ALBUGO OR CYSTOPUS

1. Systematic Position
2. Habit and Habitat
3. Structure
4. Heterothallism
5. Reproduction
6. Diagrammatic representation of Life cycle
ALBUGO OR CYSTOPUS

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Albugo name proposed by – De berry

SYSTEMATIC POSITION::

Division : Eumycophyta
Class : Phycomycetes
Order : Pernosporales
Family : Albuginaceae
Genus : Albugo or Cystopus

Note: Albuginaceae is a monotypic family. It includes only single genera Albugo.

- It is an obligate, inter cellular parasite.
- It can not be grown on culture medium. It causes "White-rust disease in the plants of family cruciferae or brassicaceae. It shows specificity towards the host.

Etiology : - Study of causes of disease in body is called etiology.

Characteristics of White-rust diesase :

- White pustules/white blisters → They are usually present on lower surface of leaves which may also spread on the upper surface of the leaves & stems.
- The infected parts of the host become abnormal & the abnormality may be in the form of hypertrophy, fleshyness or distortion.

Note :
(1) The main reason of hypertrophy is the formation of sex organs in the intercellular sapces of host.
(2) In the presence of less temperature and high moisture white rust disease spreads vigorously.

The study of sperad of disease is called Epidemiology.

STRUCTURE:

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- Mycelium is branched, aseptate, coenocytic. (Septa are only formed in mycelium during reproduction).
- The hyphal wall is made up of cellulose.
- Reserve food material is present in the form of glycogen and oil globules.
- Hyphal network is found in the inter cellular spaces of the host.
- Round, button shaped or knob like and stalked haustoria are found in Albugo.
With the help of haustoria it absorbs nutrients from the host cells.

In the apical region of haustorium dense cytoplasm, found but nuclei are absent.

The shape of haustorium have taxonomic importance.

It's mycelium is stained by cotton blue and mounted by lactophenol.

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**REPRODUCTION ::**

- Reproduction methods
  1. Asexual reproduction
  2. Sexual reproduction

**ASEXUAL REPRODUCTION ::**

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- It takes place by Conidia formation.
- It is a type of sporangium or zoosporangium.
- Conidium is a smooth colourless, spherical, thin walled and multinucleated structure, in which 3-8 nuclei are present.
- The mycelium gives rise to erect branching. They are usually formed towards lower epidermis. They are called Conidiophore.
- Conidiophores are unbranched and club shaped structure. Their cell wall of the apical region is thin.
- The thin walled apical region forms the chains of conidia by constriction technique.
- Conidia are developed in basipetal sequence. It means newly formed conidia are present at the base of chain and old large conidia are present at the end of the chain.
- A gelatinous disc is present in between the two conidia. It is called disjunctor.
- This disc helps, conidia to remain in a chain. The chains of conidia grow and press the lower epidermis.
- This causes epidermis to bulge out and appears in the form of blisters.
Due to more pressure, the epidermis bursts. And these conidia are spread in the form of **white powder** on the surface of leaf.

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DISPERAL & GERMINATION

Conidia are dispersed by air.

Two different types of germination take place in favourable conditions.

(i) Direct germination :

(ii) [Link](https://madanacademy.com/)

- It takes place at high temperature and low humidity in environment. eg. *Albugo bliti*
- Conidium absorbs some water which is present on the surface of the leaf. A germ tube comes out from the conidium. This tube enters inside host tissues through stomata and form intercellular mycelium.

(ii) Indirect Germination:

ASEXUAL REPRODUCTION

A part of vertical section of infected leaf, B-C conidium, F. A conidium with cleaves protoplasm, G. Liberation of zoospores from sporangium, H. A zoospore, I-J Germination of zoospore.
• In the presence of **less temperature** approximately **10-15°C** and **high moisture** in atmosphere, conidium germinates by (After 2-3 hours of their dispersal) **zoospores** formation.

• Conidium absorbs more water and swell up and forms **3-8 zoospores**. These zoospores are enveloped by **vesicle**.

• These enveloped zoospores are ooze out then the vesicle dissolves and zoospores become free.

  - Free zoospores swim in water for few minute and finally they reaches on the surface of host, then after withdraw their flagella and round off and secretes a wall around itself.

  - Deflagellated zoospores with wall germinates through the germ tube. This germ tube enter into the host tissue through **stomata** or through the **teared epidermis** and form mycelium.

### STRUCTURE OF ZOOSPORES:

- Zoospores of Albugo are **uninucleated, reniform** or **bean shaped** and **biflagellated**.

- Flagella are located on the **lateral side** of zoospore which are **unequal** in length.

- Out of them small the hairy flagellum is called **Tinsel** or **Pantonematic** or **Flimmergical**.

- Another long and smooth flagellum is called **whiplash** or **Acroneumatic** or **peitgersal flagellum**.

  - **(i) Monoplanetic Generation** : - Only primary zoospores are formed.
  
  - **(ii) Polyplanetic Generation** : - In which many generation of zoospores are formed, like primary, secondary and tertiary zoospores are formed, (during high availability of water)

### SEXUAL REPRODUCTION:

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- Sexual reproduction is **oogamous** type.

- Male and female sex organs are known as **antheridium** and **oogonium** respectively.

- In **A. candida** the sex organs are generally formed towards the **end of the growing season** of the host.

- Reproductive organs are **endogenous**. They develop in intercellular spaces, quite deep into the host tissues.

- Their presence is externally indicated by **hypertrophy** and **deformation** of the organ.

  - **(i) Antheridium** :
    - The antheridium is an elongated, **club shaped** and **multinucleated** structure.
    
    - A transverse septum is present in its basal region. It develop on male hypha which is placed very close to the oogonium.
    
    - There are many (6-12) nuclei present in a young antheridium but mature antheridium has only one **functional nucleus**.

  - **(ii) Oogonium** :
    - Oogonium is **globular** in shape. The cytoplasm of oogonium differentiated into two distinct regions.

      - **(a) Peripheral cytoplasm or Outer cytoplasm** :
        - It is vacuolated, spongy and diffused. It is called **periplasm**.

      - **(b) Central cytoplasm** :
        - It is dense. It is known as **ooplasm**.

        - Both Ooplasm and periplasm are **multinucleated** in the begining but only a **single nucleus remains** in the **ooplasm at maturity** and rest of nuclei are transfered into the periplasm.

        - However, some workers believe that all nuclei in the ooplasm except one disintegrate.
- A single nucleus present in the ooplasm is called female nucleus or oosphere.
- The oogonium of *A. bliti, A. portulacae* contains many female nuclei or oospheres.

**Note:**
- Antheridium and oogonium develops very close in the mycelium.

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**SEXUAL REPRODUCTION**


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**FERTILIZATION**

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- A small protuberance develops from oogonium towards the antheridium. The wall of the antheridium and oogonium become thin at the region of their contact.
- This out growth stimulate the antheridium for fertilization. The inner wall of stimulated antheridium produces fertilization tube which enter into the oogonium and grows until reaches the oosphere.
- The terminal end of fertilization tube burst and introduces a single nucleus along with some cytoplasm.
Male nucleus fuses with the female nucleus and results in the formation of diploid nucleus. Now it is known as zygote.

Prior to fertilization a mass of protoplast is found in ooplasm. It is called coenocentrum. Which is formed by granular cytoplasm.

After the fertilization, zygote secretes a thick tri layered wall around it self and now it is called oospore (2N).

In oospore there occur free nuclear divisions and 32 nuclei are formed in oospore (According to modern mycologists).

According to old mycologists, the diploid nucleus of the oospore divide first by a meiotic division, followed by several mitotic divisions resulting in the formation of about 32 nuclei in oospore.

Oospore with 32 nuclei is the resting stage of Albugo.

In this stage it lives on dry branches in the absence of host.

On returns of favourable conditions the 32 nuclei of oospore undergoes repeated divisions to form 100 or more nuclei.

100 or more zoospores are formed from these nuclei. The zoospores are released/liberated with vesicle by the rupturing of outer thick wall of oospore (formed by inner wall of oospore).

These zoospores are coming in contact with a suitable host (seedling plants) settle down on the host and infect them.

The initial stage of the disease during the growth period is called primary infection and it takes place through the soil born oospores.

POINT TO BE REMEMBERED ::

According to Stevens all the structures of Albugo are diploid except gamete.

According to Sansome and Sansome meiosis division takes place at the time of gamete formation i.e. gametic meiosis found in Albugo. In Albugo meiosis not takes place in oospore.

CONTROL OF WHITE-RUST DISEASE ::

1. By crop rotation :- Primary infection can be checked through the growing of crops one after another crops. This is the best method to control the white – rust.

2. By removal of infected plants from the field. Through this it can be eradicated.

3. By application of fungicides – Such as – Bordeaux mixture. It is composed of

\[ \text{CuSO}_4 + \text{Lime water} \]

\[ (1:1) \]

- Through the sulphur dust etc.
- In the absence of host Albugo grows on another plant (Cleome viscosa). This plant grows as weeds.

Note :

- Albugo never infects the underground parts of the plants such as roots.
- It infects only aerial parts of the plants.
- An excessive enlargement of diseased organ due to an excessive enlargement of cells, called hypertrophy.
Diplontic type (according to modern mycologists)/ Haplontic (According to old mycologists)
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<th>Question</th>
<th>Text</th>
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<td>Q.1</td>
<td>The disease produced by Albugo on the crucifers is (1) Rust (2) White-rust (3) Red rust (4) Black-rust</td>
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<td>Q.2</td>
<td>The mycelium of the albugo is (1) Inter cellular, septate (2) Intracellular, aseptate (3) Intra cellular, septate (4) Intercellular, aspetate</td>
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<td>Q.3</td>
<td>From one crop to next another; the infection of Albugo reaches in the form of (1) Conidia (2) Mycelium (3) Oospore (4) Zoospore</td>
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<td>Q.4</td>
<td>The male gamete in albugo reaches to the female gamete by (1) Flagella (2) Fertilization tube (3) Swimming (4) Chemotaxis</td>
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<td>Q.5</td>
<td>Which of the following sets of conditions favour rapid spread of white rust disease (1) High temperature + High humidity (2) Low temperature + High Humidity (3) High temperature + Low humidity (4) Low temperature + Low humidity</td>
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<td>Q.6</td>
<td>Albugo bliti attacks on (1) Sonchus (2) Portulaca (3) Amaranthus (4) Sweet potato</td>
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<td>Q.7</td>
<td>Haustoria of albugo are (1) Sessile (2) Stalked (3) Appendiculate (4) Biramous</td>
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<td>Q.8</td>
<td>Sexual reproduction in albugo produced which type of symptoms on host plant (1) Hypertrophy &amp; deformation (2) Raised white spots (3) Phylloidy (4) All the above</td>
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<td>Q.9</td>
<td>After fertilization coenocentrum in albugo (1) Persists (2) Grows in size (3) Grows in number (4) Disappears</td>
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<td>Q.10</td>
<td>Haustoria of Albugo is (1) Club shaped (2) Button shaped (3) Palmate (4) Pinnate</td>
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<td>Q.11</td>
<td>Viruses are similar to albugo in (1) Being obligate parasite (2) Having DNA as genetic material (3) Being Coenocytic (4) All the above</td>
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<td>Q.12</td>
<td>Resting oospore of A.candida contains (1) 100-nuclei (2) 64-nuclei (3) 32-nuclei (4) One nucleus</td>
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<td>Q.13</td>
<td>Which of the following is the source of primary infection by Albugo candida (1) Soil born oospores (2) Conidia born on Cleome viscosa (3) Conidia born on crop host (4) 1 and 2 both</td>
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<td>Q.14</td>
<td>Albugo is (1) Intercellular, obligate parasite (2) Intracellular, obligate parasite (3) Intercellular, facultative parasite (4) Intercellular, facultative saprophyte</td>
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<td>Q.15</td>
<td>Which stain and mount are generally used for fungi (1) Cotton blue and glycerine (2) Saffranine and glycerine (3) Cotton blue and Lactophenol</td>
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</table>
Q.16 Conidia of *Albugo-candida* collected from mustard are not infective to raddish leaves because
1. Thick cuticle on raddish leaves
2. Raddish leaves secrete antibiotics
3. Biological specialization in *Albugo-candida*
4. Biological specialization is raddish

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Q.17 Study of secondary infection is called
1. Etiology
2. Ecology
3. Epidemiology
4. Pathology

Q.18 Bordeaux mixture is first fungicide, is discovered by
1. Millardet
2. De-berry
3. Mitchelli
4. Alexopulus

Q.19 How many nuclei is/are found in conidia of *Albugo*
1. 1
2. 2-3
3. 3-8
4. Many

Q.20 At what stage septa are formed in *Albugo*
1. At the time of vegetative growth
2. At the time of haustorial formation
3. At the time of sexual & asexual reproduction
4. Never Formed

Q.21 *Albugo* is found
1. In dung
2. In streams
3. In decaying organic matter
4. On the leaves of a living plant

Q.22 Which part of the plant is not infected by *Albugo*
1. Stem
2. Root
3. Leaf
4. Flowers

Q.23 Most common method of asexual reproduction in *Albugo*, by
1. Zoosporangia
2. Aplanospores
3. Conidiosporangia
4. Zygospore

Q.24 *Albugo* produces conidiosporangia
1. In chain
2. In Clusters
3. Singly
4. In Clumps

Q.25 The order of development of conidia in *Albugo* is
1. Acropetal
2. Basipetal
3. Irregular
4. Radial

Q.26 The flagella on the zoospores of *Albugo* are
1. Equal & Lateral
2. Equal and terminal
3. Unequal and terminal
4. Unequal and Lateral

Q.27 *Albugo* draws nutrition from its host by
1. Extracellular phagocytosis
2. Club shaped conidiophores
3. Tuberculate rhizoids
4. Globular or Button shaped haustoria

Q.28 In what form of the food is stored in the mycelium of *Albugo*
1. Sugar, oil and mannitol
2. Strach and protein
3. Protein and cellulose
4. Glycogen and oils

Q.29 Which structure of *Albugo* exhibits symptoms of white rust disease
1. Mycelium
2. Conidia
3. Gametangia
4. Oospore
Q.30 Albugo mycelium can reproduce (a) Sexually (b) Asexually (c) Vegetatively. (1) 'a' and 'b' (2) 'a' and 'c' (3) 'b' and 'c' (4) 'a', 'b' & 'c'

Q.31 The conidiophores of Albugo are (1) Club shaped and branched (2) Club shaped and unbranched (3) Peltate and branched (4) Peltate and unbranched

Q.32 Secondary infection of white rust could be controlled by (1) Crop rotation (2) Use of bordeaux mixture (3) Soil fumigation (4) Use D.D.T.

Q.33 Female Gametangium of Albugo is called: (1) Trichogyne (2) Archegonium (3) Ascogonium (4) Oogonium

Q.34 The gametes of Albugo are (1) Non-flagellated (2) Flagellated and Motile (3) Male flagellated & Female non-flagellated (4) Female flagellated & Male non-flagellated

Q.35 Sexual reproduction (or fertilization) can occur without water in (1) Ulothrix (2) Albugo (3) Funaria (4) Fern

Q.36 Which stage in the life cycle of Albugo candida is not coenocytic (1) Vegetative mycelium (2) Conidiosporangia (3) Zoospores (4) All of these

Q.38 Hypertrophy of floral parts in a cruciferous plant is caused by (1) Conidia of Cystopus (2) Conidiophores of Cystopus (3) Accumulation of hyphae of Cystopus for sexual reproduction (4) All the above

Q.39 To cause infection, the germ tube enters through (1) Epidermal cell (2) Guard cell (3) Stomata (4) Lenticels

Q.40 An excessive enlargement of a diseased organ due to an increase in the number of its cells is called (1) Hyperplasia (2) Damping off (3) Necrosis (4) Hypertrophy

Q.41 Which of the following is the symptom of white rust disease of crucifers (1) Hypertrophy of floral axis (2) White blisters on the stem (3) White blisters on the leaf (4) All the above

Q.42 Which of the following produced non-motile gamete - (1) Ulothrix (2) Albugo (3) Riccia (4) Pteridium

Q.43 Sexual reproduction in Albugo is (1) Isogamous (2) Anisogamous (3) Oogamous (4) None of these

Q.37 The flagella on the zoospore of Albugo are
Q.44 What holds the conidia together into a chain in *Cystopus/Albugo* -
(1) Middle lamella
(2) Cell-wall
(3) Intercalary mucilagenous septum
(4) Plasmodesmata

Q.45 *Albugo* belongs to
(1) Phycomycetes and zygomycetes
(2) Archaemycetes and Oomycetes
(3) Phycomycetes and Oomycetes
(4) Zygomycetes and archaemycetes

Q.46 A combined solution of copper sulphate and calcium hydroxide which used as a fungicide is
(1) Collins mixture
(2) Bordeaux mixture
(3) Carminative mixture
(4) Fehling's solution

Q.47 Which is correct statement : -
(1) Perithecium is fruiting body of *Aspergillus*
(2) Sexual reproduction in *Albugo* is oogamous
(3) Ascomycetes is known as club fungi
(4) Male gametes of *Albugo* are flagellated

Q.48 Botanical name of species which cause white rust of cruciferae -
(1) *Pernospora Parasitica*
(2) *Puccinia graminis*

Q.49 Branched aseptate, coenocytic mycelium present in :
(1) *Aspergillus* (2) *Albugo*
(3) *Penicillium* (4) *Erysiphe*

Q.50 *Albugo candida* which causes white rust of cruciferae is :
(1) Saprophyte
(2) Facultative parasite
(3) Obligate parasite
(4) Obligate saprophyte

Q.51 White rust disease of crucifers is caused by :
(1) *Puccinia* (2) *Ustilago*
(3) *Albugo candida* (4) *Aspergillus*

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