Classification of Fungi by C. J. Alexopoulos (1962):

C. J. Alexopoulos (1962) also included slime molds under fungi and placed them as Division Mycota and it was divided into two subdivisions: Myxomycotina (wall-less form) and Eumycotina(true, walled fungi).The outline of his classification is:

Division: Mycota

Microscopic, unicellular or filamentous thallus withchitinous or cellulosic cell wall containing typicaleukaryotic nucleus. Reproduction takes place both asexually and sexually.

A. Subdivision. Myxomycotina: Plant body is Plasmodium.

1. Class. Myxomycetes:

Vegetative phase is plasmodium. Reproductiontakes place by very small multinucleate spore.

B. Subdivision. Eumycotina:Vegetative phase is either unicellular or branchedmycelium with distinct cell wall. Hyphae are coenocytic (aseptate and multinucleate) or septate. Eachcell may be uni-, bi- or multinucleate. Reproductionby asexual (spore) or sexual (gamete) means.The sub-divisions has been .divided into eightnatural classes and one form-class.

These are:

1.Class. Chytridiomycetes: Motile cells with single whiplash flagellum placedposteriorly.

2.Class. Hypochytridiomycetes: Motile cells with single tinsel flagellum placedanteriorly.

3. Class. Oomycetes: Vegetative phase con sists of multinucleate and welldevelopedmycelium. Motile cells have two flagellai.e., biflagellate consists of one whiplash and theother tinsel type.

4. Class. Plasmodiophoromycetes: Multi nucleate thallus without cell wall, remainsparasitically inside the host cells. Motile cells arewith two whiplash flagella of unequal inlength.

5. Class. Zygomycetes: Well-developed coenocytic (multinucleate andaseptate) mycelium grows either parasitically orsaprophytically. Motile cells are absent.

6. Class. Trichomycetes: Multinucleate simple or branched thallus; mostlyparasite on arthopods.

7. Class. Ascomycetes: Well-developed mycelium with septate hyphae.Ascospores are produced endogenously insideascus.

8. Class. Basidiomycetes: Well-developed mycelium with septate hyphae.Basidiospores are produced exogenously onbasidium.

1. Form-class. Deuteromycetes:
Well-developed mycelium with septate hyphae.Sexual phase unknown.Reproduces mainly by asexual means.

Classification of Fungi:A schematic outline of Ainsworth's (1973)

Kingdom: Mycota
Important features:
i. Free-living, parasitic or mutualistic symbionts,devoid of chlorophyll.
ii. Cell wall composition is very variable, majoritycontain chitin and glucan.
iii. Reserve food materials are oil, mannitol andglycogen.
iv. Except some unicellular members, majority arefilamentous.

A. Division. Myxomycota:
Wall-less organisms possess either a Plasmodium (amass of naked multinucleate protoplasm havingamoeboid movement) or a pseudoplasmodium (anaggregation of separate amoeboid cells). Both are ofslimy consistency, hence slime molds.
1. Class. Acrasiomycetes (cellular slime molds)
2. Class. Hydromyxomycetes (net slime molds)
3. Class. Myxomycetes (true slime molds)
4. Class. Plasmodiophoromycetes (endo- parasitic
slime molds).

B. Division Eumycota (True fungi, all withwalls):

a. Subdivision Mastigomycotina (motile cells –zoospores present, perfect state spore-oospore).
1. Class. Chitridiomycetes (unicellular, zoosporewith single whiplash flagellum).
2. Class. Hyphochytridiomycetes (unicellular,zoospore with single tinsel flagellum).
3. Class. Oomycetes (aseptatemyceli um, zoosporeswith two flagella).

b. Subdivision. Zygomycotina (mycelium aseptate,perfect state spore-zygospore).
1. Class. Zygomycetes (mycelium immersed in thehost tissue).
2. Class. Trichomycetes (mycelium not immersed inthe host tissue).

c. Subdivision. Ascomycotina (yeasts or septatemycelium, perfect state spore- ascospores formed inascus, usually within ascocarp).
1. Class. Hemiascomycetes (no asco carp, ascinaked).
2. Class. Loculoascomycetes (fruit body anascostroma, ascibitunicate i.e., 2-walled).
3. Class. Plectomycetes (fruit body cleistothecium,asciunitunicate i.e., 1-walled).
4. Class. Laboulbeniomycetes (bodyperithecium, asciunitunicate, exoparasite ofarthopods).
5. Class. Pyrenomycetes (fruit body perithecium,asciunitunicate, not parasitic on arthopods.
6. Class. Discomycetes (fruit body apothecium, asciunitunicate).

d. **Subdivision. Basidiomycotina (yeast or septate**mycelium, perfect state spore – basidiospore
formed on a basidium).
1. Class. Teliomycetes.Basidiocarplacking,teliospores grouped in sori or scattered within thhost tissue, parasitic on vascular plant.
2. Class. Hymenomycetes.Basidio- carp present.Hymenium is com pletely or partly exposed at maturity. Basidiosporeballistospores.
3. Class. Casteromycetes.Basidiocarp present.Hymenium enclosed in basidiocarp. Basidiospore
notballistospores.

(e) Subdivision. Deuteromycotina or Fungiimperfecti.Yeast or septate mycelium.Perfect stateunknown.
1. Class. Blastomycetes.Budding (Yeast or Yeastlike) cells with or without pseudomycelium.Truemycelium lacking or not well-developed.
2. Class. Hyphomycetes. Mycelia ste rile or bearingasexual spore directly or on conidiophore, invarious aggregation.
3. Class. Coelomycetes.Mycelial; asexual sporeformed in pycnidium or acervulus.

Classification of Fungi by Hawksworth*et al.* (1983 and 1995)

Ten years after the classification of Ainsworth(1973), Hawksworth*et al.* (1983) revisedAinsworth's classification in the 7th edition of the*"Dictionary of the Fungi"*.
The changes made by them are:

1. The Division Myxomycota divided into eightclasses instead of four classes.
2. The Sub-division Ascomycotina is directlydivided into thirty seven (37) orders and arranged alphabetically; there are no classes in between.
3. The subdivision Basidiomycotina is divided intofour classes instead of three, where class Teliomycetes is replaced by Urediniomycetes andUstilaginomycetes.
4. In the sub-division Deuteromycotina, the classBlastomycetes was not considered.

Later, Hawksworth et al. (1995) thoroughly revisedthe classification in the 8th edition of the *"Dictionary of the Fungi"*. The classification wasbased on the sequence of 18s rRNA among the
different members.Though members of fungi, show similarity in their morphology, mode of nutrition and ecology, but thehigher dissimilarity is observed in the base sequences of their 18s rRNA (or more precisely inthe DNA coding for it), which is now considered asthe most important parameter to determine thegenetic relationship. Thus, it shows that the fungiare polyphyletic aggregation of unrelated members.Based on the above fact and Phylogenetic consideration, **the entire fungal communities are nowsegregated out and placed them under threedifferent Kingdoms Fungi (Eumycota), Straminopila(Chromista) and Protozoa**.Based on comparison of several factors such as, 18srRNA, cytoskeleton protein, chemical features likechitin, mitochondrial codon UGA coding fortryptophan instead of termination, storage ofglycogen, elongation factors and morphologicalstructure of motile cells like male gamete in animal and zoospores in fungi, there is close similarity offungi with animals than to other two groups likeStraminopila and Protozoa.

Further the species are divided into varieties,biological strains, physiological races, etc.The different taxa considered in this systemalong with their 'ending' are:

Phylum — mycota

Sub-phylum — mycotina

Class — mycetes

Sub-class — mycetidae

Order — ales

Family — aceae

But the genera and species have no standardending. In this system, division has been replacedby phylum and all taxa are written in italics.All the three groups are placed under the DomainEukaryota. Out of three kingdoms, kingdom Fungiincludes only fungi, but the other two kingdomsinclude non-fungal phyla also.The earlier consideration of the sub-divisionDeuteromycotina representing the asexual stages ofAscomycotina and Basidiomycotina (Ainsworth1973, Hawksworth*et al.*1983) was now reconsideredas a formal taxon as they are not a monophyleticgroup. The members are described underMitosporic fungi.

Phylum Ascomycota

1. Vegetative body is unicellular or commonly welldeveloped, branched septate mycelium with uni ormultinucleate cells having perforated septa.
2. Mostly, the cell wall is composed of chitin andglucans, but in unicellular form, it is composed ofglucans and mannans.
3. Vegetative reproduction takes place byfragmentation (in filamentous form), fission and budding (in unicellular form).
4. Asexual reproduction takes place by non-motilespores, such as conidia, oidia and chlamydospores.
5. Sexual reproduction takes place by gametangialcopulation (Saccharomyces), gametangial contact(Penicillium), somatogamy (Morchella) orspermatiza- tion (Polystigma).
6. Complete absence of motile structures.
7. The product of sexual reproduction is theascospores grown inside a small specialised saclike structure, called ascus.
8. The fruit bodies (inside which ascus developed)are the ascocarps. The asco- carps may be cleistothecium (Penicilliumi), apothecium(Ascobolus), peritheci um (Daldenia) or ascostroma(Elsinoeveneta).

Common genera:*Saccharomyces, Penicillium, Daldenia, Ascobolus,Morchella* etc.

Phylum Basidiomycota

1. Presence of well-developed, branched and septatemycelium having simple (e.g., Ustlaginales andUredinales) or dolipore (e.g., Auriculariaceae,aphyllo- phorales and Agaricales) septum.
2. The mycelial cells contain one nucleus, calledmonokaryotic i.e., primary mycelium or two nuclei,called dikaryo tic i.e., secondary mycelium. Thesecondary mycelia may organise and form fruitbody, called tertiary mycelium.
3. The cell wall is mainly composed of chitin andglucans.
4. Reproduction

(a) Vegetative reproduction takes place by buddingand fragmentation.

(b) Asexual reproduction takes place by conidia,oidia or chlamydospores. This is lacking in somehigher taxa of this subdivision.

(c) Sex organs are absent. During sexu alreproduction, the dikaryotic cell is formed by somatogamy, sperma- tisation or by bullerphenomenon. The dikaryotic phase persists for longperiod of time. Karyogamy occurs in basidiummother cell and forms diploid nucleus, which isephemeral (short lived). 4-haploid basidiosporesare formed by meio- sis. Basidio spores aredeveloped exogenously on the horn-shapedstructure, the sterigmata (generally 4) on thebasidium.

5. Basidia are of two types: Holobasidium (aseptate)e.g., Agaricus, Polyporusetc.and Phragmobasidium (septate) e.g., Puccinia, Ustilago
6. Except in lower forms (*Puccinia, Ustilago*),secondary mycelia by aggregation form fruit body,the basidiocarp [Agaricus, Polyporus etc.). Thenumber of spores' on eachbasidium is commonly 4,but 2 or more than 4 are also pre sent.

Common genera:*Agaricus, Polyporus, Puccinia* etc.

Phylum.Chytridiomycota

1. Vegetative body is coenocytic and thalloid, eitherglobose or ovoid structure, either an elongatedsimple hypha, or well, developed mycelium.
2. Cell wall is mainly made up of chitin and glucan.
3. Nuclear division is intranuclear and centric type.
4. Members of this group produce motile cells atsome stage of their life cycle.
5. Motile cells (zoospores and gametes) possesssingle posteriorly placed, whiplash type of flagellumexcept a few polyflagellate cells.
6. Sexual reproduction takes place by planogametesdeveloped in gametangia. The fused gametes formzygote. Zygote on germination develops either intoa resting spore or resting sporangium except' a fewthose develop diploid thallus.

Common genera:*Synchytrium, Monoble- pharis, Rhizophidium* etc.

PhylumZygomycota

1. The thallus is normally haploid, consisting ofcoenocytic mycelium and its wall contains chitin and chitosan.
2. The mycelium contains cell organelles like otherfungi, except typical Golgi bodies and centriole.
3. Asexual reproduction takes place byaplanospores.
4. Sexual reproduction takes place by gametangialcopulation results in the formation of zygospore (2n)[only diploid spore].

Common genera:Mucor, Rhizopus, Phyco- myces, Cunninghamellaetc.

Kingdom Straminopila or Chromista (i.e., pseudofungi)

Phylum Hyphochytriomycota

It is a very small group, comprising of about 23known species.Important characteristics:
1. The organisms are thalloid, soil-inhabiting oraquatic, chitridlike.
2. Cell wall contains both chitin and cellu lose.
3. Thalli are either holocarpic or eucarpic. Theholocarpicthalli are endobiotic and converted into azoosporangium. In eucarpic forms, the thalli mayconsist of a single reproductive organ bearing abranched rhizoidal system or may be polycentricwith septate and branched hyphae.
4. Motile cells (zoospores) possess single anteriorlyplaced flagellum, converted with flagellar hairs,which developed inside zoosporangium and arereleased through discharge tubes.
5. Sexual reproduction has not been demonstratedconclusively in any member. But some evidencesuggestive of sexual cycle has been described for*Anisolpidiumectocarpiparasitises* on *EctocarpusmitchelIae*. Suspected zygote has been reported insome, but meiosis has not been reported.
Common genera:*Rhizidiomyces, Reessia, Hyphochytrium* etc.

Phylum Labyrinthulomycota(Net Slime Molds)

1. Members are found primarily in estuarine (a widetidal mouth of a river) and near shore habitat;associated with algae, leaves of higher plants and organic debris.
2. Members are mostly saprobic or weak parasitesand exhibit nutrition through absorption.
3. Vegetative body is a net slime mold.
4. Presence of an ectoplasmic net-work ofanastomosing, branched, wall-less filaments,produced by cells with a specialized cell surfaceorganelle, the sagenogen or bothrosome.
5. Cell walls are composed of scales derived fromGolgi.
6. Zoospores are flagellate, heterokont (unequalflagella) type. Flagella are laterally inserted. Largerone is tinsel, directed anteriorly and the shorter oneis whiplash, directed posteriorly.

Common genera:*Labyrinthula, Thraustochytrium* etc.

Phylum Oomycota

1. Members of Oomycetes are found to grow in bothfresh water and salt water as well as in terrestrialhabitat.
2. They are either unicellular or filamentous,composed of profusely branched and coenocytichyphae.
3. Septa develop in older region and also at the baseof reproductive structures.
4. Cell wall is composed primarily of β-glucans, butalso contains hydroxylpro- line, an amino acid; andsmall amount of cellulose.
5. Cells contain mitochondria with tubular cristaeand with various types of bio chemical andmolecular characteristics.
6. Cell divisions (both mitotic and meiotic) areintranuclear and centric (i.e., the nuclear envelopremains intact until the end of division andcentrioles are pre sent at the poles of the dividingnuclei).
7. Unicellular forms are holocarpic, but filamentousforms are eucarpic.
8. Asexual reproduction takes place by means ofbiflagellate zoospores with shorter whiplash andlonger tinsel flagella.
9. Zoospore ultrastructure shows variouscharacteristics.
10. Sexual reproduction is oogamous and takesplace by gametangial contact and which producesthick-walled sexual spore, the oospore.
11. Meiosis takes place in the developinggametangia (antheridia and oogonia).

Common genera:*Phytophthora,Pythium, Peronospora, Albugo* etc.

Kingdom Protozoa (i.e., the slime moulds)

Phylum Plasmodiophoromycota(Endoparasitic Slime Molds)

This group is commonly known as endoparasiticslime molds. They are obligate parasites grow onalgae, aquatic fungi and higher plants (commonly inthe roots).

1. Members of this class are obligate parasites (i.e.,biotrophic) on fresh water algae, aquatic fungi andhigher plants (commonly in the roots).
2. Vegetative body consists of a naked holocarpicplasmodium.
3. Plasmodia are of two types in their lifecycle:Sporangiogenous plasmodium (forms sporangium)and cytogenous- plasmodium (gives rise to cyst i.e.,res ting spore).
4. Zoospores biflagellate, having equal flagella ofwhiplash type situated in opposite direction, theshorter one in anterior and longer one in posteriorside.

Common genera:*Plasmodiophora, Octomyxa, Sorodiscus* etc.

Phylum Dictyosteliomycota(Dictyostelid Cellular Slime Molds)

1. These are saprobic slime molds; grow in themiddle of organic debris like dung, decaying plantsand also in soil.
2. Somatic phase is microscopic and thefructifications are minute, inconspicuous (not easilynoticed) and ephemeral (short-lived).
3. The somatic amoebae have filose pseudopodiaand a nuclear envelope persisting up to later stage.
4. Somatic amoebae aggregate together to form apseudoplasmodium.
5. The amoebae never fuse together, but retain theirindividuality with full co operation as member of anassociation till the formation of sorocarp (Gr. sorus,heap; karpos, fruit).
6. The sorocarp is differentiated into two regions:stalk and spores. On germination, spores developinto myxamoeba.

Common genera:*Dictyostelium, Polysphondylium* etc.

Phylum Acrasiomycota(Acrasid Cellular Slime Molds)

Members of this group are commonly known asAcrasid Cellular Slime Molds. They are foundprofusely in the upper layer of humus in deciduousforests and in cultivated lands.

1. Somatic phase mainly consists of amoeboid cellsor myxamoebae.
2. Myxamoebae aggregate to form a pseudoplasmodium, which develops fruit body.
3. Lack of flagellated cells except in Pocheinarosea.
4. Fruit bodies may be sorocarp (in Dictyostelium)or sporocarp (in Protostelium).

Common genera:Dictyostelium, Protostelium etc.

Phylum Myxomycota

They are commonly known as true slime molds orplasmodial slime molds, found in damp placesespecially on old wood and other decomposingplant parts.

1. Somatic body is a free-living plasmodium.
2. They feed on yeast cells, protozoa, fun gal sporesand other substances.
3. Reproduction takes place by asexual and sexualmeans.Asexual reproduction takes place by fragmentationin plasmodium or by binary fission in myxamoebae.Sexual reproduction takes place by fusion betweenflagellated zoo spores or myxamoeba to form zygote,from which multinucleate plasmodium develops bymitotic divisions. They develop different types offructification. These are sporangium, aethalium andplasmodiocarp. Meiosis takes placeduring spore formation in the fructification.

Common genera:*Ceratiomyxa, Physarum* etc.

Deuteromycota or Fungi imperfecti ……..?

Deuteromycota, arethe fungal groupwhich do not fit into the commonly establishedtaxonomicclassifications of fungi that are based onbiological species conceptsor morphological characteristics of sexual structures; because their sexual form of reproduction has never been observed.
All members are**anamorphic fungi**, or**mitosporic fungi**, but these are terms without taxonomic rank. Examples are *Alternaria, Colletotrichum, Trichoderma* etc.

Although Fungi imperfecti/Deuteromycotais no longer formally accepted as ataxon, many of the fungi it included have yet to find a place in modern fungal classification. This is because mostfungiare classified based on characteristics of the fruiting bodies and spores produced during sexual reproduction, and members of the Deutromycota have only been observed to reproduce asexually or vegetatively.

Mycologistsare unique among those who study extant organisms in using a dual system of nomenclature. Dual naming was permitted by Article 59 of the*International Code of Botanical Nomenclature*(which governs the naming of plants and fungi); however, this was abolished in the 2011 update of the Code.

Under the former system, a name for an asexually reproducing fungus was considered a*form taxon*. For example, the ubiquitous and industrially important mold,*Aspergillus niger*, has no known sexual cycle. Thus*Aspergillus niger*is considered a form taxon. In contrast, isolates of its close relative,*Aspergillusnidulans*, revealed it to be the anamorphic stage of a**teleomorph**(theascocarpor fruiting body of the sexual reproductive stage of a fungus), which was already named*Emericellanidulans*. When such a teleomorphic stage is known, that name will take priority over the name of an**anamorph**(which lacks a sexual reproductive stage). Hence the formerly classified*Aspergillus*species is now properly called*Emericellanidulans*.