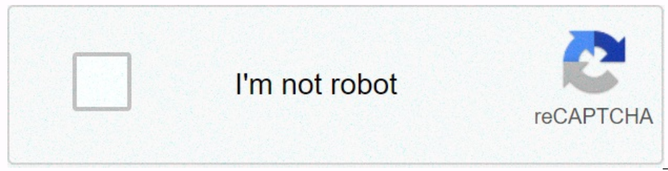

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Formation of ascus in ascomycetes

This article is about the spore-carrying cell in fungi. For atypical squamous cells of indeterminate importance (ASCUS), see Bethesda System. This article must have additional quotes for confirmation. Help improve this article by adding citations to trusted sources. Material that does not have sourced material may be challenged and removed. Find sources: Ascus - news · newspapers · books · scholar · JSTOR (June 2015) (Learn how and when to remove this template message) Asci by Morchella elata, Phase contrast image There are 8 ascospores in each ascus of Sordaria fimicola. An ascus (plural monodemia; from Greek ἀσκός åskós 'skin bag'[1]) is the sexual spore-carrying cell produced in ascomycete mushrooms. Each ascus usually contains eight ascospores (or octad), produced by meiosis followed, in most species, by a mitotic cell division. However, asci in some genera or species may occur in numbers of one (e.g. In a few cases, the ascospores can run conidia, which can fill asci (eg Tympanis) with hundreds of conidia, or ascospores can fragment, e.g. some Cordyceps, also fill asci with smaller cells. Ascospores are non-microtil, usually single cell, but not rarely can be coenocytic (lacking a septum), and in some cases coenocytic in multiple planes. Mitotic divisions within the evolving spores populate each resulting cell in septate ascospores with nuclei. The term ocular chamber, or oculus, refers to epiplasm (the part of cytoplasm not used in ascospore formation) that is surrounded by bourrelet (the thickened tissue near the top of the ascus). [2] In many cases asci is formed in a regular layer, hymenium, in a fruity body that is visible to the naked eye, here called an ascocarp or ascoma. In other cases, such as single-celled yeast, such structures do not exist. In rare cases asci of some genera can regularly develop inside older ones derived asci one after another, e.g. Dipodascus. Asci usually release their spores by bursting at the tip, but they can also digest themselves, passively releasing ascospores either in a liquid or as a dry powder. Discharge asci usually has a specially differentiated tip, either a pore or an operculum. In some hymenium forming genera when one ascus ruptures, it can trigger bursts of many other asci in ascocarp resulting in a massive discharge visible as a cloud of spores - the phenomenon called puffing. This is an example of positive feedback. A faint ifent sound can also be heard for species of Peziza and other cup mushrooms. Asci, especially those of Neurospora crassa, have been used in laboratories to study the process of meiosis because the four cells produced by meiosis line up in regular order. By changing genes coding to track color and nutritional requirements, the biologist can study passage over and other phenomena. The formation of asci and their use in genetic analysis are described in detail in crassa. Asci of most Pezizomycotina develop after the formation of croziers at their base. Croziers help maintain a short dicaryon. The compatible nuclei of the dikaryon merge form a diploid core that then undergoes meiosis and eventually internal ascospore formation. Members of Taphrinomycotina and Saccharomycotina do not form croziers. Classification Asci of Hypomyces chrysospermus (they are unitunicate-inoperculate). DIC image. The shape of ascus, the capsule that contains the sexual spores, is important for the classification of Ascomycota. There are four basic types of ascus. A unitunicate-operculate ascus has a lid, Operculum, which breaks open when the spores are ripe and allows spores to escape. Unitunicate-operculate asci occurs only in the ascocarps that have apothecia, for example morels. 'Unitunicate' means 'single-walled'. Instead of an operculum, a unitunicate-inoperculate ascus has an elastic ring that acts as a pressure valve. When ripening the elastic ring card expands and lets the spores shoot out. This type appears both in apothecia and in perithecia; one example is the illustrated Hypomyces chrysospermus. Ascus of Saccharomyces cerevisiae contains a tetrad of four spores A bitunicate ascus is surrounded by a double wall. It consists of a thin, brittle outer shell and a thick elastic inner wall. When the spores are ripe, the shell divides up so that the inner wall can take up water. As a consequence this begins to stretch with its spores until it sticks out over the rest of the ascocarp, so that the spores can escape into the open air without being blocked by the bulk of the fruit strait. Bitunicate asci occurs only in pseudothecia and is found only in the classes Dothideomycetes and Chaetothyriomycetes (which were previously united in the old class Loculoascomycetes). Examples: Venturia inaequalis (apple basket) and Guignardia aesculi (Brown Leaf Mold of Horse Chestnut). Prototunicate asci is mostly spherical in shape and has no mechanism for forced dispersal. The mature ascus wall dissolves allowing spores to escape, or it is broken open by other influences, such as animals. Asci of this type can be found both in perithecia and in cleistothecia, for example, with Dutch elm disease (Ophiostoma). This is something of a catch-all term for cases that don't fit into the other three ascus types, and they probably belong to several independent groups that have evolved separately from unitunicate asci. References ^ Henry George Liddell, Robert Scott, A Greek-English Lexicon, ἀσκός. www.perseus.tufts.edu. Retrieved February 27, 2018. ^ Hawksworth DL. (2013). Ascomycete Systematics: Problems and perspectives in the nineties. Springer, what's up? p. 116. ISBN 978-1-4757-9290-4. External Links IMA Mycological Glossary: Ascus APSnet Illustrated Glossary for Plant Pathology: Ascus Retrieved from Jules J. Berman, in Taxonomic Guide to Diseases, 2012All members of class Ascomycota who reproduce sexually produce an ascus (from the Greek askos, which means sac) that contains spores. Unfortunately for taxonomists, many members of class Ascomycota simply do not reproduce sexually; therefore they do not produce the ascus that characterises their taxonomy class. Taxonomists invented a temporary class of organisms known as deuteromycotes (or imperfect fungi) to keep these asexual species. Thanks to molecular analyses, many of these ascus-inhibited species have been sorted into correct subclasses in class Ascomycota. Currently, three large classes account for all the pathogenic members of class Ascomycota: Saccharomycotina, Taphrinomycotina, and Pezizomycotina. Class Saccharomycotina is yeast; round, single-celled fungi that multiply by budding. This class contains a single genus that is pathogen in humans: Candida. Class Taphrinomycotina contains a single species that is pathogen in humans: Pneumocystis jiroveci. All the remaining Ascomycotes, and there are many, belongs to class Pezizomycotina.AscomycotaSaccharomycotinaSaccharomycetesSaccharomycetalesSaccharomycetaceae*CandidaNicholas P. Penge, in The Fungi (Third Edition), 2016The Ascomycota is the largest phylum of mushrooms, comprising more than 33,000 named species and a large number of undecost mushrooms. Phylum includes yeast and filamentous fungi, fungi that cooperate with algae and cyanobacteria to form low symbiosis, mycorrhizal species, saprotros, and pathogens of plants and animals. Ascomycetes are used for industrial applications, in food production and aroma, and fruit bodies of morels and truffles are prized edible mushrooms. Many species are known only as asexual fungi (anamorphs) that produce asexual spores (conidia) on stems called conidiophores (Figure 1.12), but sexual phases (telemorphs) have been identified in the life cycle of most ascomycetes that have been studied in detail. The genitals formed by ascomycetes are called ascomata (p. ascoma, Figure 1.13). Ascomata includes open cup-shaped fruit organs (apothecia), flask-shaped structures with a single vent for spore release (perithecia), and fruit organs that develop as closed structures that open in a variety of ways to release spores (cleistothecia). Ascomata contains the characteristic spore-producing cells in phylum called asci (p. ascus). The sexual spores of ascomycetes, called ascospores, form inside asci. This internal development of ascospores contrasts with the production of basidiospores on the outside of basidia in Basidiomycota (compare Figure 1.14 with Figure 1.7). Hyphae of ascomycetes lacks dolipore septa and squeeze connections of basidiomycetes; their septa has a single, central pore. Mobile organelles (microbodies) with dense protein nuclei, called Woronin organs, put septal pores and isolate damaged hyphalum from the rest of the colony. organs are found in the largest Pezizomycotina, which contains 90% of Ascomycota, but is absent from the other members of the phylum (whose groups are described below). Figure 1.12. Selection of concmoral phases, or anamorphs, of ascomycetes. (a) Basipetospora variabilis, a soil fungus. b) Scopulariopsis brevicaulis, a saprotrophic that grows in the soil and causes opportunistic infections in humans. c) Harziella (Lepisticola) capitata, which grows on fruit organs Lepista nuda (blewits). d) Tyrannosorus pinicola, isolated from decaying wood. (e) Haplotrichum chilese, isolated from wood. f) Junewangia globulosa, isolated from rotting plant stems. Source: a) Minter, D.W., Kirk, P.M., Sutton, B.C., 1983. Thallic phialides. Trans. Br. Mycol. Soc. 80, 39-66; (b) Minter, D.W., Kirk, P.M., Sutton, B.C., 1983. Holoblastic phialides. Trans. Br. Mycol. Soc. 79, 75-93; c) Gams, W., Seifert, K.A., Morgan-Jones, G., 2009. New and validated hyphomycete taxi to solve nomenclatural and taxonomy problems. Mycotaxon 110, 89-108; (d) Müller, E., et al., 1987. Taxonomy and anamorphes of Herpotrichellaceae with notes on generic synonymymana. Trans. Br. Mycol. Soc. 88, 63-74; (e) Partridge, E.C., Baker, W.A., Morgan-Jones, G., 2001. Comments on Hyphomycetes. LXXXII. An additional contribution to a monograph of the genus Haplotrichum. Mycotaxon 78, 127-160; (f) Baker, W.A., Partridge, E.C., Morgan-Jones, G., 2002. Comments on Hyphomycetes. LXXXV. Junewangia, a genus to classify four Acrodicty species and a new taxon. Mycotaxon 81, 293-319.Figure 1.13. Examples of fruit organs, or ascomata, produced by Ascomycota in Subphylum Pezizomycotina. a) Goblet shaped apothecia of Urnula crater, devil's urn. (b) Flattened disobedience apothecia on thallus of a species of laven Xanthoparmelia. c) Heavily modified apotthecium of summer truffle, Tuber aestivum. d) Perithecial stroma of Cordyceps militarizes fruits from parasitic caterpillars. Source: (a) Michael Kuo, (b) Lichen_reproduction1.jpg, c) (d) 1.14. Sexual cycle of a filament ascomycete. Source: Peraza-Reyes, L., Berteaux-Lecellier, V., 2013. Peroxiomes and sexual development in fungi. Front. Physiol. 4, 244.A.K. Sarbhoy, in the Encyclopedia of Food Microbiology (Second Edition), 2014Ascomycota has 3255 genera consisting of 32 267 species. The presence of lamellate hyphal walls with a thin electron-dense outer layer and a relatively thick electron transparent inner layer of ascus is one of the diagnostic signs; this allows mitosporic mushrooms to be recognized as Ascomycetes even in the absence of asci. In the past, great importance has been made to ascis (Hemiascomycetes, Plectomycetes, Pyrenomycetes,Discomycetes, Laboulbeniomycetes, Loculoascomycetes). In the recent the development of ascomata and, in particular, the method of discharge of asci has become essential. The main problem with previous classifications was that low-forming fungi – almost half of Ascomycetes – had often been classified separately. A similar intercalation in a hierarchical system based on variations in non-low fungi was not expected.M. McConnaughey, of the Reference Module in Biomedical Sciences, 2014Fungi is classified in 7 divisions or phyla, based on the way the fungus reproduces sexually. These divisions include: Ascomycota, Basidiomycota, Blastocladiomycota, Chytridiomycota, Glomeromycota, Microsporidia and Neocallimastigomycota.Ascomycota are septate mushrooms with filaments divided by cellular transverse walls called septa. Ascomycetes produce sexual spores, called axcospores, formed in sac-like structures called asci, and also small asexual spores called conidia. Some species of Ascomycota are asexual and do not form asci or ascospores. Basidiomycota's septate filamentous fungi consist of hyphae partitioned by cellular cross-walls called septa. Basicomycota reproduce sexually with mycelium producing reproductive spores in basidia, which are club-shaped end structures that usually have external meiospores or basidiospores. Some Basidiomycota also reproduce a sexually. Blastocladiomycota are saphrotrophs and generally feed on decomposing organic matter. Blastocladiomycota undergoes tracer meiosis and exhibits a form of sexual reproduction known as anisogami, which consists of the fusion of two sexual gametes that differ in morphology. Blastocladiomycota can also produce asexual zoo spores to colonize new substrates. Chytridiomycota (commonly known as chytrids) are saphrotrophs, and have chitin cell walls and a posterior whiplash flam. Chytridiomycota reproduce with zoo spores that are capable of active movement through aqueous phases. For most members of Chytridiomycota, asexual reproduction occurs through the release of these zoospores derived through mitosis. In some members, sexual reproduction is achieved through the fusion of isogametes. Chytridiomycota is coenocytic without the distinction between individual cells. The filaments are long and tubular with a cytoplasm lining and large vakuol in the middle. These single-celled organisms have branched hyphae with rhizoids. Glomeromycota is septate mushrooms and has coenocylic mycelia. Glomeromycota forms a form of symbiosis in which fungal hyfa invades plant root cells, and both species benefit from the increased supply of nutrients. The fungi symbion receive carbohydrates from the plant in exchange for acting as an extended root system, which dramatically improves the mineral uptake of the plant roots. Glomeromycota reproduce a sexually through blastic development of hyphae tips to produce relatively large spores with layered walls containing hundreds to thousands of cores. Microsporidia is binding, trace-forming, intracellular parasites that invade vertebrates and invertebrates. A characteristic feature of microsporid is the polar tube or polar filament found in the spore used to infiltrate host cells. These eukaryotic parasites mainly infect arthropods and fish, but have gained recognition in the past few decades due to their increased infection in immunocompromised people. Microsporidia produces highly resistant spores that can survive outside the host for up to several years. Spores are usually oval-shaped, but can be rod-shaped or spherical and are transferred off when the host ingests them from the environment. Neocallimastigomycota are anaerobic mushrooms found in the digestive tract of herbivores, such as cows, sheep and horses. They are also found in various rural and aquatic environments enriched with cellulose, especially waste dumps. Neocallimastigomycota lacks mitochondria, but instead has hydrogenosomes. Neocallimastigomycota forms small mycelia of cenocytic hyphae, which is spread through the production of posteriorly-directed flagella. These fungi reproduce the axing in the stomach of herbivores through posteriorly uniflagellated or polyflagellated zoo spores. CAROL A. SHEARER, ... JOYCE E. LONGCORE, in The Biodiversity of Fungi, 2004Freshwater ascomycetes can be found by collecting and examining living and dead macrophytes around the edges of ponds, lakes, marshes, swamps, wetlands, drainage ditches, and small temporary bodies of water. Submerged and partially submerged wood waste is also a good source of fresh water ascomycetes, especially in Lotic habitats, and a few species occur on submerged deciduous tree leaves. Although the fruiting organs (ascomata) of some species can be seen on the substrata in the field using a hand lens, many are undetectable until the substrata is studied with a dissect microscope. Substrata can be collected in the field by hand or by means of a sturdy rake. In some cases, a wooden trimmer can be used to cut the macrophytes rooted in deep water. For large woody dirt, a saw, twig cutters, and an axe are useful for obtaining samples. Once the material is collected, it should be placed in plastic bags containing several pieces of paper roll to absorb excess water. Samples in plastic bags should be stored on ice in a cooler until they are transported to the laboratory to inhibit the growth and respiration of the bacterium and other organisms. At the time of collection, detailed information on the sample, including the date of collection, geographical location (including latitude and longitude and height), the identity of the substrate, the state of the substrate (living, death, degradation rate, submerged or not), the type of aquatic habitat, air and water temperatures, the pH-based condition and other available water chemistry parameters and all other relevant factors shall be recorded. Substrata is returned to the laboratory and rinsed with sterile tap, distilled or deionized water. Attached aufwuchs (i.e. growths such as algae, protozoa, bryozoans, and mud and sand must be removed from the surface of the substrata by hand or by gentle scraping with a spatula. That cleaning allows mushrooms to sporulate and increases the visibility of fungal fruit organs. Substrata then should be transferred to moist chambers for incubation. Glass or plastic petri sheets containing damp filter paper; plastic boxes, e.g. or plastic bags containing moistened paper roll, can be used as incubation chambers (see Appendix I). Material placed in a damp chamber should just cover the lower surface. If the substrata is tightly layered, ascomata can be hidden and oxygen can be depleted, which inhibits the growth and sporulation of ascomycetes. Standing water should be poured from the moist chamber before incubation to prevent accumulation of bacterial populations and anaerobic conditions. Incubated samples should be stored at temperatures corresponding to the temperature of the natural habitat, although temperatures in space may be sufficient, and in changing light and dark conditions (12 hours/12 hours), which apparently increases sexual reproduction (Shearer and von Bodman 1983). Substrata placed in damp chambers should be examined before incubation and any freshwater ascomycettes should be detected because some fungal species deteriorate when removed from water and may not be recognisable after an incubation period. When incubation is initiated, the samples should be examined regularly for about 6 months. Because it is often difficult to determine the origin and identity of randomly collected samples, or how long they have been submerged, investigators often use bait to follow the colonization and development of freshwater ascomycetes (Shearer 1972; Shearer and von Bodman 1983). Baits such as twigs or wooden blocks cut from identified tree sources can be attached to masonry brick or cement blocks and placed in habitat for specific periods. They can also be assembled in packs of nylongarn and attached to a line tied to a relatively permanent structure such as a pier or a tree (Shearer 1972). Substrata such as dead macrofyte leaves and stems can be placed in nylon mesh bags and immersed in the habitat, as explained earlier. Given the fluctuating water levels and often muddy conditions common in freshwater habitats, a great deal of thought and planning should go into the selection of baits and the methods of placement and bait retrieval. Both flood and drought conditions should be taken into account. Indirect collection techniques such as plating water, mud or homogenized substrate are not very effective at detecting freshwater ascomycetes. Ascospores of some fresh water ascomycetes sprout poorly or not at all. Those that sprout are often overgrown by fast-growing, weedy mushrooms, such as species of Mucor, Penicillium, Trichoderma, and Sclerotium. Although suspected ascomycetes can be achieved that induce reproduction in order to the identity of cultures often requires long periods of time and specific cultural procedures. Moreover, some species do not reproduce in culture, and without reproductive structures, freshwater ascomycetes cannot be identified unless molecular techniques are used. Thus, testing the many isolates that are due to plating is quite cumbersome and often in vain. The techniques of foam examination and membrane filtration of water, which are so useful for the identification and quantification of aquatic hyfomyces (Iqbal and Webster 1973b, 1977), have little value for freshwater-like. Ascospores of freshwater ascomycetes occur at much lower densities than the conidia of aquatic hyphomycetes and therefore rarely encounter membrane filters. Moreover, ascospores of many freshwater ascomycetes are not very characteristic morphological, and unless the investigator already knows freshwater ascomycetes are likely to be present, they cannot be identified. These restrictions make it very difficult to quantify spora of freshwater areas in water. Thomas J. Volk, in the Encyclopedia of Biodiversity (Second Edition), 2013The Ascomycota carries their sexual spores (ascospores) internally in sacks called asci, which are usually cylindrical. Many members also form conidia as asexual spores. Well-known members of this phylum include morels (Figures 5 and 6) (Weber, 1988; Kuo, 2005) and other cup and saddle mushrooms, truffles, mildew, the industrial yeast Saccharomyces cerevisiae, spells of chestnut blight (Cryphonectria parasitica,) the cause of Dutch elm disease (Ophiostoma ulmi), and a number of other plant pathogens. About 1/3 to 1/2 of the species of Ascomycota is associated with algae or cyanobacteria in the form of low (see Lichens), while an increasing number of genera, such as Morchella, Helvella, and Leotia, are discovered to form ectomycorrhizae with host plants. Figure 5. Morchella esculenta, the more, a premium edible mushroom. Figure 6.

Morel asci contains ascospores. Owen W. Ryan, Jamie H.D. Cate, in methods in Enzymology, 2014Ascomycete yeast expresses all their transfer RNAs (tRNA), U6 splice seosomal RNA SNR6, snoRNA SNR52, the RNA component of RNase P RPR1 and the RNA component of signal recognition particle scr1 using RNA Polymerase III (RNA Pol III) initiators (Marck et al., 2006). These RNA Pol III prints have different architectures, but all contain the essential components for the RNA Pol III transcription initiation. They contain A Box and B Box binding domains and a TATA Box binding domain. Only one print, SNR52, looks like a canonical RNA Polymerase II promoter with polymerase binding motifs (A and B Boxes) 5' of the TATA box and SNR52 RNA coding sequence. Transfer RNAs, on the other hand, have the A and B Box motifs in the mature tRNA sequence. All RNA Polymerase III transcription termination is done by the same mechanism, with RNA Pol III transcription ending with a string of poly-U six in yeast and five in higher eukaryotes (Marck et al., 2006). This means that screening promotors for the term of sgRNA are directly comparable and not confused by promoter-terminator effects found with RNA Pol II promoters (Curran, Karim, Gupta, & Alps, 2013). The SgRNA expression systems, developed in higher eukaryotes, use the promoter of the U6 snRNA gene as the RNA Pol III promoter to express the sgRNA, an approach that has been used for RNA interference trials for several years (Mali, Esvelt, et al., 2013; Mali, Yang, et al., 2013). In mammalian cells, cell levels of sgRNAs correlate with the effectiveness of Cas9-mediated genome targeting (Hsu et al., 2013), increasing the possibility that sgRNA density is speed limiting for in vivo CRISPR mediated genome targeting. It is therefore important to consider ways to increase print levels of sgRNAs. One way to increase cellular abundance is to protect sgRNA from the intracellular RNA degradation machines. This can be done by adding self-clovering ribozyms (or an RNA) that may be physically associated with sgRNA to increase in vivo stability and regulation of expression or treatment. However, the added RNA must not interfere with the structure or expression of the SGRNA, so that the sgRNA is in a bodily state that allows binding to Cas9 in the cell. To increase sgRNA levels in yeast, we developed a new sgRNA architecture by merting sgRNA(+ 85) (Mali, Esvelt, et al., 2013; Mali, Yang, et al., 2013) to 3' end of self-deciduous hepatitis delta virus (HDV) ribozyme, to protect sgRNA from 5′-exonucleolytic activities in the cell. Naturally occurring self-clovering ribozyms are noncoding RNAs widespread nature (Webb, Riccitelli, Ruminski, & Luptak, 2009), and HDV-like ribozymes have been identified in a wide range of eukaryotes. We chose to use HDV ribozyme because its cleavage leaves a pure 5′-end on RNA with no extraneous nucleotides 5' of HDV ribozyme (Ke, Ding, Batchelor, & Doudna, 2007). In addition, the pure 5' end can also support in nuclear retention of RNA (Kohler & Hurt, 2007). HDV-like ribozyms are strongly preserved, forming a double-pseudoknot secondary structure, and the nucleotides that are essential for its enzymatic activity have been mapped (Ke et al., 2007). Although it should be possible to use an inert HDV ribozyme or other structured but non-caesarean protection RNAs, we chose the active form of HDV ribozyme because its cleavage would remove any structured or unstructured RNA used as an promoter, leaving HDV ribozyme covalently 5's for sgRNA (Fig. 22.3A). Figure 22.3. The RNA structure of the sgRNA expression module. (A) SgRNA is expressed using a tRNA as an RNA Pol III promoter. The HDV folds into its catalytically active form and removes the 5' tRNA sequence from the mature sgRNA (cleavage site characterized by a star). The target sequence is protected between HDV sgRNA. The RNA Pol III term ends with a series of six or more uridine nucleotides. (B) Engineering sgRNAs for improved coexistence. Future polycistronic sgRNAs could be expressed using a single RNA PolIII promoter (tRNA) and treated internally by their catalytically active HDV (cleavage sites are marked with *). This panel contains three sgRNAs in tandemarrays. We measured the relative cellular abundance of sgRNAs expressed by a yeast RNA Pol III promoter with and without 5' ribozyme, by reverse transcription quantitative polymerase chain reaction (PCR) and found that the presence of ribozyme increases intracellular abundance of sgRNAs by sixfold. This is consistent with our hypothesis that the structure of HDV ribozyme serves as protection at the 5' end of sgRNA from 5' exonucleases (Houseley & Tollervey, 2009). Especially in the absence of HDV ribozyme we found that RNA Polymerase II promoters resulted in highly expressed sgRNA molecules in yeast, but they were physiologically inactive, resulting in very low efficiency (≪ 1%) Cas9 targeting. Although we do not characterize these sgRNAs further, we suggest that the lack of sgRNA activity may be due to the failure of RNA Pol II terminators to purely terminate transcription, resulting in 3' RNA sequences that interfere with sgRNA folding, or sgRNA nuclear localization. Therefore, we suggest that the overall abundance of sgRNA is not limiting, but rather a total abundance of properly folded and localized sgRNAs. In summary, we have shown that sgRNA is easily constructed in a modular way that incorporates structured RNAs 5' for sgRNA guide sequence. In the future it could be possible to incorporate several HDV-like ribozyme-sgRNA chimeras into series to produce more sgRNAs with increased genome editing functionality. Expressing sgRNA chimeras using a single promoter and allowing them to be posttranscriptionally modified could control the coexistence of multiple guides used in higher order multiplex editing (Fig. 22.3B). In addition, the ribozyme allows for modification of 5' conductor sequence (promoter), so that future promoters can be designed to adjust the expression of sgRNA. Furthermore, it is possible to add 3' sequences to sgRNA to protect them from 3' exonucleases (Hsu et al., 2013; Jinek et al., 2013). There are still many options for the construction of sgRNA, so that the term level gap between Cas9 and the speed limit sgRNA can be bridge. We expect that by improving the coexpression stoichiometry of protein and RNA components crispr/Cas9 systems will be of great value in more complex editing experiments such as higher order multiplexing.I.J. Goldstein, H.C. Winter, in extensive Glycoscience, 2007A second related ascomycete carries fruitive bodies, M. chateri, was found to contain an l-fucose-specific lectin with a high degree of sequence homology to AAL.61 Presumably it also forms β-propeller fold, although no X-ray structural work has been reported for this lectin. The pathogenic, mycelial ascomycete fungus, A. oryzae (A. flavus v. oryzae), contains a lectin that has about 30% sequence identity with AAL and which possesses six tandem repetitions, suggesting the six-bladed β-propeller structure. Its agglutination activity is also inhibited by l-fucose.62A.B. Gould, in the Encyclopedia of Microbiology (Third Edition), 2009The Ascomycota are some of the best known true fungi, and at least 30 000 different species of ascomycetes are described. The group is very diverse and occupies a number of niches. A minority of these fungi form partnerships with algae to form low; the rest are saprophytes or symbiotes. Parasitic ascomycetes can infer nutrition such as biotrofer, necrhythpher, or hemibiotrofish. Although some ascomycetes, such as yeast, have a single-cell thallus, the thallus of most of these terrestrial fungi consist of a well-developed, septate, haploid mycelium that contains chitin in the cell wall. The ascomycete thallus grows under the substratum surface; only reproductive structures are exposed to the air. Ascomycetes are named after ascus, a sac-shaped structure that contains ascospores, products of meiosis during the sexual reproductive process. Asci is formed when the female germ cell (ascogonium) is fertilized by the male gamet (antheridium). The diploid zygote kernel undergoes meiosis followed by a mitotic division to form eight ascospores, which remain in the bag until they are discharged and disseminated. Asci is unitunicate (with a single wall) or bitunicate (with a double wall). For most ascomycetes, asci is produced in fruit-striving structures called ascomata (or ascocarps). The different types of ascomata are apotthecium (open, cup-shaped with exposed unitunicate asci); cleistothecium1 (completely closed, lined with one or more unitunicate ascus) perithecium (flask-shaped with an opening or ostiole, on the tip, lined with unitunicate asci) and pseudothecium (or ascostroma; bitunicate asci is produced in a cavity or locule buried in a stroma of fungal mycelium). (Historically, ascoma associated with mildew has been called a cleistothecium because, at least initially, sporocarp is completely closed. Later, however, these structures develop a line of weakness to break open during ascospore release. In other texts, these structures are defined as chasmothecia. Although, developmentally, ascoma produced by powdered mildew may be more similar to perithecia, the previously accepted term cleistothecium used here.) The asci that is formed freely without a supportive fruiting structure (e.g. for leaves curl fungi and yeast) is called naked asci. Asexual reproduction in ascomycetes is most common as conidia produced on conidiophores; other forms include clingyo spores and reproduction by budding or fission (yeast). One of the most notable diseases caused by a is meldd of rye and wheat, caused by the perithecial fungus C. purpurea (Table 4). Grains in the seed head are replaced by a survival structure of the fungus, called an ergot (sclerotium). Ergots are toxic to humans and animals, and when ingested with flour made from contaminated rye or wheat, affect the nervous system and restrict blood vessels. Side effects of the disorder in humans, known as ergotism, holy fire, or St. Anthony's fire, include convulsions, gangrene, hallucinations, and miscarriage. Convulsions hallucinations caused by ergot were implicated in salem witch trials, but the relationship remains unproven. Interestingly, LSD (lysergic acid diethylamide) was first isolated from the scleotia of this fungus. Table 4. Plant pathogens ascomycetesClassAscomaExamplesArchiascomycetesNakedTaphrina caerulescens (oak leaf blisters)Taphrina deformans (peach leaf curl)Leotiomycetes (Erysiphales)CleistotheciumTribes (genus):Erysiphae: Erysiphe (herbacious plants), Microsphaera (purple), Uncinula (grape)Phyllactinieae: Phyllactinia (shade trees), Leveillula (tomato)Golovinomyceteae: Arthrocladiella (boxthorn), Golovinomyces (Asteraceae, coreopsis)Cystotheceae: Podoserapha (apple, cucurbits rose)Blumerieae: Blumeria (grains)PyrenomycetesPeritheciumCeratocystis fagacearum (oak withers)Claviceps purpurea (larvae of rye and wheat)Gaeumannomyces graminis (take-all of wheat)Gibberella zeae ana. Fusarium graminearum (spoilage of wheat)Glomerella cingulata (bitter rot of apple and pear)Monosporascus cannonball (root rot and vine decline of melon)Nectria spp. (canker of hardwood) Ophiostoma ulmi; Ophistoma novo-ulmi (Dutch elm disease)LoculoascomycetesPseudotheciumApiosporina morbosa (black knot of plum)Helsinoë ampelina (grape anthracnose)Guignardia bidwellii (black rot of grapes)Mycosphaerella musicola; M. fujiensis (Sigatoka disease of banana)Venturia inaequalis (apple basket)DiscomycetesApotheciumDiplocarpon rosae (black spot of rose)Lophodermium spp. (pine needle cast) Monilinia fructicola (brown rot of stone fruit)Rhabdocline pseudotsugae (Rhabdocline needlecast of Douglas-fir)Rhytisma acerinum R. punctatum (tar spot of maple)C. purpurea (ana. S. segetum) occurs worldwide and is a more serious rye pathogen than wheat or other cereals. In spring, sclerodentia associated with fallen seed heads sprout to form many perithecia on stems along the sclerotium periphery. Each perithecium contains many asci, which in turn contains eight multicellular ascospores. The ascospores are conveyed with wind to infect the ovaries to develop flowers. Within a week, drops of conidia radiate from the infected bouquets in a matrix of sticky liquid called honeydew. Insects, attracted to honeydew, carry conidia from flower to flower. Conidia is also scattered by splashes of rain. As the disease develops, ergots form instead of nuclei. They ergot mature at the same time as the grain, and are harvested or fall to the ground. As these sclerotia lose after one year, the management of this disease includes deep ploughing and crop rotation and the use of pathogen-free seeds. It is not permitted to mill flour containing more than 0,3 % scleotia. Apple basket, one of the main diseases of apple, crabapple and other rosaceous species worldwide, is caused by V. inaequalis. Symptoms of this disease include lesions on leaves (olive-green spots with feather margins), premature leaf and fruit drop, scabbing and cracking of fruit, poor bud sets, and decreased yield. The disease was likely introduced to North America in the 1600s, when European colonies planted infected apple trees and scions. The first botanical description of the symptoms was made by Elias Fries in Sweden in 1819, and the pathogen itself was described by Cooke in 1866. Once considered an accepted fact, apple scab can be debilitating to susceptible commercial apple and decorative hosts. The Apple scab only develops shortly after a budbreak as ascospores are forcibly ejected from pseudothecia embedded in infected plant material (leaf litter) on the ground. Each pseudothecium contains up to 100 asci. The ascospores are transported by plane to the developing leaves and fruit on the tree. Ascospore release (as primary inoculum) continues for a period of up to 9 weeks, through the period the host is most vulnerable to infection. Penetration of new leaves requires a period of leaf corrosion that varies from 9 to 28 hours, depending on the temperature. A fungal germ tube from acidic ascospor penetrates cuticles, and a mycelium develops between the epidermis and cuticles. Conidia is produced on sporophores that push through cuticles into mats. These asexual spores (like secondary inoculum) are released through the rest of the growing season. On leaves falling, the fungus grows deeper into the mesophyll of infected leaves, forming pseudothecia. The fungus winters in this state until the following spring, when the disease cycle starts anew. Apple basket management is extremely important for commercial growers, and usually requires a multifaceted approach. Cultural management techniques include proper plantation placement and wood orientation, management of humidity and leaf wetness, use of resistant varieties where possible, removal of fallen leaves, if practical, and shredding leaf waste with a lawnmower, adding urea to hasten degradation. Growers usually rely, however, on fungicide sprays for effective disease control. The goal of chemical control is to effectively control the release of primary inoculum (ascospores) at the beginning of the season. Calendar sprays used in the past are based on the phrenology of the host tree. Currently, more advanced forecasting systems, based on temperature and precipitation, are in use. As a result, fewer better timed sprays are made. Mildew is biotrophic, named after the mats of mycelium and clearly tracks on the plant's surface. They are the most common, and probably best recognised, of all plant diseases. Although all kinds of plants are affected by mildew, the greatest economic impact is likely to have on cucurbits and grains. Mildew mushrooms rarely kill their hosts, but diminished photosynthetic capacity results in decreased growth and decreased yields may occur in some susceptible species. For example, serious disease caused by mildew of wheat (caused by Blumeria graminis f. sp. tritici) results in significant loss of yield and lodging in the field. As biotrofers, mildew mushrooms draw nutrients from epidermal cells via haustoria that penetrate the cell wall. All mycelial and spore development occurs on the plant's surface. Throughout the growing season, meldugs fungus produces asexual spores (conidia, some egg-shaped) in chains on short conidiophores on the plant's surface. Conidia is conveyed by airflow to new hosts (secondary cycle). When humidity is high, conidia sprout to initiate new infections. At the end of the growing season, host and environmental factors trigger the sexual cycle. Cleistothecia serve as survival structures through winter; some fungi, such as mildew of rose fungus, Podosphaera (sect. Sphaerotheca) pannosa f. sp. rosae, also wintering in buds. In this species, primary inoculum is produced in the spring, when mycelium in buds infects developing tissue, or when ascospores developed within cleistothecia are released. Mildew is classified in one of the five strains (Table 4). Characteristics of anamorphic (conidial chains and surface ornamentation) as well as cleistothecial morphology (number of asci per ascocarp, morphology of hyphal appendages on cleistothecium) are useful taxonometric criteria. Management of mildew includes the use of resistant varieties when available. Unfortunately for rose growers, most popular varieties are susceptible to this disease. The mildew of wheat pathogen is easy to adapt and has many breeds, so breeders strive to incorporate as many genes for resistance as possible into wheat varieties to increase their shelf life. Best practices for this disease include rotating crops, removing voluntary plants, and mixing wheat varieties with different genes for resistance within a single planting. For most mildews, moisture control through proper distance and weed control is useful, as is the use of contact or systemic fungicides. Unlike many other diseases, unconventional control products (such as oils, potassium bicarbonate, diluted hydrogen peroxide, and biological controls) are useful for powdery mildew management, presumably because the thallus of the fungus is on the plant's surface and is easy to eradicate. These products offer attractive alternatives to fungicides for landscape or residential customers. Brown rot of stone fruit (eg peaches, cherries, plums and almond) is caused by several different species of discomycete Monilinia (M. fructicola, M. laxa and M. Losses from this disease occur both in the field and after harvest. Brown rots manifest as a flower and fruit blight. Cankers can also develop on twigs and branches. Fruits affected by this disease develop brown spots that quickly consume fruit. Totes of gray/brown mycelium break through cuticles, and the fruit eventually loses moisture and mummifies. The sexual scene develops on mummified fruit that falls to the plantation floor and becomes partially buried. As many as 20 apothecia, each lined with thousands of asci, develop per fruit. Management is best achieved by controlling the disease's flowering phase.M.A. Cousin, in the Encyclopedia of Food Microbiology (Second Edition), 2014Some ascomycetes are responsible for food depravity. others are used in fermentations, in particular yeasts (Tables 3 and 4). The large fermentative yeasts are strains of Saccharomyces cerevisiae used to make bread, beer, saké, wine, and many other fermented foods. Zygosaccharomyces rouxii can be isolated from the fermentation of soy sauce. An ascomycetous mold genus is used for fermentation; Monascus pilosus and M. purpureus are used for the production of rice wine and kaoling brandy, respectively. Other ascomycettes are occasionally used in fermentations (Tables 3 and 4). Table 3. The importance of the large ascomycetous molds in foodMold genusSpeciesImportance in foodByssochlamysfulva, niveaHeat-resistant spores in fruit products; B. nivea not commonTChaetomium brazililiense, funicolaInsulated by cereals, legumes, nuts in tropical countriesChaetomiumglobosumInstulated from wheat, cereals, legumes, nutsEmericellanidulansInsulated by grains, legumes, meat, nuts, produce mycotoxinsEurotiumamstelodami, chevalieri, repens, rubrumXerophiles isolated from many foods: cereals, cheese, dried fruits, nutsMonasusruberSpoilage of high-fertile moistures; isolated from dried fish and other foodsMonascuspilosus, purpureusFefeche wine and kaoliang brandyNeosartoryafischeriProduce heat-resistant ascospores in acid-heated fruit productsTalaromycesmacrosporus bacillisporusProduces heat-resistant ascospores in fruit productsTalaromycesflavus, wortmanniiIsolated from cereals, nuts, meat, but no reports of spoilage of heat-treated foodsXeromycesbisporusXerophile, which grows down to 0.61 aw; isolated from licorice, dried fruitsTable table 4. The importance of some ascomycetous yeast in foodYeast genusSpeciesImportdebaryomyceshanseniiD110° C 1.3 min; is salt-tolerant, film-past in brine, destroys orange juice, yogurtHanseniasporaguilliermondii, uvarumIsolated from fruits, vegetables, wine, salted foods, soft drinksKluyveromycesmarxianusInsulated from beer, dairy products, molasses, sugar cane, vinPichiaanomola, fermentedans, membrane aefaciensInsulated from fruit juices, drinks soft, wine, beer, confectionery, dried fruit, mayonnaise, salad dressings; some species preservative resistantSaccharomycescerevisiaeFermentation yeast (bread, beer, wine, saké, whiskey, cocoa, bread (syretolerant)Saccharomycoidesludwigii Spoils cider, isolated from beer and vinSchizosaccharomycespombeXerotolerant reduces malic acid in wine, preservative-resistantTorulasporadelbrueckiiUsed in fermented bread, isolated from many foods (dairy, fruit, high sugar foods, vegetables)YarrowialipolyticaInsticaInst from chilled foods (dairy, meat, salads, shellfish)Zygosaccharomycesbailii Spoils salad dressings, mayonnaise, ice mix, wine; preservative resistantZygosaccharomycesrouxiiXerotolerant to aw 0.62, preservative resistant, isolated from fermented foods (soy sauce, cocoa, pickles)Generally, there are few ascospores present in most foods; Therefore, it will take time to discover their presence. The main problem with ascospores in food has been their resistance to heat, which allows them to survive the thermal treatments of pasteurization, canning or aseptic treatment. This has been a particular problem with heat-processed fruit juices and fruit puree or pieces products. Various D and Z values have been reported. Values of D90°C of 1-12 min and a z-value of 6-7°C have been recorded for Byssochlamy's fulva, slightly higher than for B. nivea with a D88°C of 0.75-0.8 min and z of 4.0-6.1°C. For Talaromyces, macrosphorus values for D90°C of 2-7 min and a z value of 10.3°C were recorded, and for Neosartorya fischeri, D88°C was 1.2-16.2 min and z was 5.6°C. Ascospores of these moulds have been particularly troublesome in fruit products. In fact, Byssochlamys species are rarely isolated from non-thermally processed spoiled acid foods. Yeast cells as well as mold hyphae and conidia are not as resistant to heat as ascospores. Mold ascospores are more resistant to heat than yeast ascospores. Most of the xerophilic mushrooms belong to Ascomycotina or closely related deuteromycetes. The most xero tolerant mold is Xeromyces bisporus, which grows down to a water activity (aw) of 0.61 in dried fruits, licorice, fruit cakes, and cookies with fruit fillings; but it takes about 120 days to germinate on aw at 0.61. Zygosaccharomyces rouxii is the most xero tolerant yeast that grows in foods high in sugar (sugar syrup, fruit concentrates, cake milling, confectionery, jams, chocolate sauces) by at least 0.62. Other xerophiles are species of Eurotium (Table 3), which have been isolated from many different types of foods, such as dried fruits, stored grains, dried meat and fish, and nuts. Since foods that have low water activities are not optimal for microbial growth, xerophiles generally will take months to become evident in food. Several ascomycetous yeasts are resistant to common chemical preservatives used in foods, especially benzoates and sorbate. Pichia membrane aphacience grows in foods with 1% acetic acid and up to 1500 mg kg−1 sodium benzoate at pH 4.0. Schizosaccharomyces pombe is resistant to sulphur dioxide at pH 3.0-3.5 and is isolated from foods with a sulphur dioxide content of 120-250 mg kg−1; it also grows in 600 mg l−1 l−1 benzoic acid. Zygosaccharomyces bailii is resistant to several chemical preservatives, such as acetic acid, benzoe, propionic acid and sorbic acids and sulphur dioxide at levels of 400-800 mg l−1. These yeasts have caused spoilage in foods preserved with vinegar, salad dressings and mayonnaise, sugar syrup, soft and sports drinks and fruit products. Products.