References: Webster, J., & Weber, R. (2007). *Introduction to fungi*. Cambridge, UK: Cambridge University Press.

GENERAL FEATURES OF ASCOMYCOTA

Division Ascomycota is the largest fungal division which contains approximately 75% of all described fungi. The division includes 15 class, 68 order, 327 families, 6355 genera and approximately 64000 species. It is a morphologically diverse division which contains organisms from unicellular yeasts to complex cup fungi. Most of its members are terrestrial or parasitic. However, a few have adapted to marine or freshwater environments. Some of them form symbiotic associations with algae to form lichens.

The division members, commonly known as the sac fungi, are characterized by the presence of a reproductive microscopic sexual structure called ascus in which ascospores are formed. Nuclear fusion and meiosis occur in the ascus and one round of mitosis typically follows meiosis to leave eight nuclei. Finally, eight ascospores take place. Ascospores are formed within the ascus by an enveloping membrane system, which packages each nucleus with its adjacent cytoplasm and provides the site for ascospore wall formation.

Another unique character of the division (but not present in all ascomycetes) is the presence of Woronin bodies on each side of the septa separating the hyphal segments which control the septal pores.

Like all fungi, The cell walls of the hyphae of Ascomycota are variably composed of chitin and β-glucans. The mycelia of the division usually consist of septate hyphae. Its septal walls have septal pores which provide cytoplasmic continuity throughout the individual hyphae. Under appropriate conditions, nuclei may also migrate between septal compartments through the septal pores.

Asexual reproduction of Ascomycota is responsible for rapid reproduction. It takes places through vegetative reproductive spores called conidia but chlamydospores are also

frequently produced. Division members also reproduce asexually through budding and fission. Sexual reproduction of the division leads to the formation of the ascus, It is the uniting characteristic of the division and it plays an important role of producing sexual spores called ascospores that are involved in sexual reproduction.

Vegetative structures

Ascomycota may grow either as yeasts, i.e. unicells multiplying by budding or fission, or as mycelia consisting of septate hyphae. Some fungi may switch from the yeast to the filamentous state or vice versa, i.e. they are dimorphic. A good example of a dimorphic fungus is Candida. Candida albicans is the cause of diseases such as thrush in mammals, including man. The mycelial septa of ascomycetes are usually incomplete, developing as transverse centripetal flange-like ingrowths from the cylindrical wall of a hypha, which fail to meet at the centre so that in most ascomycete septa there is one central pore permitting cytoplasmic continuity and streaming between adjacent segments of mycelium. This means that organelles such as mitochondria and nuclei are free to travel from cell to cell; the large nuclei are constricted as they pass through the pore. Individual cells may be uni- or multinucleate and the cytoplasmic continuity between the cells means that the myceliu of an ascomycete is effectively coenocytic. Proteinaceous organelles termed Woronin bodies (Buller, 1933) may be closely grouped near the central pore (Fig. 8.3). Woronin bodies are globose structures or ‘hexagonal’ (polyhedral) crystals made up essentially of one protein, and surrounded by a unit membrane. Woronin bodies have been recorded from ascomycota members and their related conidial fungi, but there are no reliable reports from other fungal division. The mycelium of many ascomycetes is homokaryotic i.e. all nuclei in a given mycelium are genetically identical. Heterokaryotic mycelia also occur and generally arise through anastomosis, i.e. the cytoplasmic fusion of vegetative hyphae. Following anastomosis between homokaryons of differing genotypes, nuclei, other organelles and plasmids may be transferred between one

mycelium and another so that a given mycelium or even a single cell may contain nuclei of different kinds. However, the ability to form heterokaryons is under genetic control and a degree of genetic similarity between homokaryons is necessary for it to ocur (Webster& Weber, 2007).

LIFE CYCLES OF ASCOMYCOTA

Sexual life cycles

Sexual life cycles in the strict sense, i.e. involving nuclear fusion and meiosis, occur only in those Ascomycota which possess asci, because it is within the young ascus that these events occur. Ascospores of most Ascomycota contain one or more haploid nuclei, and therefore most Ascomycota have a haploid vegetative mycelium. The mycelium is often capable of asexual reproduction, e.g. by fragmentation, budding or by the formation of conidia, chlamydospores, sclerotia, etc. The structure and formation of conidia is described below. Some yeasts, e.g. *Saccharomyces cerevisiae*, show an alternation of diploid and haploid yeast-like states and here the diploid state is the commonly encountered form, in contrast to *Schizosaccharomyces* in which the vegetative cells are haploid (Webster& Weber, 2007).

The mating behaviour of ascomycetes may be homothallic or heterothallic. In homothallic Ascomycota the mycelium derived from a single ascospore is capable of reproducing sexually, i.e. by developing asci. Examples are *Emericella nidulans*, *Pyronema domesticum* and *Sordaria fimicola*. However, the homothallic condition does not preclude outcrossing as is shown by the formation of hybrid asci containing black and white ascospores in crosses between different strains of Sordaria fimicola. In heterothallic ascomycetes the ascus usually contains four ascospores of one mating type and four of the other. The two mating types differ at a single allele and the mating types may be designated A and a, or (+)

and (-). Sexual reproduction occurs following plasmogamy between cells of the two mating types. Plasmogamy is of three main types (Webster& Weber, 2007);

1. **Gametangio-gametangiogamy.** Fusion occurs between differentiated gametangia. An example is Pyronema domesticum where fusion is between the trichogyne, a filamentous extension of the large, swollen 'female' gametangium (the ascogonium) and a less swollen 'male' gametangium, the antheridium, which donates nuclei to the trichogyne and thereby to the ascogonium (Webster& Weber, 2007).

2. **Gameto-gametangiogamy**: Fusion takes place between a small unicellular male gamete (spermatium) and a differentiated femal gametangium (ascogonium). The spermatium is rarely capable of independent germination and growth and may only germinate to produce a short conjugation tube which fuses with the wall of the ascogonium. An example is Neurospora crassa in which the spermatium fuses with a trichogyne (Webster& Weber, 2007).

3. **Somatogamy:** Fusion takes place between undifferentiated hyphae, i.e. there are no recognizable sexual organs. This type of sexual behaviour is shown by Coprobia granulata, whose orange ascocarps are common on cattle dung (Webster& Weber, 2007).

Asexual life cycles

Most fungi which were formerly classified in the artificial group Deuteromycetes or Fungi Imperfecti are conidial forms (anamorphs) of Ascomycota, although a few have affinities with Basidiomycota. Evidence for a relationship to Ascomycota comes from morphological similarity and from DNA sequence comparisons Morphological similarities include the structure of the mycelium, the layering of the hyphal wall as seen by electron microscopy, the finestructure of nuclear division, and also close resemblances of conidial structure and development. Some genera contain species which reproduce by asexual means only, whilst closely similar forms have sexual as well as asexual reproduction. Examples include Aspergillus and Penicillium, which are anamorphs of several genera of Ascomycota

and Fusarium which is the anamorph of Gibberella and Nectria. It is presumed that fungi which reproduce only by conidia have lost he capacity to form ascocarps in the course of evolution (Webster& Weber, 2007).

REFERENCES

Webster, J., & Weber, R. (2007). *Introduction to fungi*. Cambridge, UK: Cambridge University Press.