusion of some nuclei in the haploid homokaryon.

Heterokaryosis is the pre-requisit of the sexual reproduction, but sometimes fusion of hyphae may also fuse to form vegetative heterokaryon, if fungi do not fuse, then phenomenon is called vegetative incompatibility.

Some species of fungi produce distinguishable male and female sex organs on each thallus, this type of phenomenon is called hermaphrodite (Gr. Hermes = messenger of gods, symbol of male sex + Aphrodite = goddess of love, symbol of female sex.

Some species are monoecious (Gr. monos = single, one + oikos = dwelling, home). This is in fact a single thallus

Hermaphrodite can reproduce singly by itself while, there is another term DIOECIOUS (Gr. twice, two + oikos = Home), in this type of sexual organs, male and female sex organs are present separately on separate thalli.

Terminologies:-

(1) Gametangia (sing. Gametangium); Sex organs of fungi are called gametangia. Gametangia reproduce and form gametes. If gametangia and gametes are morphologically same are called isogametes or isogametangia. If are different, these are called Heterogametangia. male gametangia is also called Antheridia (sing. Antheridium (Gr. ~~antheridium~~ = antheros = flowery + idion, dimin suffix). The female gametangia is called oogonia (sing. oogonium) Gr. (oon = egg + gennao = I give birth)

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Sexual compatibility:-

Some fungi do not produce sex organs or fungi are sexually self-sterile. on the basis of fungi may be classified into three-categories.

A-Hermaphroditic: (monoecious), in which each thallus bears both male and female organs that may or may not be compatible

B- Dioecious, male and female sex organs are separately present on different thalli very less fungi occur in this category.

Sexually undifferentiated:-

Sex organs, which can not be differentiated into male and female or sex organs are morphologically same and can not be differentiated into male and female structures.

On the basis of compatibility fungi may be devided into following categories:

① Homothallic fungi:-

In which every thallus is self-fertile and can, therefore, reproduce sexually by itself without the aid of another thallus. Obviously no dioecious fungus may be homothallic.

② Heterothallic fungi:-

Those fungi in which each thallus is sexually self-~~fertile~~ sterile and require the aid of another thallus.

③ Secondary Homothallic fungi:-

In some heterothallic fungi during spore formation, two nuclei from different mating types are incorporated into single spore or at least some spores. Germlings emerge from these spores act as self-fertile, while in fact they are heterothallic. This condition is known as secondary homothallism or pseudohomothallism.

Heterothallic fungi belong to one of the other two groups. One group includes, in which mating is controlled by one pair of loci, known as Unifactorial or bipolar heterothalism. On other group, mating is controlled by more than one loci located on different chromosomes, known as bifactorial or tetrapolar heterothallism.

Some fungi do not pass through sexual cycle, but may drive benefits of sexual recombination through a process known as parasexuality (Gr. Para = beside sex). On this process, plasmogamy, karyogamy and haploidization take place, but not at specific points in the thallus or life cycle. Parasexuality may occur in sexual fungi.

The End