LICHENS

A unique life style,

unusual creatures

"Lichens are fungi that have discovered agriculture“

What are lichens?

Pioneer of Life, composite, Dual, symbiotic organisms showing

- **Controlled parasitism**
- **Mutualism**

A* unique morphology, composed of Ascomycete and Basidiomycete fungi with an *obligate symbiotic mode of nutrition with a photosynthetic partner

About 17,000-20,000 species known

The Photobiont

- Most lichen partners are **green algae** (Division Chlorophyta)

  Common genera include *Trebouxia, Hyalococcusand Trentepohlia*

- Some partners are **Cyanobacteria**

  Common genera include *Nostoc and Stigonema*

The Mycobiont

- Most lichen fungi are ascomycetes from the Series Discomycetes (apothecial forms) and Pyrenomycetes (perithecial forms)
- A few are basidiomycetes related to mushrooms and bracket fungi and one is a purported Zygomycete form

Where do lichens grow?

- **Rocks – Saxicolous / Endolithic**
- **Bark – Corticolous / Lignicolous**
- **Soil – Terricolous**
- **Other substrates – Stained glass, metal, insects, land tortoises etc.**

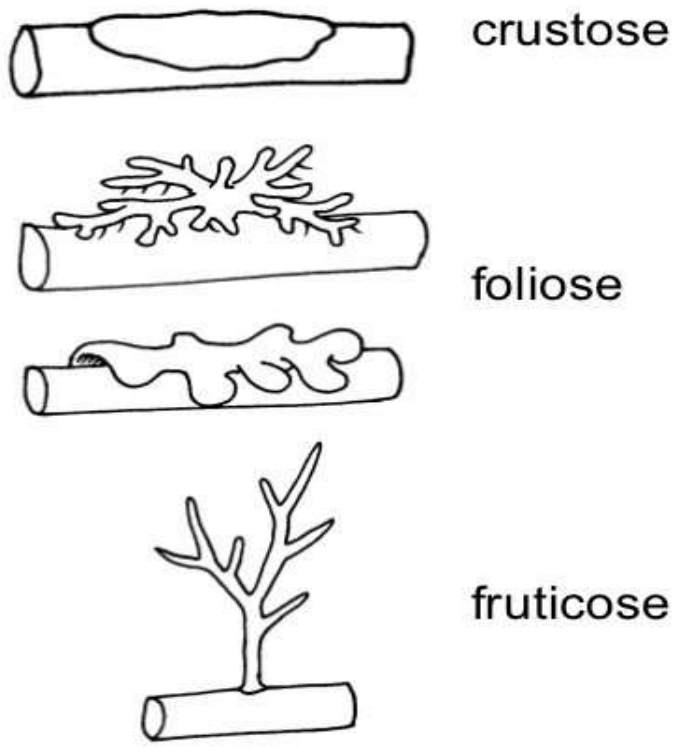
Non-aquatic (with a few of exceptions in freshwater and the marine intertidal zone)

Some Features of Lichen Biology

- Very slow growing organisms
- Cannot self-maintain water balance as in higher plants (homiohydric)
- Secondary chemical metabolites abundant and unique in the Fungi

Lichen Growth Forms

- Crustose
- Squamulose
- Foliose
- Umbilicate
- Fruticose
- Gelatinous



lichen growth forms

Lichen Anatomical Features

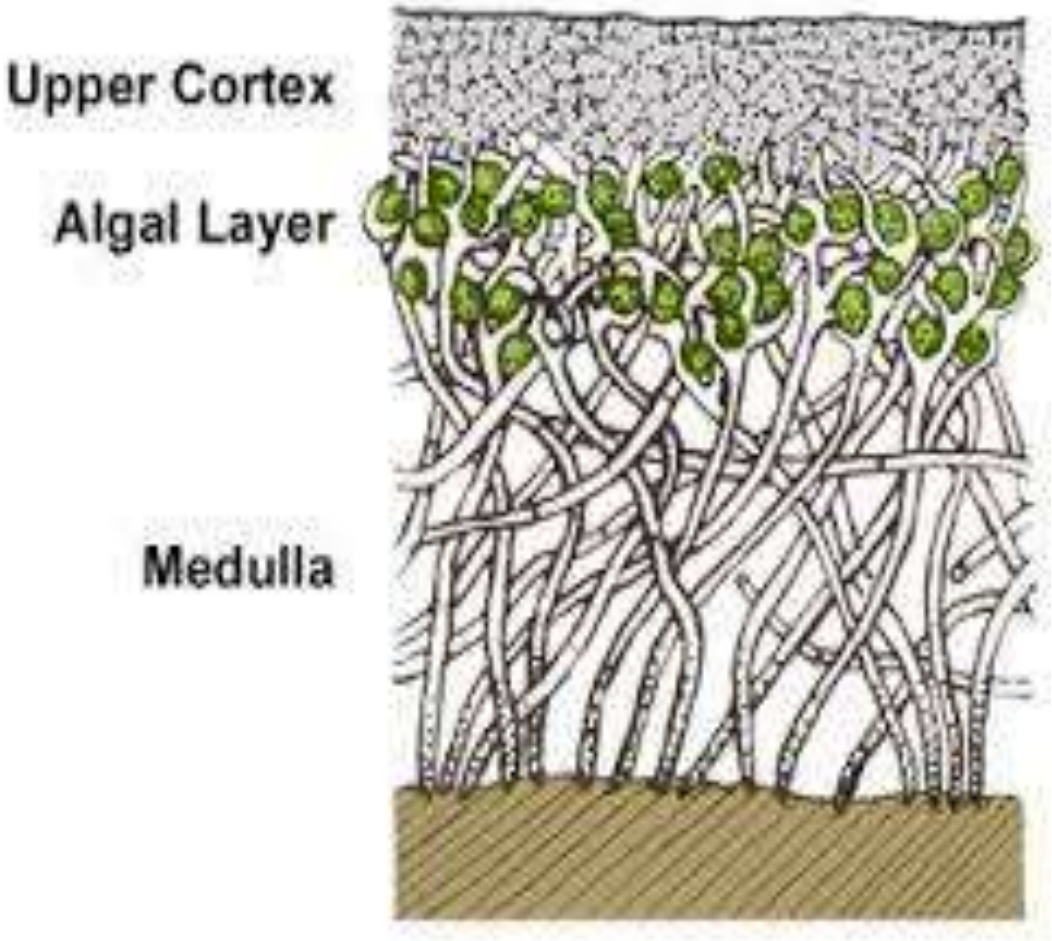
- **Cortex –** Composed of conglutinated fungal hyphae
- **Algal layer –** Usually located in the upper portion of the medulla below the upper/outer cortex
- **Medulla –** Loosely interwoven inner portion of the thallus or may be as central strand in the fruticose lichen
- **Rhizines –** Root-like attachment organs common in most foliose lichens
- **Cilia –** Fibrillar outgrowths from lobe margins
- **Cyphellae –** A type of air pore appearing as a crater on lower surfaces
- **Pseudocyphellae –** Another type of air pore found in the upper cortex
- **Cephalodia –** A second photobiont
- **Tomentum –** External surface hyphal development

Crustose Lichens

- **Tightly attached to the substrate and considered to be the most primitive growth forms**

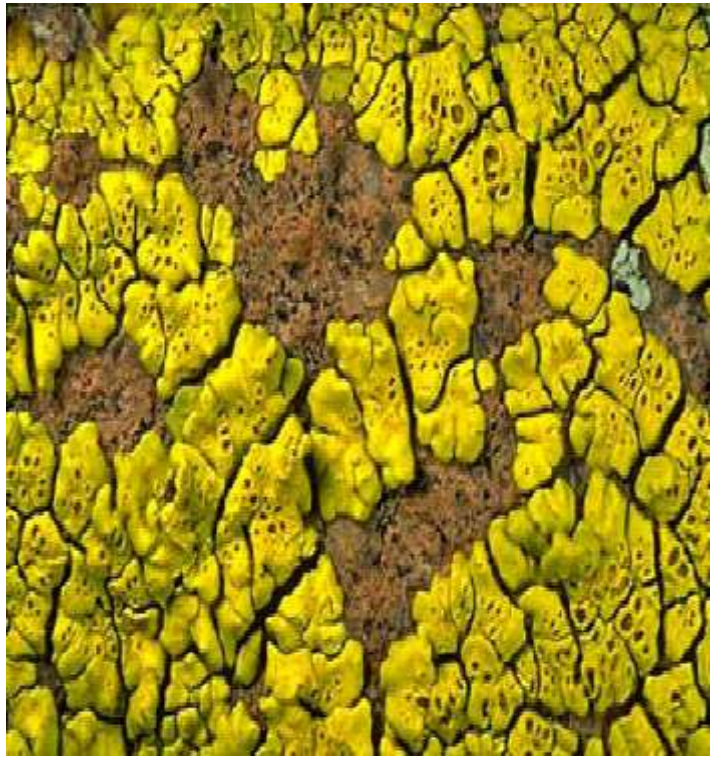
  Subtypes include: powdery, endolithic, endophloeodic, lobate, effigurate

Crustose Lichens

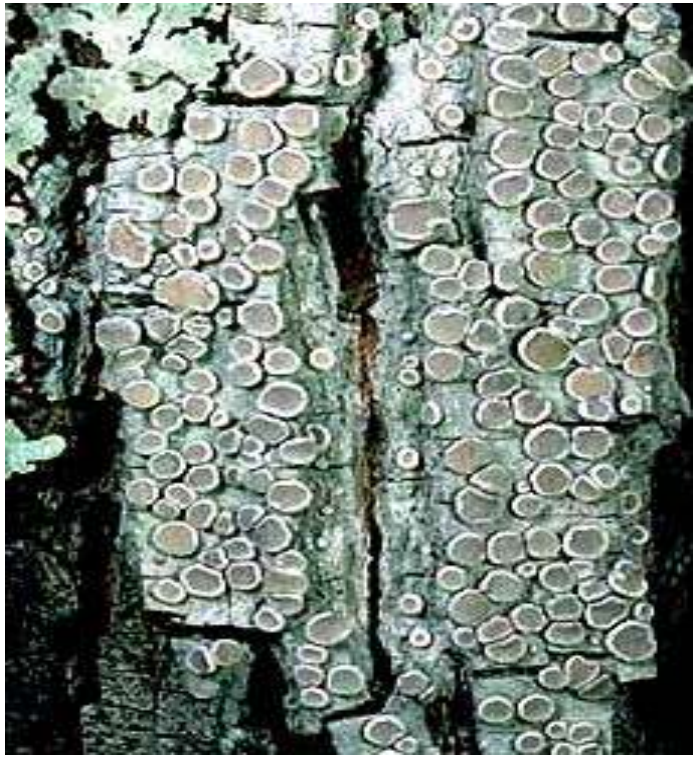


Crustose Lichens

Acarospora(epilithic)



Lecanora(epiphloeodic)



Squamulose Lichens

- Thallus composed of individual, tiny lobes (areolae) which may be partially free from the substrate
- Often described as overlapping or scale-like structures

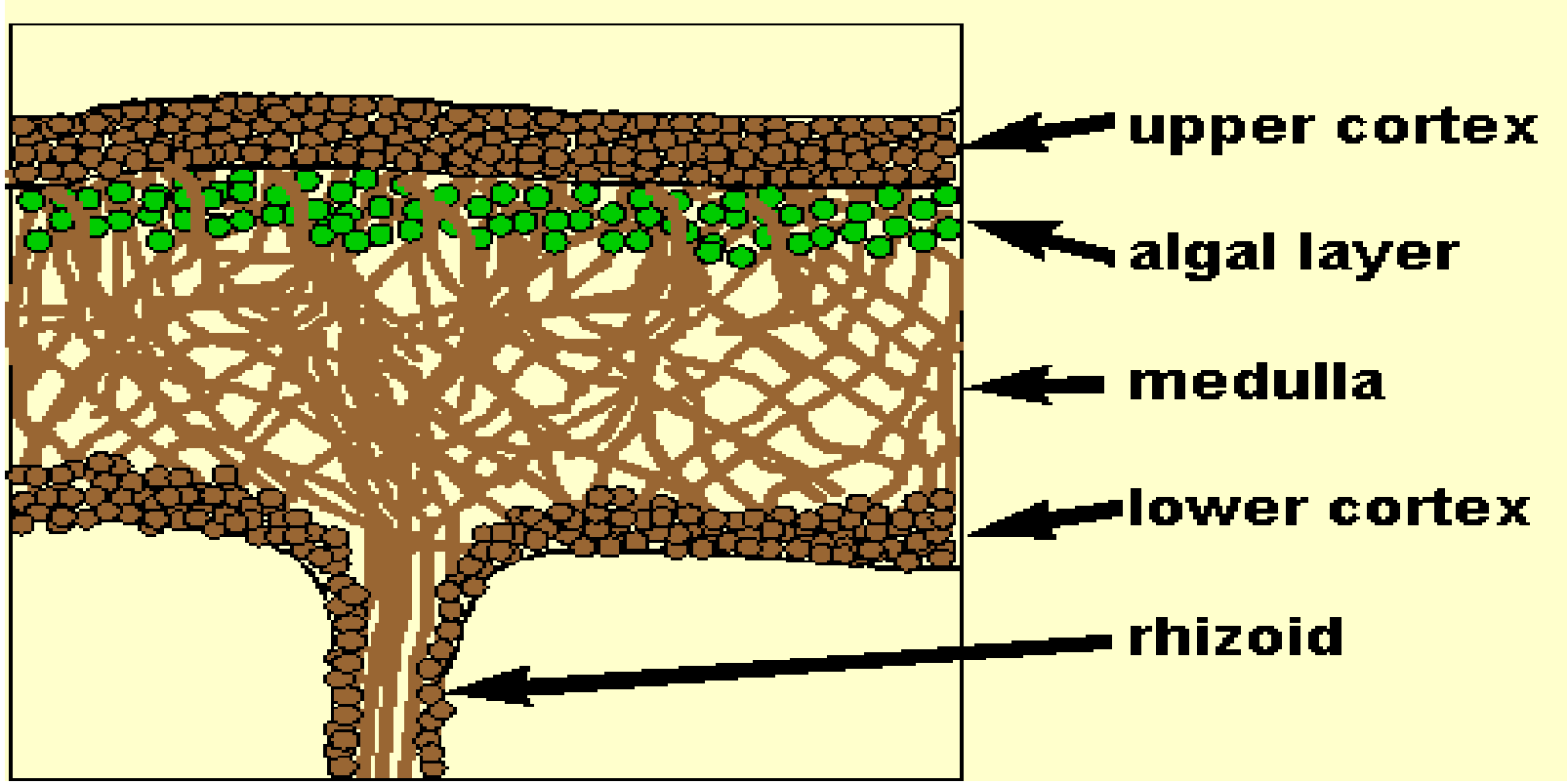
Squamulose Lichens

Psora

Foliose Lichens

- Leaf-like, flat with lobes (lacinae) and attached to the substrate usually with rhizines
- Great diversity and common in most environments

Foliose Lichens



Foliose Lichens

Peltigera

Melanelia

Parmotrema

Umbilicate Lichens

- A foliose thallus attached by a single point (an umbilicus)
- Occur on rocks, both acidic and basic substrates

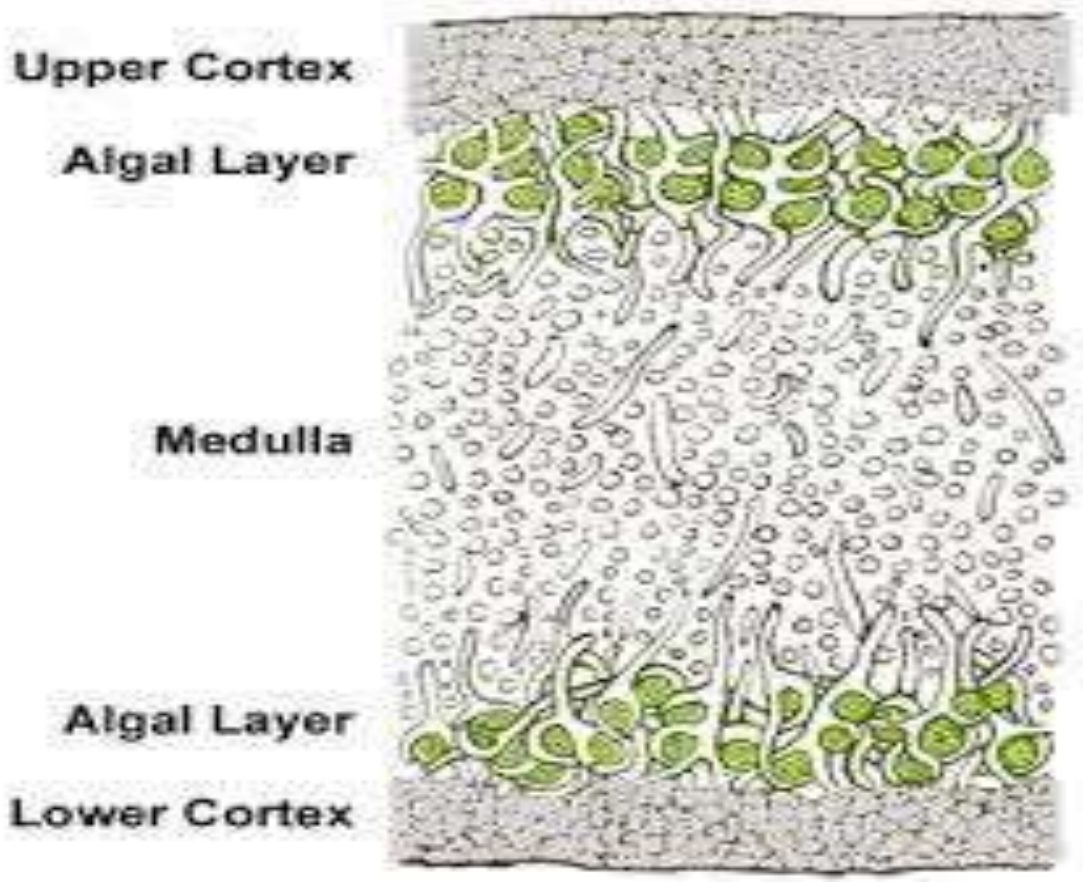
Umbilicate Lichens

Umbilicaria

Fruticose Lichens

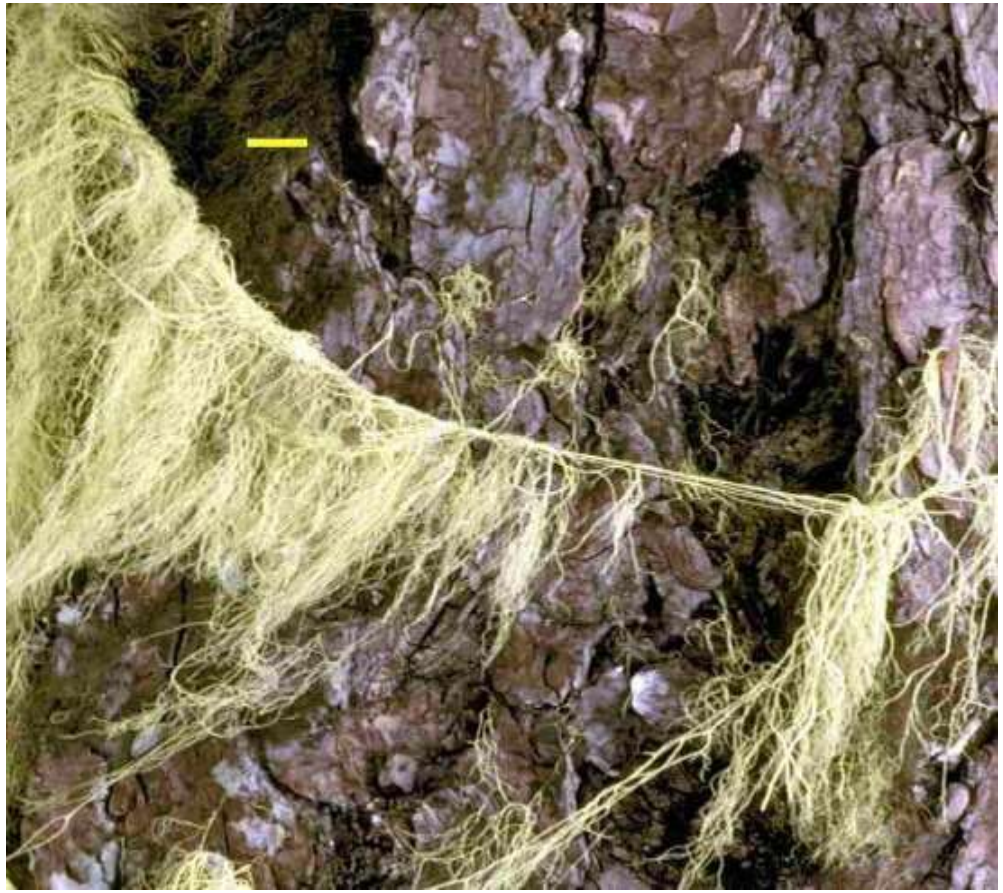
- Usually described as hair-like, shrubby, or pendulous species with rounded or flattened lobes
- Some taxa develop a two-fold thallus (thallus verticalis and thallus horizontalis)

Fruticose Lichens



Fruticose Lichens

Alectoria sarmentosa

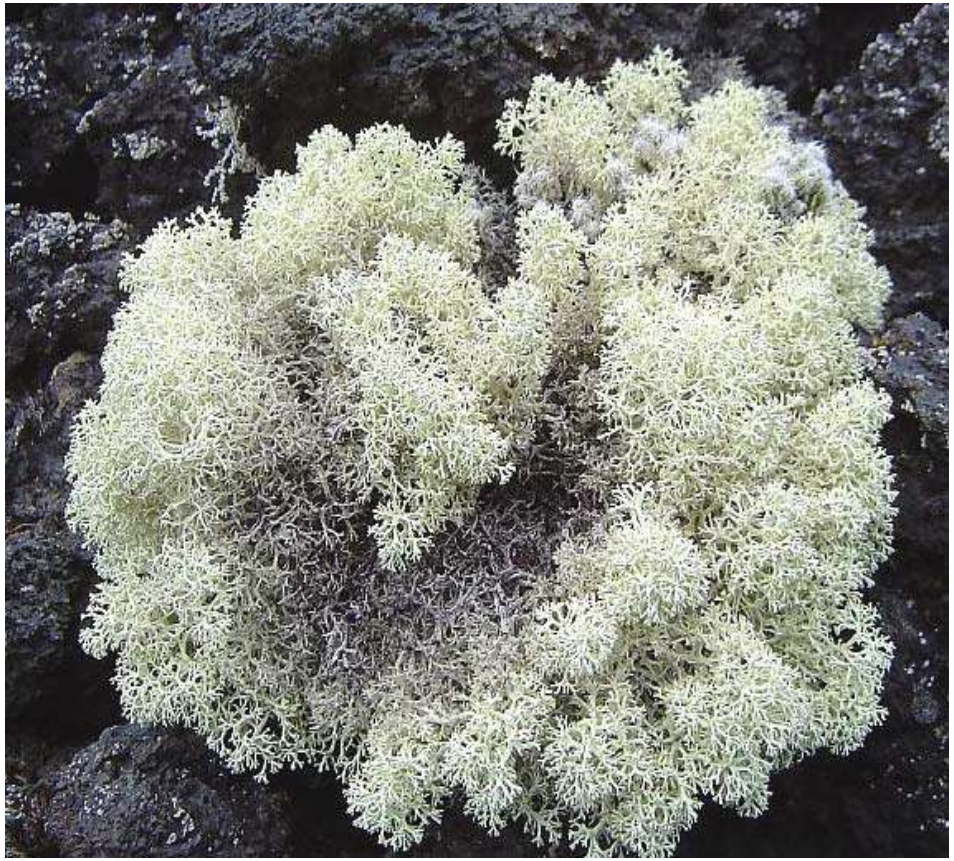


Bryoria

Fruticose Lichens

Cetraria

Cladina "Reindeer Lichen"



Fruticose Lichens

Chaenotheca

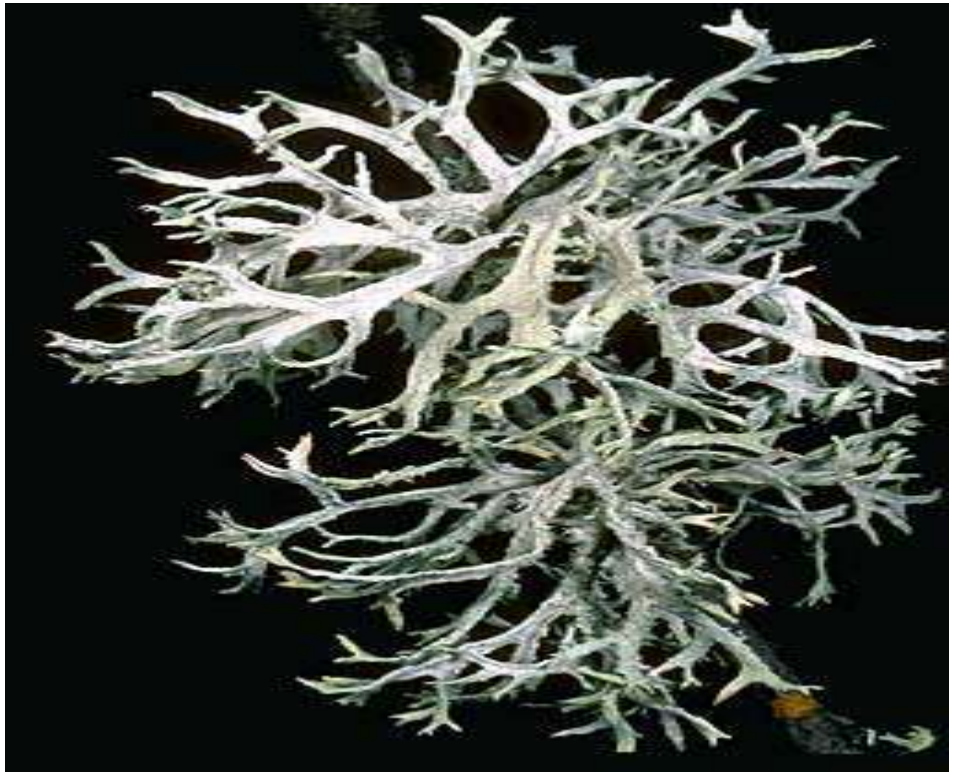
Letharia

Fruticose Lichens

Cladonia

Fruticose Lichens

Evernia



Fruticose Lichens

Pilophorus

Usnea

Gelatinous Lichens

- Thalli usually contain cyanobacteria
- Often dark blue-green, brown, or black in color

Gelatinous Lichens

Collema

Reproductive Structures
Asexual

- **Symbiotic asexual propagules**

Soredia – Contain both fungal hyphae and photobiont cells
Develop from outgrowth of the medulla

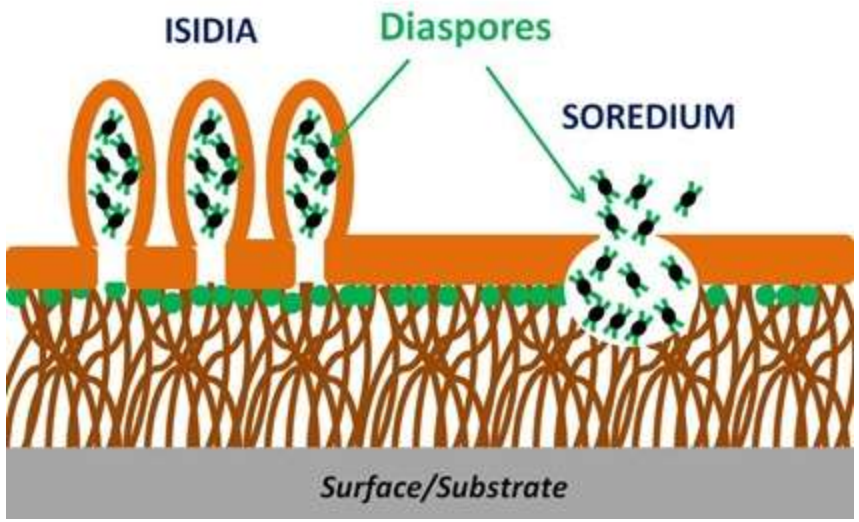
Isidia – Simple, warty, globose or coralloid outgrowths of the medulla with a cortical covering

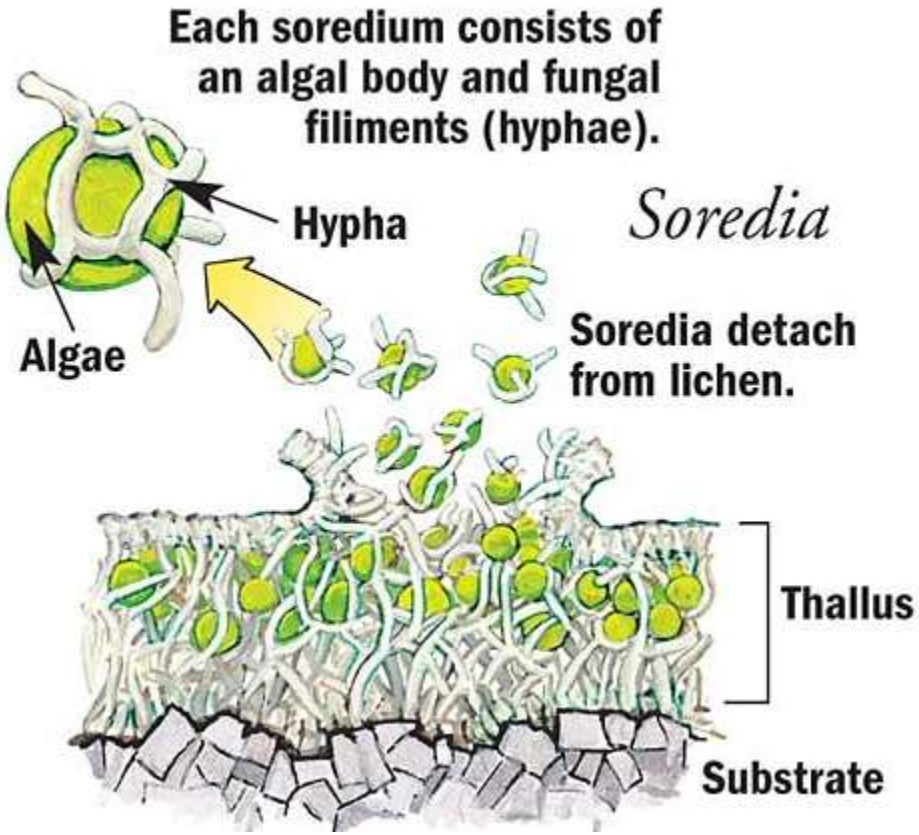
Lobules – Flattened, corticate ““flapsflaps””of thallus tissue on the margins or surface of some foliose species

- **Vegetative, non-symbiotic reproduction**

Conidia on conidiophores produced in pycnidia – Tiny, flaskTiny, flask-like or globose fungal structures

Lichen Asexual Reproduction

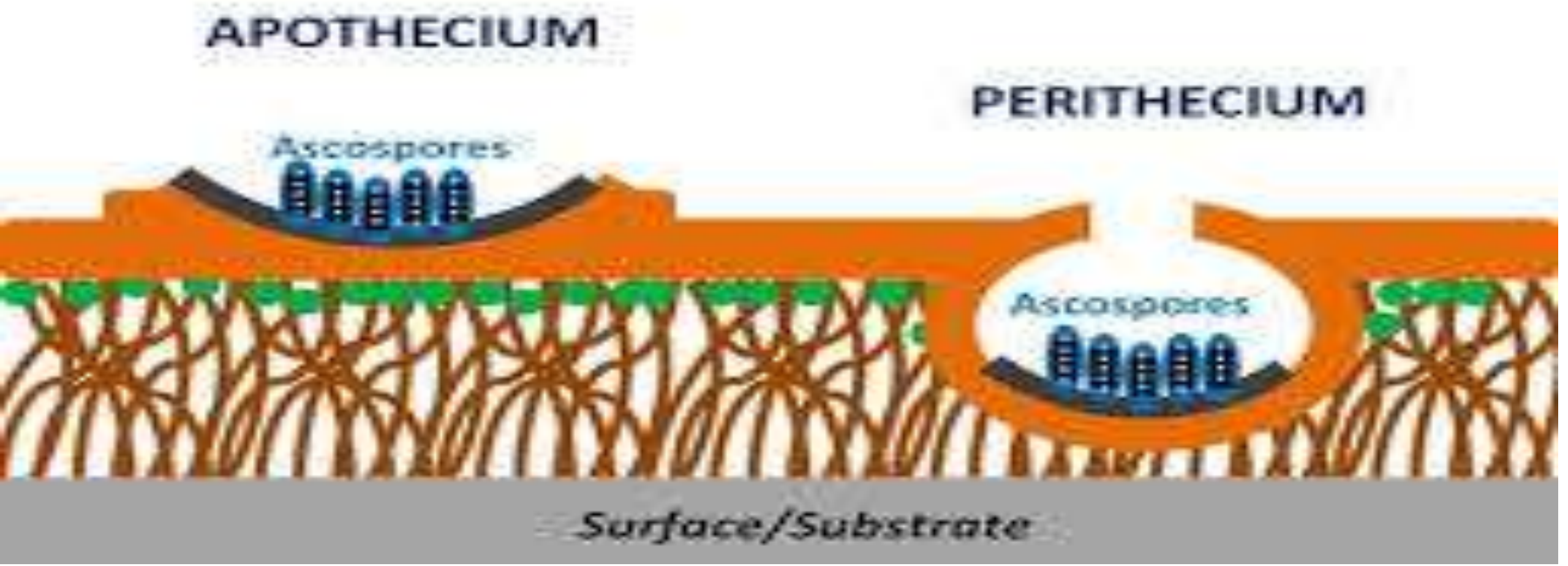




Reproductive Structures
Sexual

- **Mazaedia –** Type of ascoma (ascocarp)
- **Apothecia –** Produces a distinct thalloid exciple with photobiont cells present
- **Perithecia –** Bottle or flask like ascomata embedded in the thallus
- **Hysterothecia –** Elongated or branched ascomata with a split like hymenium
- **Pseudothecia (ascolocular) –** Resemble perithecia (especially in crustose, embedded species) or apothecia

Lichen Sexual Reproduction



Economic Importance of Lichens

- Food for humans and other animals
- Medicinal problems and uses
- Lichens as dyes
- Lichens in the perfume industry
- Miscellaneous uses
- Biodeterioration problems

Lichens as Food

Lichens as Food for Humans

Rich in carbohydrates, less proteins and lipids

Human consumption is limited

Umbilicaria, Bryoria **used by native peoples of North America**

Sometimes used for survival (*Cladina, Cetraria*)

Medicinal problems and uses

- Usnic acid has been shown to inhibit the growth of gram+ bacteria
- Active ingredient in some topical ointments sold in Europe and Russia ("USNO, BINAN")
- Some lichen fatty acids and carbohydrates have anti-tumor effects in study animals

Dyes

- **Orchil (purple dyes)**

Earliest documented use from ancient Rome as a purple dye or togas using *Roccellaspecies from rocks around the Mediterranean*

- **Crottal(brown dyes)**

Extracted from *Parmelia, Ochrolechia, Evernia and Xanthoparmelia spp*

Perfume Manufacture

- Many companies buy many of tons of lichens every year
- Involved in the manufacture of “moss”and “leather”fragrances in perfumes and some types of soap

Biodeterioration Problems

- Damage to stained glass windows in old cathedrals in Europe due to “etching”of the glass by lichen growth or *Caloplaca/Xanthoria on roof tiles*

Miscellaneous Uses

- Production of litmus paper
- Commercial Products
- Material for model trains, landscape designs and architectural renderings
- Decorative displays
- Illustrations for stamps

Lichens and (Air) Pollution

Lichens are used as indicators of different Types of Pollutants

- SO_2 as by-product of coal or fuel oil combustion, ore reduction, paper manufacture, and automobile exhaust
- Photochemical toxins such as ozone, NO_2, PAN (peroxyacetylnitrate)
- Acid Rain
- Heavy Metals from pesticides and insecticides
- Lead (Pb) from gasoline (tetraethyl lead) or from industrial activities
- Fluorine as a by-product of aluminum, zinc and phosphate ore reduction or from power plants
- Nickel (Ni) from coal combustion, industrial processes, and automobile exhaust
- Mercury (Hg) from pesticides and insecticides
- Zinc (Zn) from automobiles
- Chromium (Cr) from power plants
- Oil Spill Pollution
- Ionizing Radiation from nuclear testing or accidents

Index of Atmospheric Purity

- The Index of Atmospheric Purity (IAP) was based not only on presence or absence, but on the species frequency and an "ecological index"for the species

$$IAP = 1/10\ \Sigma n = 1\ x\ Qifi$$

n= the number of species at the site.

Qi= ecological index of toxiphoby of the i th species expressed as the average number of species found with it.

fi= frequency-coverage on a scale of 1 to 5.

Larger vales = cleaner air