Volume 1, Issue 2

SEXUAL REPRODUCTION OF FUNGI

Urinboeva B.O.
Lyceum of Andijan State Medical institute, Uzbekistan

Following a period of intensive growth, fungi enter a reproductive phase by forming and releasing vast quantities of spores. Spores are usually single cells produced by fragmentation of the mycelium or within specialized structures (sporangia, gametangia, sporophores, etc.). Spores may be produced either directly by asexual methods or indirectly by sexual reproduction. Sexual reproduction in fungi, as in other living organisms, involves the fusion of two nuclei that are brought together when two sex cells (gametes) unite. Asexual reproduction, which is simpler and more direct, may be accomplished by various methods. Typically in asexual reproduction, a single individual gives rise to a genetic duplicate of the progenitor without a genetic contribution from another individual. Perhaps the simplest method of reproduction of fungi is by fragmentation of the thallus, the body of a fungus. Some yeasts, which are single-celled fungi, reproduce by simple cell division, or fission, in which one cell undergoes nuclear division and splits into two daughter cells; after some growth, these cells divide, and eventually a population of cells forms. In filamentous fungi the mycelium may fragment into a number of segments, each of which is capable of growing into a new individual. In the laboratory, fungi are commonly propagated on a layer of solid nutrient agar inoculated either with spores or with fragments of mycelium.

Budding, which is another method of asexual reproduction, occurs in most yeasts and in some filamentous fungi. In this process, a bud develops on the surface of either the yeast cell or the hypha, with the cytoplasm of the bud being continuous with that of the parent cell. The nucleus of the parent cell then divides; one of the daughter nuclei migrates into the bud, and the other remains in the parent cell. The parent cell is capable of producing many buds over its surface by continuous synthesis of cytoplasm and repeated nuclear divisions. After a bud develops to a certain point and even before it is severed from the parent cell, it is itself capable of budding by the same process. In this way, a chain of cells may be produced. Eventually, the individual buds pinch off the parent cell and become individual yeast cells. Buds that are pinched off a hypha of a filamentous fungus behave as spores; that is, they germinate, each giving rise to a structure called a germ tube, which develops into a new hypha.

Although fragmentation, fission, and budding are methods of asexual reproduction in a number of fungi, the majority reproduce asexually by the formation of spores. Spores that are produced asexually are often termed mitospores, and such spores are produced in a variety of ways.
Sexual reproduction

Sexual reproduction, an important source of genetic variability, allows the fungus to adapt to new environments. The process of sexual reproduction among the fungi is in many ways unique. Whereas nuclear division in other eukaryotes, such as animals, plants, and protists, involves the dissolution and re-formation of the nuclear membrane, in fungi the nuclear membrane remains intact throughout the process, although gaps in its integrity are found in some species. The nucleus of the fungus becomes pinched at its midpoint, and the diploid chromosomes are pulled apart by spindle fibres formed within the intact nucleus. The nucleolus is usually also retained and divided between the daughter cells, although it may be expelled from the nucleus, or it may be dispersed within the nucleus but detectable.

Sexual reproduction in the fungi consists of three sequential stages: plasmogamy, karyogamy, and meiosis. The diploid chromosomes are pulled apart into two daughter cells, each containing a single set of chromosomes (a haploid state). Plasmogamy, the fusion of two protoplasts (the contents of the two cells), brings together two compatible haploid nuclei. At this point, two nuclear types are present in the same cell, but the nuclei have not yet fused. Karyogamy results in the fusion of these haploid nuclei and the formation of a diploid nucleus (i.e., a nucleus containing two sets of chromosomes, one from each parent). The cell formed by karyogamy is called the zygote. In most fungi the zygote is the only cell in the entire life cycle that is diploid. The dikaryotic state that results from plasmogamy is often a prominent condition in fungi and may be prolonged over several generations. In the lower fungi, karyogamy usually follows plasmogamy almost immediately. In the more evolved fungi, however, karyogamy is separated from plasmogamy. Once karyogamy has occurred, meiosis (cell division that reduces the chromosome number to one set per cell) generally follows and restores the haploid phase. The haploid nuclei that result from meiosis are generally incorporated in spores called meiospores.

Fungi employ a variety of methods to bring together two compatible haploid nuclei (plasmogamy). Some produce specialized sex cells (gametes) that are released from differentiated sex organs called gametangia. In other fungi two gametangia come in contact, and nuclei pass from the male gametangium into the female, thus assuming the function of gametes. In still other fungi the gametangia themselves may fuse in order to bring their nuclei together. Finally, some of the most advanced fungi produce no gametangia at all; the somatic (vegetative) hyphae take over the sexual function, come in contact, fuse, and exchange nuclei.

Fungi in which a single individual bears both male and female gametangia are hermaphroditic fungi. Rarely, gametangia of different sexes are produced by separate individuals, one a male, the other a female. Such species are termed dioecious. Dioecious species usually produce sex organs only in the presence of an individual of the opposite sex.

Sexual incompatibility

Many of the simpler fungi produce differentiated male and female organs on the same thallus but do not undergo self-fertilization because their sex organs are incompatible. Such fungi require the presence of thalli of different mating types in order for sexual fusion to take place. The simplest form of this mechanism occurs in fungi in which there are two mating types, often designated + and − (or *A* and *a*). Gametes produced by one type of thallus are compatible only with gametes produced by the other type. Such fungi are said to be heterothallic. Many fungi, however, are homothallic; i.e., sex organs produced by a single thallus are self-compatible, and a second thallus is unnecessary for sexual reproduction. Some of the most complex fungi (e.g., mushrooms) do not develop differentiated sex organs; rather, the sexual function is carried out by their somatic hyphae, which unite and bring together compatible nuclei in preparation for fusion. Homothallism and heterothallism are encountered in fungi that have not developed differentiated sex organs, as well as in fungi in which sex organs are easily distinguishable. Compatibility therefore refers to a physiological differentiation, and sex refers to a morphological (structural) one; the two phenomena, although related, are not synonymous.

Sexual pheromones

The formation of sex organs in fungi is often induced by specific organic substances. Although called sex hormones when first discovered, these organic substances are actually sex pheromones, chemicals produced by one partner to elicit a sexual response in the other. In *Allomyces* (order

Blastocladiales) a pheromone named sirenin, secreted by the female gametes, attracts the male gametes, which swim toward the former and fuse with them. In some simple fungi, which may have gametangia that are not differentiated structurally, a complex biochemical interplay between mating types produces trisporic acid, a pheromone that induces the formation of specialized aerial hyphae. Volatile intermediates in the trisporic acid synthetic pathway are interchanged between the tips of opposite mating aerial hyphae, causing the hyphae to grow toward each other and fuse together. In yeasts belonging to the phyla Ascomycota and Basidiomycota, the pheromones are small peptides. Several pheromone genes have been identified and characterized in filamentous ascomycetes and basidiomycetes.

Life cycle of fungi

In the life cycle of a sexually reproducing fungus, a haploid phase alternates with a diploid phase. The haploid phase ends with nuclear fusion, and the diploid phase begins with the formation of the zygote (the diploid cell resulting from fusion of two haploid sex cells). Meiosis (reduction division) restores the haploid number of chromosomes and initiates the haploid phase, which produces the gametes. In the majority of fungi, all structures are haploid except the zygote. Nuclear fusion takes place at the time of zygote formation, and meiosis follows immediately. Only in **Allomyces** and a few related genera and in some yeasts is alternation of a haploid thallus with a diploid thallus definitely known.

In the higher fungi a third condition is interspersed between the haploid and diploid phases of the life cycle. In these fungi, plasmogamy (fusion of the cellular contents of two hyphae but not of the two haploid nuclei) results in dikaryotic hyphae in which each cell contains two haploid nuclei, one from each parent. Eventually, the nuclear pair fuses to form the diploid nucleus and thus the zygote. In the Basidiomycota, binucleate cells divide successively and give rise to a binucleate mycelium, which is the main assimilative phase of the life cycle. It is the binucleate mycelium that eventually forms the basidia—the stalked fruiting bodies in which nuclear fusion and meiosis take place prior to the formation of the basidiospores.

Fungi usually reproduce both sexually and asexually. The asexual cycle produces mitospores, and the sexual cycle produces meiospores. Even though both types of spores are produced by the same mycelium, they are very different in form and easily distinguished (**see above** Sporophores and spores). The asexual phase usually precedes the sexual phase in the life cycle and may be repeated frequently before the sexual phase appears.

Some fungi differ from others in their lack of one or the other of the reproductive stages. For example, some fungi reproduce only sexually (except for fragmentation, which is common in most fungi), whereas others reproduce only asexually. A number of fungi exhibit the phenomenon of parasexuality, in which processes comparable to plasmogamy, karyogamy, and meiosis take place. However, these processes do not occur at a specified time or at specified points in the life cycle of the organism. As a result, parasexuality is characterized by the prevalence of heterokaryosis in a mycelium—i.e., the presence, side by side, of nuclei of different genetic composition.

References :

1. THOMAS H. NASH, **Lichen Biology**, 2nd ed. (2008); and WILLIAM PURVIS, **Lichens** (2000), provide an introduction to lichens. IRWIN M. BRODO, SYLVIA DURAN SHARNOFF, and STEPHEN SHARNOFF, **Lichens of North America** (2001) is a comprehensive work on lichenology and a useful reference source.

2. Shoxabbos, S., & Mahramovich, K. S. M. K. S. (2023). CAUSES OF THE ORIGIN OF CARDIOVASCULAR DISEASES AND THEIR PROTECTION. *IQRO JURNALI*, 1-6.
3. Salomov, S. N. O. G. L., Aliyev, H. M., & Dalimova, M. M. (2022). RECONSTRUCTIVE RHINOPLASTY METHOD WITH EXTERNAL NOSE DEFORMATION AFTER UNILATERAL PRIMARY CHEILOPLASTY. *Central Asian Research Journal for Interdisciplinary Studies (CARJIS)*, *2*(10), 87-90.
4. Salomov, S., Aliyev, H. M., & Rakhmanov, R. R. (2022). MORPHOMETRIC INDICATORS OF THE GROWTH OF THE THICKNESS OF THE LAYERS OF THE VISUAL CORTEX (FIELD 17, 18, and 19) OF THE LEFT AND RIGHT HEMISPHERES OF THE BRAIN IN A HUMAN IN POST-NATAL ONTOGENESIS. *Galaxy International Interdisciplinary Research Journal*, *10*(1), 875-878.
5. Mirzakarimova, D., Ya M. Yuldashev, and Sh T. Abdukodirov. "Factors biochemical morphological given toxic hepetitis, depending on treatments." RE-HEALTH JOURNAL 2, no. 6 (2020).

