

Q.1. Define plant pathology. Write objectives of plant pathology.

Plant pathology - It is the branch of Agricultural biological science which deals with the study of diseases in plants their causes, ethiology, epidemiology resulting losses & management.

objectives of plant pathology.

- i) To study living, non-living & environmental cause of disease of the plant.
- ii) To study mechanism of disease development by pathogens.
- iii) Study the interaction between plant & pathogen in relation to overall environment
- iv) Develop the system of management & reduces losses caused by them.

Q.2. Write down importance of plant disease & its classification.

- 1) Losses caused by plant disease about 34% of crop produced is lost annually due to disease, insects, pests, & weeds on the global basis out of which 12% loss is due to the disease caused by fungi, bacteria, viruses, 11% due to nematodes, 7% due to insect, pests and 8% due to weeds.
- 2) When plant protection measures are not

implemented annual loss of 30-50 % are common in major crops.

Epidemics - late blight of potato caused by phytophthora infections was responsible for causing Irish famine in 1846 by destroying the potato crop staple food & of people

Brown spot of rice caused by helminthosporium oryzae was responsible for bengal famine in 1943.

### 3) Losses in India -

i) Wheat rust caused loss of ₹ 400 crore annually

ii) loose smut of wheat is estimated to cause an average loss of about 800 crore annually of every year.

### 4) Effects on society

Infected grains or fruits may contain toxins which causes stomach disorder, paralysis & liver cancer.

5) This money spent on the management of plant disease is also a loss because in the absence of disease money could be saved.

6) There are many other implication on the disease & transport.

7) There is restriction on the movements of food grains & other agri produce due to threat of quarantine pathogens.

Q.3. Enlist causes of plant disease, explain in short along with examples of disease caused by them.

Plant diseases are caused by variety of pathogens

1) Abiotic factors - They include mainly deficiency or excess of nutrients, light, moisture, aeration, abnormality in soil condition, atmospheric impurities.

e.g. khaira disease of rice; caused due to zinc deficiency.

Black heart of potato due to excess accumulation of  $\text{CO}_2$  in the storage.

2) Mesobiotic causes - These are the diseases causing agents which are neither living or non-living.

e.g., viruses & viroids

viruses - Potato leaf roll, leaf curl of potato & chillies & mosaic disease of many plants

Caused by viruses.

3) Biotic causes - This category includes pathogens which are animate or living or cellular organisms

i) They are prokaryotes like bacteria which are unicellular, prokaryotic, organisms lacking through nucleus.

e.g. disease caused by bacteria - wilt of potato, citrus canker, soft root of vegetables etc.

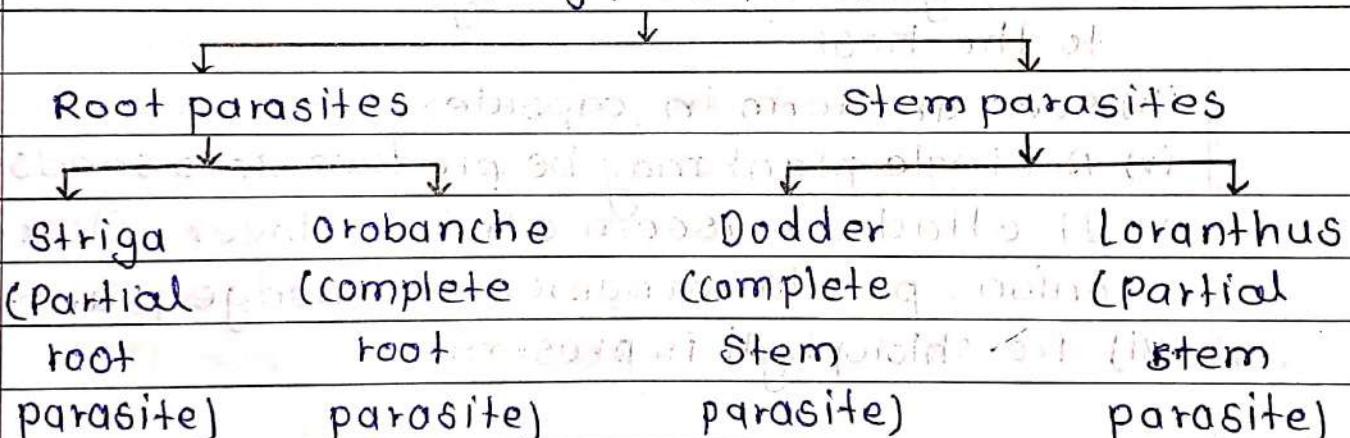
ii) Phytoplasma are cell wall less prokaryotes & causes disease of grapes, white almond leaf

Q) Eukaryotes are the organism with true nucleus like

- a) fungi - powdery mildew, downy mildew, Red rot of sugarcane, white rust, late blight of potato, damping off.
- b) Protozoa - Heart root of coconut tree
- c) Algae - Red rust of mango
- d) Nematodes - Root knot of vegetables
- e) Parasitic flowering plants - dodder, striga, Loranthus, Orobanche.

Q.4. Classify phanerogamic plant parasites & explain in brief

flowering plant parasites



Most of the disease are caused by fungi

bacteria and viruses. There are few seed plants called flowering parasites which are parasitic on living plants. Some of this attack roots of the host, while some parasites on stem. Some are devoid of chlorophyll & entirely dependent on their host for food supply, while other have

have chlorophyll & obtain only mineral constituent of food from host. They produce flowers & seeds & parasitize their host by drawing nutrition & water they are called as holoparasite or complete or total parasite. They have haustoria as absorbing organs, which are sent deep into the vascular bundle of the host to draw nutrients, water & minerals.

#### a) Stem parasite -

##### i) Complete parasite -

Cuscuta or dodder, family Cuscutaceae

Genus - Cuscuta

i) It is non-chlorophyllous, leaf less parasitic seed plant.

ii) It is yellow, pink or orange in colour & attached to the host.

iii) Seeds are formed in capsules

iv) A single plant may produce 3000 seeds.

v) It attacks berseem, alfalfa, clover, flax, onion, potato, ornamental & hedge plants.

vi) No chlorophyll is present.

#### e) Loranthus partial parasite -

Loranthus family Loranthaceae.

i) Stem is thick & flattened at the node, appear in clusters at the point of attack which can be easily spotted on the trees.

ii) At the point of attachment with the tree, it shows swellings or tumourous growth where the haustoria are produced.

iii) The affected host plant becomes stunted in growth & dispersal of seed is mostly through the birds & animals. It attacks mango, citrus, apple, guava.

### b) Root parasite

#### i) Complete parasite -

- i) It is annual flashy flowering plant growing up to height of about 15-50 cm long, yellow colour, scaly leaves.
- ii) fruits are capsule containing and seeds are very small black in colour remain viable for several years.
- iii) It attacks tomato, brinjal, cabbage.

#### ii) Partial parasite -

- i) It is a small plant with bright green leaves grows up to height 20-60 cm leaves.
- ii) Dissemination takes place with rain water, flood, wind & irrigation water.
- iii) It attacks sugarcane, jowar, maize, cereals & millets.

Q.5. Write general characters of following micro-organism

#### a) fungi -

- i) fungi are chlorophyllus, non-vascular, thallophytes
- ii) They are eukaryotic, micro-organisms.
- iii) Their size ranges from 5.0 to 10.0 Nm.

- iv) Fungi are heterotrophs i.e. live as parasite & sporophyte.
- v) Genetic material is DNA & mitosis is intracellular.
- vi) Cell wall is present & made up of chitin.
- vii) Reproduction is sexual, asexual & vegetatively.
- viii) They have both beneficial, harmful activities.

### b) Bacteria -

- i) Belongs to group of phylogenetically related prokaryotes but distinct from archas.
- ii) Size ranges from  $0.5 - 3.0 \mu\text{m}$ .
- iii) Structure is unicellular.
- iv) Cell wall is present.
- v) Simple internal structure.
- vi) Reproduction through asexual simple cell division.
- vii) Some bacteria reduces soil fertility.

### c) viruses -

- i) viruses are non-cellular organism.
- ii) Size ranges from  $0.015 - 0.2 \mu\text{m}$ .
- iii) obligate parasite.
- iv) virus may contain either DNA or RNA but they use biosynthetic machinery of host to produce capsid protein from their genetic machinery.
- v) Don't have protoplasm.
- vi) Depends on higher organism for energy & reproduction.

## d) Algae -

- i) Algae are the group of eukaryotes organisms that is chlorophyllous & carry out oxygenic photosynthesis.
- ii) Thallophytes without true stem, root & leaf
- iii) size ranges from 1mm to many metres.
- iv) unicellular & multicellular.
- v) They are autotrophic
- vi) Reproduction by sexual, asexual, vegetative method

## e) Nematodes -

- i) Nematodes are microscopic form under animal kingdom with body 70 cm long
- ii) Diameter is 15-35 Nm, length ranges 300 - 1000 Nm.
- iii) Three tabular layer.
- iv) They bound by cuticle covers all natural aperture.
- v) Head protein has mouth with six lips.
- vi) This are multicellular worms.
- vii) Almost all nematodes feed on higher organism.

## f) Protozoa -

- i) They are eukaryotic, unicellular organisms
- ii) cell wall is absent
- iii) size ranges from 2-200 Nm
- iv) Survive in soil, fresh water & marine water
- v) most are motile.
- vi) Reproduction by asexual & sexual pores.

### g) Mycoplasma-

- i) Mycoplasma are virus like bodies ( $0.8-1.0 \text{ nm}$ )
- ii) These are simplest cellular micro-organisms
- iii) These lack cell wall, flagella & mesosomes.

Q.6. Write down short note on symptoms produced by different pathogens & explain in detail.

Symptoms - External expression or the evidence of the abnormalities in the appearance of the diseased plants brought about by the pathogen after host-pathogen interaction.

- I) Symptoms of plant disease due to character & appearance of visible pathogen, its structure & organ

#### i) Mildews -

- i) Mildews consist of white-grey, brownish or purplish pathogen growth on host surface
- ii) Downy mildew is characterised by a tangled cottony or downy growth mostly on the lower surface of leaves or other plant parts.
- iii) Black minute fruiting bodies may also develop in the powdery mass.

#### ii) Rust -

- i) Rust appears as relatively small pustules of the spores, usually breaking through the host epidermis.
- ii) Pustule is a small blister-like elevation

of the epidermis, often opening to expose spores. The pustules may be dusty or compact & red, brown, yellow or black in colour.

### iii) Smut -

- i) Smut means a sooty or charcoal like powder.
- ii) The affected parts of the plants show black or purplish black dusty areas.
- iii) Symptoms usually appear on floral organs, particularly the ovary areas.
- iv) The pustules on the leaves & stems are usually larger than those of rusts.

### iv) White blister -

- i) White blister-like pustules appear on the leaves & other parts of cruciferous plant which break open the epidermis expose powdery masses of spores.
- ii) Such symptoms are called 'white rust', although there is nothing common with them & the rusts.

### v) Blotch -

- i) It consists of superficial growth giving the affected plant parts i.e. fruits, leaves, smoky appearance.
- ii) Sclerotia -
- i) A sclerotium is a compact, often hard mass of dormant fungus mycelium.

ii) Sclerotia are mostly dark in colour & are found mixed with the healthy grains as in the case of ergot of wheat & rye.

### vii) Exudation -

- i) Mass of bacterial cells ooze out on the surface of the affected organs where they may be seen as a drop or smear in several bacterial diseases such as bacterial blight of paddy.
- ii) They form crusts after drying.

### viii) Mycelial growth

- i) Appearance of white cottony mycelial growth of the fungi like dematophora mucedo on affected roots of apple is an important diagnostic feature of white root in the field.

## II) Symptoms resulting from Internal disorders in the Host plants.

### i) Colour change -

- i) Discolouration is change of colour from normal. It is one of the most common symptoms of plant disease. The green pigment of leaves disappears entirely & is replaced by yellow pigment.

- ii) Etiolation is yellowing due to lack of light.

- iii) Chlorosis is yellowing due to low temperature, lack of iron, excess of the lime or alkali in soil & infection of viruses.

- iv) Albinism is the phenomenon in which the leaves become devoid of any pigment.

v) Chromosis is change of colour to red, purple.

vi) Overgrowths or hypertrophy.

i) Hypertrophy is the abnormal disease increase in the size of the plant organ due to increase in the size of the cells of a particular tissue.

ii) Hyperplasia is the abnormal increase in the size of the plant organs due to increase in the no. of cells of which the tissue or organ is composed.

iii) The overgrowth cause galls, pockets or bladders, hairy root.

iii) Atrophy or Hypoplasia or Dwarfing.

i) Atrophy is inhibition of growth & thereby showing stunting & dwarfing effect on the plants.

ii) The whole plant may be dwarfed or only certain organs are affected.

III) Necrosis

i) Death of the cells, tissues and organ occurs as a result of parasitic activity.

ii) The characteristics appearance of the dead areas differs with different hosts, host organs & with different parasites.

iv) Nectrotic symptoms include spot, streaks or stripes, Canker.

IV) Wilt

i) characterised by drying of the entire plant

- i) usually seen first in some of the leaves
- ii) Later, the young growing tip or the whole plant may dry up.
- iii) May be caused by injuring to the host system or the conducting vessels.

#### vi) Die-back or Wither Tip

- i. Symptoms are characterised by drying of plant organs, especially stems or branches, from the tip backwards.
- ii. It is also form of necrosis caused directly by the pathogen or its toxins.

**Q.7.** Define fungi. Enlist methods of reproduction of fungi & explain in detail sexual reproduction in fungi.

**Fungi-** Fungi are eukaryotic, spore bearing achlorophyllous organisms with absorptive nutrition that generally reproduce both sexually & asexually.

#### Methods of reproduction of fungi -

- 1) Vegetative reproduction
- 2) Asexual reproduction
- 3) Sexual reproduction

#### Sexual reproduction -

- 1) It is union of two different nuclei or gametes of opposite sex, i.e. haploid.
- 2) Process of sexual reproduction consist of three different stages

- i) Plasmogamy - union of two protoplast bringing two haploid nuclei together in the same/common cell.
  - ii) Karyogamy - Actual fusion of two haploid nuclei brought together as a result of plasmogamy.
    - karyogamy immediately follows the plasmogamy
  - iii) meiosis - The nuclear fusion is followed by meiosis. It reduces the number of chromosomes to haploid.

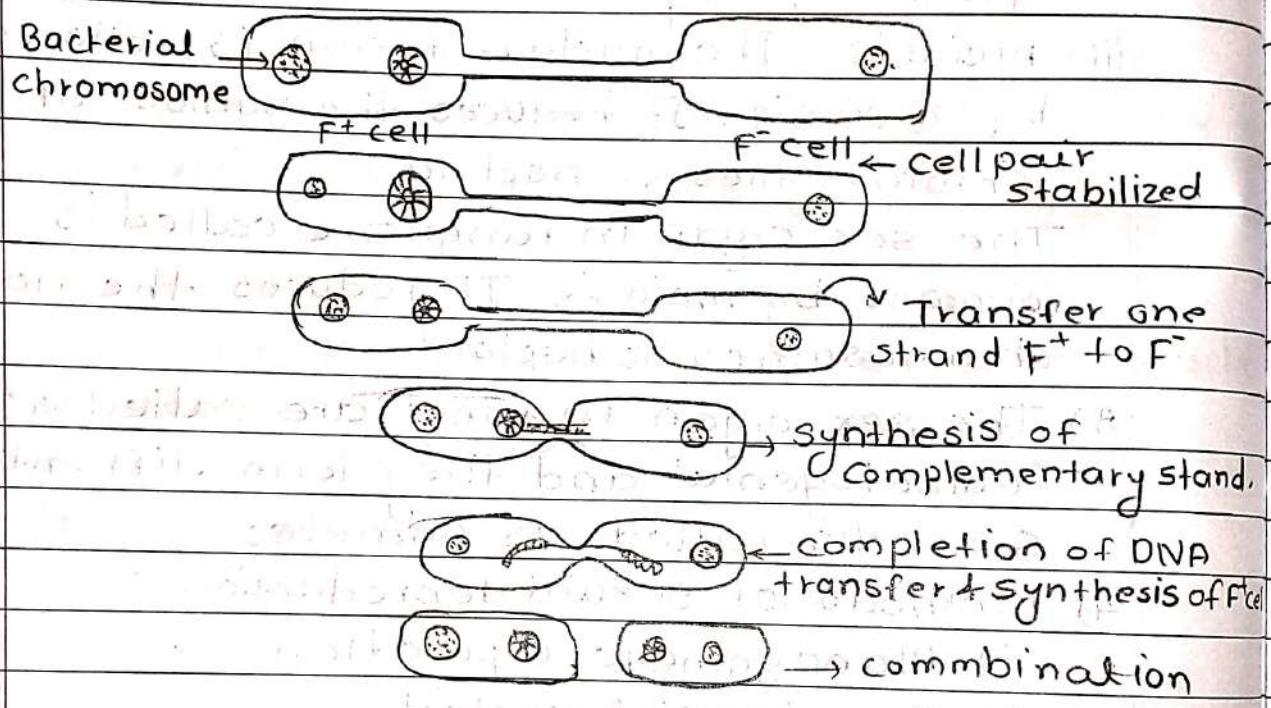
The sex organ in fungi are called is followed by meiosis. It reduces the no. of chromosomes to haploid.
- 8) The sex organ in fungi are called as 'Gametogenia' and they form differentiated sex cells called as Gametes.
- 4) Methods of sexual reproduction
- i) Plano gametic copulation
  - ii) Gametangial contact
  - iii) Gametangial population
  - iv) Spermatization
  - v) Somatogamy
  - vi) Diakaryotization
  - vii) Heterokaryosis

Q.8. What do you mean by genetic recombination in Bacteria, explain in brief.

The prokaryotic micro-organisms their is no fusion of the cells sexuality is limited to the

transfer of the genetic material from donor cell to recipient cell. This combining of genes from 2 different cell is known as recombinant & resulting cell is known as recombinant.

Gene transfer is significant because it greatly increase genetic diversity of bacteria.



### I) Conjugation

During the conjugation donor cell ( $F^+$ ) comes in physical contact with recipient cell ( $F^-$ ) via conjugation bridge formed by sex pili & transfer its genome to recipient cell.

Transfer of  $F$  plasmid DNA is initiated by formation & cut at origin of transfer by the enzyme endonuclease. A single strand of plasmid DNA transfer to the recipient cell & replacement strand is synthesized in donor cell & complementary strand in recipient cell.

## 2) Transduction -

During transduction a portion of DNA of one bacterium is transferred by bacteriophage as vector to another recipient cell. A bacteriophage undergo rapid lytic growth cycle in bacterium & helps in transfer of gene to recipient cell.

a) Generalised transduction - A fragment of bacterial DNA is accidentally introduced into a new phage particle during viral replication & thereby transfer to another bacterial cell.

b) specialised transduction - In this transduction phage particles can transfer only specific gene from one bacterial cell to another.

## 3) Transformation -

It is the process where cell free DNA containing limited amount of genetic material is transfer from one cell to another.

DNA is obtained from donor cell by natural cell lysis or by chemical extraction once the DNA is taken by recipient cell recombination occurs.

After the DNA entry into bacterial cell one strand is immediately degradable by deoxyribose enzyme while other strand undergoes base pairing with homologous portion of recipient cell chromosome.

Since complementary base pairing takes place bet'n one strand of donor DNA & a specific region of the recipient chromosome only closely related strains of bacteria can be transformed.

Q.9. Write down short notes on

a) Replication of viruses -

Viruses multiply by replication of their genome within host cell they multiply or reproduce without loosing their shape or structure viral multiplication involves several steps which are as follows:

- 1) Entry into host cell - viruses need injury or vector for entry into host & unable to penetrate in cell wall.
- 2) Uncoating - virus genome must be released from protein coating. The uncoating occurs during early phase of infection where exactly it takes place is not known.
- 3) Nucleic acid replication & synthesis of protein virus with similar type of nucleic acid replicate in the host cell & synthesis of protein take place on host ribosome.
- 4) Assembly of new virogs - The newly synthesized protein coat & nucleic acid are assembled in a such a way that to form virus particle identical to original.
- 5) Release of virogs or lysis of host cell - The host cell gets ruptured & lysed due to

newly form virion particle & viron particles released from the host-cell.

### b) Transmission in viruses -

Virust must be brought in contact with the contains of living host cell. They achieve this quite effective by transmission from an infected plant to a healthy plant in a no.of ways.

- 1) through vegetative propagation
- 2) Mechanical transmission through sap
- 3) Seed transmission & pollen transmission.
- 4) Insect transmission
- a) Stylete borne viruses
- b) circulative viruses
- c) persistant viruses
- d) transsovarial transmission
- e) fungus transmission
- f) mite transmission

Q.10. Enlist the principle & methods of plant disease management & explain in brief cultural methods of disease management.

Principles -

- 1) Avoidance
- 2) Exclusion of inoculum
- 3) Eradication
- 4) protection
- 5) Disease resistance

## Methods of plant disease management.

- 1) Cultural method
- 2) Physical method
- 3) Biological method
- 4) Mechanical method

### 1) Cultural method -

A) Avoidance of pathogen -

i) Proper selection of geographical area -

Many fungal & bacterial disease are more severe in wet areas than in dry areas.

Cultivation of bajra in wet areas is not profitable due to the disease smut & ergot.

ii) Proper selection of field - Proper selection of field will help in the management of many diseases, especially the soil borne disease.  
eg. late blight of potato, wilt of redgram.

iii) Time of sowing - Generally pathogens are able to infect the susceptible plants under certain environmental condition. Alteration of date of sowing can help in avoidance of favourable conditions for pathogen  
eg. Rhizoctonia root rot of redgram is more severe in the crop sown immediately after the rains.

iv) Disease escaping varieties - certain varieties of crops escape the disease damage because

of their growth characteristics.

eg. Early maturing varieties of wheat escape the damage due to ~~Puccinia graminis tritici~~

### 5) Proper selection of seed & planting material.

Selection of seed & seedling material from healthy sources will effectively manage the disease such as loose smut of wheat.

### B) Exclusion of the pathogen-

1) Seed inspection & certification - Crops grown for seed purpose are inspected periodically for the presence of diseases that are disseminated by seed.

2) Plant quarantine regulation - plant quarantine is defined as "a legal restriction on the movement of agricultural commodities for the purpose of exclusion, prevention or delaying the spread of the plant pests & diseases in uninfected areas.

a) Domestic quarantine - Rules & regulations issued prohibiting the movement of insects & disease & their hosts from one state to another state in India is called domestic quarantine.

eg. Bunchy top of banana.

b) foreign quarantine - Rules & regulations issued prohibiting the import of plants, plant materials, insect & fungi into India from

foreign countries by air, sea & land.

c) Eradication -

1) Rouging - Removal of diseased plants or their affected organs from field, which prevent the dissemination of plant pathogens  
eg. loose smut of wheat & barley.

2) Eradication of alternate & collateral hosts -  
Eradication of alternate hosts will help in management of many plant diseases.  
eg. Eradication of Thalictrum species in USA to manage leaf rust of wheat caused by Puccinia recondita.

3) Crop rotation - Continuous cultivation of the same crop in the same field helps in the perpetuation of the pathogen in the soil.  
eg. Panama wilt of banana.

4) Crop Sanitation - Collection & destruction of plant debris from soil will help in the management of soil borne facultative saprophytes as most of these survive in plant debris.

5) Manures and fertilizers - The deficiency or excess of a nutrient may predispose a plant to some diseases. Excessive nitrogen application aggravates disease like stem rot bacterial

leaf blight & blast of rice.

- a) mixed cropping - Root rot of cotton is reduced when cotton is grown along with sorghum. Intercropping sorghum in cluster bean reduces the incidence of root rot and with.
- b) Summer ploughing - ploughing the soil during summer months expose soil to hot weather which will eradicate heat sensitive soil borne pathogens.
- c) Soil amendments - Application of organic amendments like saw dust, straw, oil cake etc, will effectively manage the disease caused by Pythium, Phytophtora.
- d) changing time of sowing - Pathogens are able to infect susceptible plants under certain environmental conditions.  
eg. Rice blast can be managed by changing planting season from June to Sep.
- e) Seed rate & plant density - close spacing raises atmospheric humidity & favours sporulation by many pathogenic fungi.
- f) Irrigation & drainage - The amount, frequency & method of irrigation may affect the dissemination of certain plant pathogens.

Q.11 Write down short note on -

a) Binomial system of nomenclature -

Taxonomy - Taxonomy is the science that deals with the identification, nomenclature & classification of organisms.

Nomenclature - It is the system of assigning names to the taxonomic groups according to international rules.

Systematics - It is the scientific study of organisms with the ultimate object characterising & arranging in an orderly manner.

Rules of nomenclature -

i) The name of genus should always be capitalised & species name should not be capitalised.

ii) When binomial written should always be underline separately & it printed them Italics.

iii) The binomial written should always be underline separately & it printed then Italics.

iv) The name of scientist describing the species 1<sup>st</sup> time should be written after binomial - pseudomonas, syringia valhall.

v) If the name is revised the name of the original describer should be written in bracket followed by the name of revised scientist.

vi) To avoid the confusion the same binomial should not be used to different

species.

vii) The year in which organism was described should be written after the name of author or scientist.

### b) Signs & symptoms

Sign - When the pathogen itself becomes visible on the host surface in the form of its organs or structures

e.g. Sclerotia, mycelium etc.

Symptoms - External expression or the evidence of the abnormalities in the appearance of the diseased plant brought about by the pathogens after host-pathogens interaction

e.g. Mildews, rust, smut, powdery mildew.

### c) Antibiotics -

i) Antibiotics is defined as a chemical substance produced by one microorganism which at low concentration can inhibit or even kill other micro-organism.

ii) Because of their specificity of action against plant pathogens, relatively low phytotoxicity,

iii) absorption through foliage and systemic translocation & activity at low concentration

iv) The use of antibiotic is becoming very popular & very effectively used in managing several plant disease.

v) They can be grouped as antibacterial antibiotics & antifungal antibiotics.

vi) most antibiotics are products by several actinomycetes and a few from fungi & bacteria.

d) characters of phytonematodes. Koch's postulates.

Q.12. Write down contribution of scientist.

Q.12.

a) B.B. Mundkar - Started work on control of cotton wilt through viral resistance. He was also responsible for the identification & classification of large no. of Indian smut fungi.

b) E.J. Butler -

He is also known as father of plant pathology in India.

Initiated & exhaustive study of fungi & diseases caused by them. In 1901 at imperial agricultural research institute located at Pusa (bihar) fungal study measurly done by this scientist.

During his stay of 20 years in this country, disease studied by him for the 1st time included wilt of cotton, of pigeon pea.

c) P.A. Millardet - Use of bordaxedus mixture for control of downy mildew of grapes

d) Anton de Bary -

He proved that late blight of potato was caused by phytophthora infestation father of plant pathology.

e) Adolf mayor -

Adolf Mayer was a German agricultural chemist whose work on tobacco mosaic disease played an important role in the discovery of tobacco mosaic virus & virusus in general.

f) J.C. Iithra -

developed solar heat treatment of wheat seed for the control of loose smut of wheat.

g) K.C. Mehta -

Investigated the lifecycle of cereal bunt rusts in India.

h) N.A. Cobb -

N.A. Cobb is known as the father of nematology. He provided the foundations for nematode taxonomy & described over 1000 different nematode species.

Q.13 Explain the sexual spore fruits with suitable example.

Sexual spore fruits is of two types

A) Ascocarps -

i) It is the spore fruit produced by the fungi belonging to the sub-division Ascomycotina.

ii) Sexual spore produced endogenously are known as ascospores in sac like structure called ascus.

iii) The spore fruits are of various forms viz, spherical shaped, flask cup, saucer & pod shaped.

#### 1) cleistothecium -

i) It is closed without ostiole, round to oval ascocarp with irregularly arranged or scattered asci having dark brown to black colour & provided with appendages to anchors or to hold fast.

eg. Powdery mildew fungi of order Erysiphales.

#### 2) Apothecium -

A cup or saucer shaped spore fruit with broad opening is known as apothecium.

The asci are arranged in palisade layer called hymenium.

eg. Sclerotinia.

#### 3) Perithecium

A flask shaped ascocarp with narrow neck like having ostiole through which asci are released. The asci are arranged or lined the innerwall of perithecium.

The sterile structures present in betw the asci known as paraphyses which help asci in nutrition & dispersion.

eg. Claviceps & glomerella.

#### 4) Ascostroma -

The asciformed directly in a locale or cavity within at stroma. The forms the wall of the ascocarp.

#### B) Basidiocarps -

The highly developed & have a compound structures, may be fleshy, leathery, woody or waxy in nature & bear special structures variously known as gills, pores, needles & chambers. The sexual spores known as basidiospores.

#### II Puff balls -

It is round or spherical. Very small to big basidiocarp commonly found on dead organic matter. The basidiospores are produced in the hymenium which lines the inner surface. On maturity basidiospores are given off, in the form of puff or smoke.

#### 2) Bracket fungi -

A compound fructification growing on dead tree trunks. These are woody & hard basidiocarp. They are typically bracket, hoof or saddle shaped & highly coloured. They are borne on short stalk.

#### 3) Mushrooms -

These are the fleshy or leathery compound fructifications with variously coloured,

Commonly found on manure pits, dung heaps & on any rich organic matter. They are borne on stalk and provided with gills & pores to the underside which contains hymenial layer.

e.g. *Agaricus* sp.

Q.14. Write in brief about modification of thallus & hyphal aggregation in fungi.

1) Rhizomorphs - Rhizomorphs are thick stands of mycelium which aggregated longitudinally in varying degrees of complexity in such a way to form complex tissues in which hyphae loose their individuality. Hyphal threads cannot be distinguished. They can grow in soil as well as trunks of the trees.

e.g. *Amillaria millea*.

2) Stroma or Stromata - It is a compact mass of the hyphae & appears as pseudoparenchymatous tissue & contain fruiting body of the fungus.

e.g. Ergot of Bajra.

3) Sclerotium or Sclerotia -

Sclerotia is the modified forms of vegetative mycelium, which forms compact mass of the hyphae, becomes hard and act as resting body which is resistant to unfavourable condition.

e.g. *Sclerotium* spp.

4) Dormant mycelium: It is the mycelium which hibernates in the host tissue to tide over unfavourable conditions. It remains in a dormant condition for a part of its life cycle & come up into activity when conditions are favourable.

e.g. Downey mildew of grape, loose smut of wheat.

5) Gemmae: These are the chlamydospores produced in lower fungi whose walls are thinner. They occurs either singly or in chains & becomes separated after maturing. Gemmae break free from the mycelium & disperse in water.

e.g. *Mucor* sp., *Saprolegnia* sp.