CHAPTER 6.0 KEYS

6.0 KEY TO GENERA OF FUNGI ISOLATED FROM STORED STARCH-BASED FOOD

6.1 General key to starch-based food fungi

1.	Hyphae frequently and conspicuously septate	2
	Hyphae lacking septa	**Zygomycetes**
2.	Phialides borne on vesicles, vesicles larger than 10 μm diameter, stipes non-septate	***Aspergillus* and its teleomorphs**
	Phialides produced successively on vesicles, vesicles less than 10 μm diameter, stipes usually septate	***Penicillium* and its teleomorphs**

6.2 Microscopic key to genera Mucorales

1.	Sporangiospores borne in cylindrical sacs (merosporangia) attached around collumella (with appearance at low magnifications reminiscent of *Aspergillus*)	***Syncephalastrum racemosum***
	Sporangiospores borne within roughly spherical sacs (sporangia); collumellae without adherent cylinders	2
2.	Sporangiophores verticillate or solitary branches, sporangia and sporangioles present	***Cunninghamella polymorpha***
	Sporangiophores solitary, only sporangia, or collumellae derived from sporangia present	3
3.	Collumellae collapsing to form funnel or umbrella shapes, sporangiospore walls smooth or striate	4
	Collumellae retaining approximately spherical shape after sporangiospore discharge, sporangiospore exceeding 5.0 μm in long axis with walls smooth or spiny	***Mucor circinelloide***
4.	Collumellae collapsing outwardly to form an umbrella shape, sporangiospore walls striate	5

Collumellae collapsing inwardly from the apex to form a funnel shape, sporangiospore walls smooth — ***Absidia corymbifera***

5. Sporangiophores mostly not exceeding 0.8 mm in height; rhizoids simple; sporangia up to 100 µm diameter — ***Rhizopus microsporus***

Sporangiophores often more than 1 mm in height; rhizoids with secondary branching; sporangia often over 100 µm diameter but not exceeding 240 µm diameter — ***Rhizopus arrhizus***

6.3 Key to *Aspergillus* species and teleomorphs

1. Phialides strictly uniseriate

   A. Conidial heads clavate in blue green shades; vesicles strongly clavate — ***A. clavatus* group**

      a. Conidial structures not exceeding 4.0 mm in length and showing characteristic splitting in age — ***A. clavatus***

      b. Conidial structures not exceeding 4.0 mm in length and not splitting into divergent columns — ***A. longivesica***

   B. Conidial heads small and radiate in olive green shades; vesicles subglobose; bright yellow cleistothecia abundant; ascospores smooth walled with just a trace of longitudinal furrow — ***Eurotium repens***

   C. Conidial heads compactly columnar in light yellow to grey green shades; vesicles flask shaped. Conidiophores 0.5 mm or less; conidia globose and echinulate — ***A. fumigatus***

2. Phialides biseriate or uniseriate, or with both conditions in the same head, conidial heads usually globose when young, radiate or splitting in age; vesicles globose to subglobose; sclerotia produced in many species

   A. Conidial heads in shades of black; conidiophores smooth and colourless or becoming pigmented below the vesicle — ***A. niger* group**

a. Phialides biseriate, conidia globose and irregularly roughened, mostly 4.0 - 5.0 µm — ***A. niger***

b. Phialides uniseriate, conidia subglobose to elliptical and conspicuously echinulate; vesicles ranging from 35 - 100 µm — ***A. aculeatus***

B. Conidial heads white or cream coloured; conidiophores smooth and colourless — ***A. candidus***

C. Conidial heads in yellow green to deep olive brown shades; conidiophores usually roughened and colourless — ***A. flavus* group**

a. Conidial heads radiate or very loosely columnar; conidia globose to subglobose and echinulate — ***A. flavus***

b. Conidial heads columnar; conidia ranging from cylindrical to globose or subglobose and conspicuously roughened from prominent tubercles — ***A. tamarii***

3. Phialides strictly biseriate

A. Conidial heads radiate to loosely columnar, vesicles globose to elongate — ***A. versicolor* group**

a. Conidial heads short and columnar in light yellow green to orange yellow — ***A. versicolor***

b. Conidial heads small and radiate in blue green shades — ***A. sydowi***

B. Conidial heads compactly columnar, typically in cinnamon to pale buff shades; conidiophores colourless; vesicles hemispherical — ***A. terreus***

6.4 Key to *Penicillium* species and teleomorphs

1. Cleistothecia with a *Penicillium* anamorph present — ***Eupenicillium* spp.**

Cleistothecia absent — 2

2. Penicilli consisting of a single cluster, or verticil of phialides at the tip of the stipes; stipes usually unbranched, exceptionally with an additional branch but with each branch terminating in a distinct and separate simple penicillus — 3

   Penicilli characteristically once or twice branched below the level of phialides — 7

3. Colonies producing pale sclerotia, conidiophores rough and conidia elliptical — ***P. thomii***

   Colonies not producing sclerotia — 4

4. Stipes arising mostly from the substratum, rapid growth, conidia globose and conspicuously roughened; reverse uncoloured to purplish — ***P. spinulosum***

   Stipes primarily borne as short branches from aerial hyphae — 5

5. Colonies velvety or slightly lanate — 6

   Colonies with funiculose habit predominant, developing deep vinaceous to purple red colours, phialides small, up to 8 μm long — ***P. vinaceum***

6. Colonies loose-textured, with margin usually thin and generally consisting of a loose network of interlacing hyphae bearing short stipes, conidia elliptical — ***P. chermesinum***

   Colonies close-textured, tough, almost leathery, restricted with margin compact but showing occasionally stolon-like hyphae, conidia globose to subglobose — ***P. citreonigrum***

7. Branching asymmetrical, irregular, or one sided; phialides not acerose or needle shaped — 8

   Branching biverticillate and symmetrical, but sometimes fractional in some species and strains; phialides typically lanceolate or acerose, with long-tapered, acuminate necks — 15

8. Penicilli strongly divaricate or bifurcate, commonly presenting the appearance of irregular and apical clusters of penicilli retaining always their monoverticillate character — 9

   Penicilli not strongly divaricate, metulae less divergent — 10

9. Colonies developing pale grey green and reverse yellow to colourless. Conidiophores delicately roughened; conidia ovoid to subglobose — ***P. simplicissimum***

Colonies in blue-green shades and reverse yellow. Conidial chains usually in well-defined columns; conidia globose to subglobose — ***P. citrinum***

10. Penicilli one- or two-stage branched with abundant conidiophores arising primarily in a dense stand from the substratum or the basal felt, giving a velvety appearance to the colony surface — 11

    Penicilli usually two-stage branched with conidiophores completely or partially aggregated into loose or well-defined synnemata or fascicles, lending a granular, tufted or roughened appearance to the colony surface — 12

11. Conidia less than 5 µm in long axis, elliptical to subglobose — ***P. chrysogenum***

    Conidia commonly 5 µm or more in long axis; elliptical and smooth-walled — ***P. oxalicum***

12. Conidiophore stipe on CDA, definitely smooth-walled — 13

    Conidiophore stipe on CDA rough-walled — 14

13. Phialides short, less than 6.5 µm long, with a very short, inconspicuous neck; rami strongly divergent; colonies blue to grey green — ***P. griseofulvum***

    Phialides longer than 6.5 µm long, with conspicuous neck; rami appressed not divergent; colonies yellow green to blue green — ***P. expansum***

14. Colonies grey green to dull blue green and spreading more than 70 mm in 14 days on CDA; phialides slender — ***P.aurantiogriseum***

    Colonies blue green and spreading less than 70 mm in 14 days on CDA; phialides bottle-shaped — ***P. verrucosum***

15. Colonies with surface appearing funiculose, floccose-funiculose, or sometimes tufted; conidiophores arising primarily from aerial hyphae or ropes of hyphae — 16

    Colonies with ropiness absent, or reduced and inconspicuous, typically velvety or lanate; conidiophores arising primarily from the substratum — 18

16. Colonies spreading broadly on CDA i.e. more than 50 mm in 14 days. Vegetative hyphae in bright yellow or pinkish shades — ***P. pinophilum***

    Colonies usually more or less restricted on CDA i.e. less than 50 mm in 14 days — 17

17. Colonies bristly showing areas of red or orange mycelium and dark green conidia; exudate abundantly produced as large, sticky, clear droplets — ***P. islandicum***

    Colonies showing areas of white to brownish red mycelium and brownish green conidia; exudate lacking — ***P. minioluteum***

18. Colonies upon CDA never developing an intense red pigmentation; conidia elliptical and conspicuously rugulose. Colonies usually restricted, close textured and wrinkled — ***P. rugulosum***

    Colonies upon CDA usually developing an intense red or purple red pigmentation — 19

19. Colonies consistently deep red colours in reverse and yellow or orange red aerial hyphae evident; conidia elliptical to subglobose, typically roughened — ***P. purpurogenum***

    Colonies developing orange shades in reverse; conidia strongly elliptical, smooth or faintly roughened — ***P. variabile***