Introduction to Botany (Syllabus)

COURSE NUMBER	BO 2101		
COURSE TITLE	Introduction to Botany		
INSTRUCTOR	Rainer Stahlberg, PhD		
CLASS TIME	Mondays 2:00 to 4:50 PM Lecture in Room 55 Wednesdays Lab A 9:30-11:50; Lab B 2:00 to 4:20 PM Room 82		
CREDITS	3.0		
STUDENT ADVISING HOURS	By appointment or Wednesdays 1:00 – 2:00 PM room 82		
CONTACT INFO	(Work Phone) 206-897-1790	(Home Phone) 206-546-2395	(E-mail) raista@u.washington.edu

Class includes lectures, labs, a poster session and plant walks. The course consists of 3-hour lectures (not my choice!) and 3 hour-labs each week. No textbook has yet been written that would give you all the information contained in the lectures. **Attendance of the labs is required since there is no possibility to repeat the lab outside the planned hours. Lack of attendance without previous agreement may result in the repetition of the course.** In case you miss **one** lab for a good reason you may have the option organize a 15 min talk about a medically important herb, which should be present in the herb garden. When you have to take this alternative, please, consider that the presentation is open to the entire class and that handouts to all participants are welcome.

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. The lectures introduce **selected topics in such a way that problems in your later career can be recognized and categorized into a familiar scheme and solved in an equivalent manner.**

The lab is intended to encourage curiosity and initiative in the exploration of plant characteristics, ingredients, organs, structures and responses that may be familiar on a superficial basis. In addition it will improve the students' ability to plan experiments as well as to function as part of a team. To support the acquisition of the topics I will supply study questions that allo

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Experiments are the only means of knowledge at our disposal; the rest is just poetry and imagination…
Max Planck 1910

Experiments are the only and hard way to test the truthfulness of assumptions, opinions, ideas and hypotheses. However, where applied, this method turns a bucket of untested and countless times regurgitated opinions, rules, judicial laws and fanciful reports (as you have to suffer through in meetings, politics, elections, court sessions, history, art, newspapers, TV, philosophy, religions, myths, legends) into a reliable, proven and repeatable account of events (= science) that allows for a sober assessment of a situation. ***It is therefore that experiments and lab sessions are included in scientific courses. It is your opportunity to test some of the statements made in the lectures and textbooks****. It is also a small attempt to improve your way of judgment and make you more critical towards unacceptably low standards in the public discussion and media.*
Experiments are an attempt to find a common language with nature, a language that allows a direct dialogue. And yes, "experiment" has the same root as experimental, i.e. it may not work the way you thought it should.

How to use the Labs

To be successful means to follow a few simple recommendations.

1. ***Be prepared.*** *A lot of effort is wasted if you do not know exactly what you are going to do in the exercise and why you would want to do this. When in the first group it is your task to set up microscope and dissecting scope.*

2. **You are the one to carry the initiative.** *If lab exercises are less conceived as entertainment performed by the instructors but more as a chance to check the truth of ideas and concepts (own and indoctrinated ones) they have a much better chance to be a learning and a fun experience.*

3. You will work with flames, heaters, acids, solvents, chemicals, and instruments. It is standard for any lab to ware protecting shoes (no sandals), and clothes that cover your legs. A lab coat is recommended.

4. Please work calm and with caution, exercise responsibility and respect for your neighbors and team members. When in doubt how to proceed ask the instructor before making a mistake. Take your time. Less can be more.

How to use the labs

*5. **Clean your place after you finish the experiments**. If you are in the second group it is your duty to completely clean your work place and remove the microscope& dissecting scope back to their drawers, return all the slides and rinse lab ware.*

*6. **You are expected to keep a current lab report** with your observations and thoughts. For this purpose bring white paper (sheets can be added to this manual), a transparent ruler (mm is the unit of science), pencil #2and eraser for drawings. During the quarter the instructor collects reports 1-2 times for feedback and evaluation.*

Lab report

7. **How do write my lab reports?** *The lab report reflects your attitude towards experimentation and the scientific method as a proven path to separate facts from illusions and lore. Some people try to apply this sober approach to as many spheres of their life as possible, in most cases to their advantage. Others, starting with the classic Greeks and some newer ones as well, arrogantly dismiss this "manual" approach as not intellectual enough and overestimate the limited use & power of logic deductions and intuitions.*

In the labs I want a minimum of formalism, conformism and a maximum of training and experience. *Therefore, the lab report is a personal, individual account of what you found, observed and concluded. Here we follow Edison's famous dictum, "every apparent failure is a result" or in other words an experimental correction of the experiment by nature herself.*

This conversation with nature should be reflected in terms like hypothesis and expectation, experimental formulation of the question, received answer, and **most importantly the conclusions drawn from the experiment (the "what did I learn here").** *You should include sketches and drawings to illustrate and remember your exchange. I will discuss & collect the reports 1-2 times during the course.*

Labs

8. How to make sketches! *You can draw with pencil, color, pen or camera. Entire courses are taught on scientific sketches. The task here is to draw in order to illustrate the point you are trying to make. Microscopic sketches should not be scaled 1:1, i. e. I should not need a microscope to see your drawing.* ***The idea is to draw the details as large as fit. So if you draw pollen make your sketch of it at least 3-4 cm wide****. Also, add explanations as much as needed (not in the moment but 50 years from now when you show these pictures to your grandchildren).*

9. Most importantly; find fun in exploring nature. In spite of our shortcomings in UV and IR vision & infrasound hearing, we Neanderthals are among the few species that enjoy both stereotypic & color vision to appreciate the beauty of the natural world.

How do I succeed in this class?

To support the acquisition of the topics I will supply study questions that allow you to test whether they got the important "take home" points of each lecture. The questions for the tests will be chosen from the study questions. The questions will be posted and updated after the lectures at the web at http://staff.washington.edu/raista/ under Introductory Botany.

Go to http://staff.washington.edu/raista/ and **click IntroBot icon**. Pull down the window to get a larger view of the "study question site". Read also other categories like "upcoming events" etc.

If you ask me in 3 weeks how to do this you are likely one of the bad students in this class. **But this really happens in these classes!**

The study questions are the basis for the tests. I.e. I choose the test questions are a smaller selection of the same study questions. **Do you under stand this?**

If you do, you know what to do to succeed!

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- **Instructional Materials and Resources** (Recommended Texts or Study Aids)

1.Levetin E, McMahon K : Plants and Society, McGraw *Hill 2004 to 2011 is ok*

2. Pojar/McKinnon " Plants of the Pacific Northwest Coast"

2. "Laboratory exercises in Introductory Botany" by R. Stahlberg (2011) will be handed out in the first class for $ 15.00 (cash please!).

4. Recommended literature

Agosta W C: Chemical communication. The language of pheromones. Scientific American Library, New York 1992

Agosta, William: Thieves, deceivers and killers. Tales of chemistry in nature. Princeton University press 2001

Anathakrishnan T.N., Sen, Alok (editors): Biocommunication in insects, Science publishers Inc. Enfield 1998

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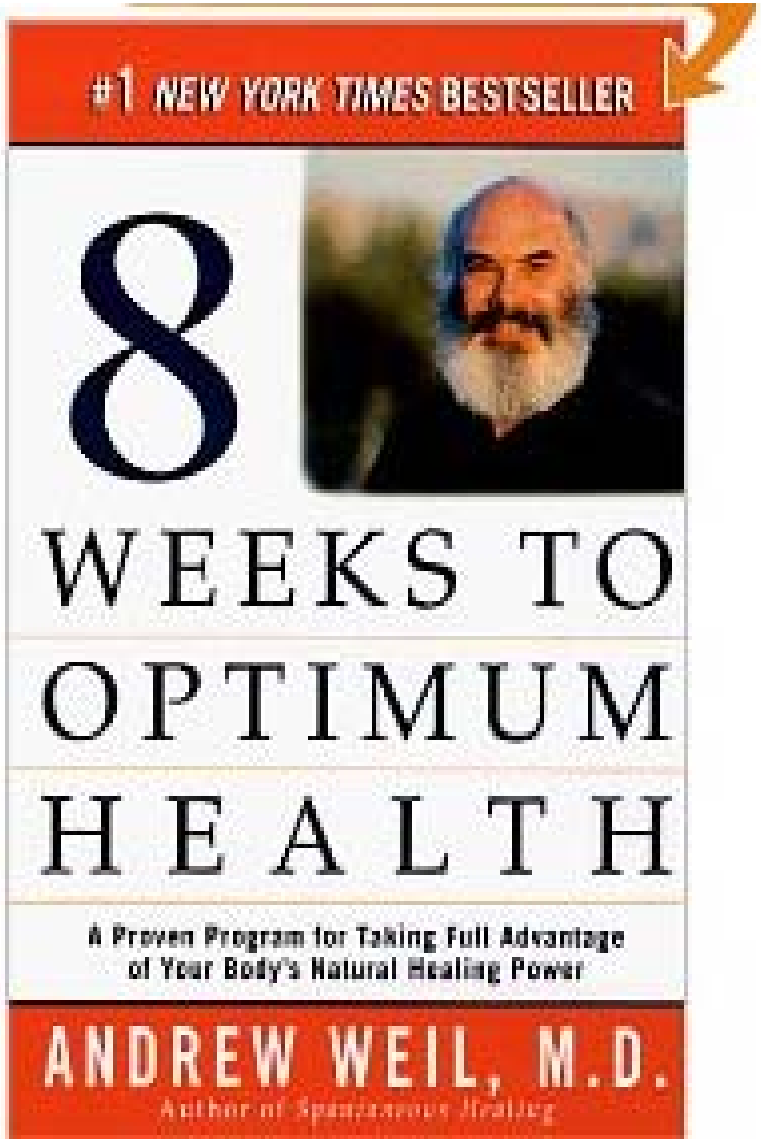
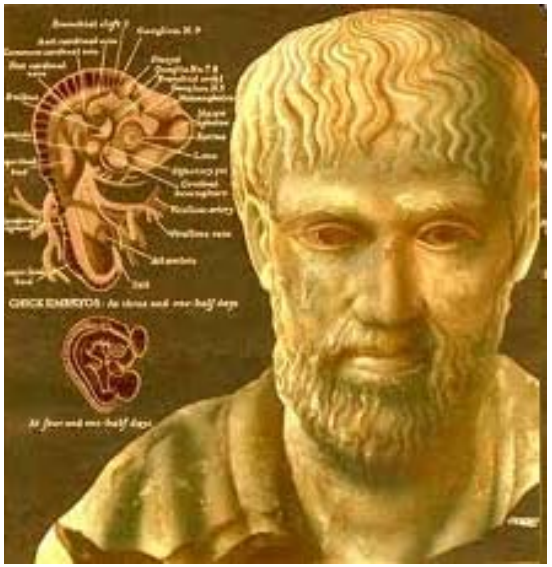
WEEK	DATE	Class TOPIC	Lab topic	Reading	BRIEF OUTLINE OF CONTENT
1	7/11	What is a plant? What are the sub disciplines of Botany	Lab # 1 The algal ancestry of plants	Relevant parts in Ch 3-6, Ch 8	Life strategies of plants: When do plants move, when do plants rest, exceptional or strange plants
2	7/18	The 6 kingdoms of life Plant families and plant ID	Lab # 2 Plant diversity and . identification : Campus walk	Relevant parts in ch 8,9, 22, 23	The role of cyanobacteria for making the oxygen atmosphere + modern life on the planet, the role of algae
3	7/25	Plant IDing by anatomy and characteristic phytochemicals	Lab # 3 Primary metabolism and the making of paper	**first written test** relevant parts in ch 4. ch. 16-20	What are lower plants and what are higher plants? Mosses, Ferns and conifers
4	8/01	Plant Primary metabolism Fats Proteins, mucilage, starch	Lab # 4 Plant diversity and identification : Visit to the UW	relevant parts from ch. 19.20	The most important families of higher plants and their characteristic features
5	8/08	Secondary metabolism from organic acids to essential oils	Lab # 5: Secondary metabolism and the making of ink	**2nd written test**	How come that plants can make compounds that we cannot: Vitamins, essential amino acids, essential fatty acids
6	8/15	Toxic plants, spices, aphrodisiacs, plant scents, perfumes	Lab # 6: Poster session you prepare your experiment and then present it in context	Relevant parts in ch. 10,11, 15. 26	the fascination of plant compounds in their interaction with other life forms including bacteria, fungi, insects & humans
7	8/22	From arrow poison to painkillers and anesthesia	Lab # 7: Plant colors and Stains	Relevant parts in ch. 26	Plant are not only the basis of all food pyramids but the basis of all life on the planet
8	8/29	3rd of final test	Finals week: no lab! time for lab make-ups (see Syllabus) !!	**3rd of final test**	



It takes 3 weeks to change good into bad habits

It takes 8 weeks to change bad into better habits

Let us use the 8 weeks we have together to make us into more observant people when it comes to Botany.



We are what we repeatedly do. Excellence and courage, then, are not acts of a moment, but trained habits.

Aristotle

Feel what is beautiful, think what is true and do what is right.

J. W. von Goethe

The three columns of your life

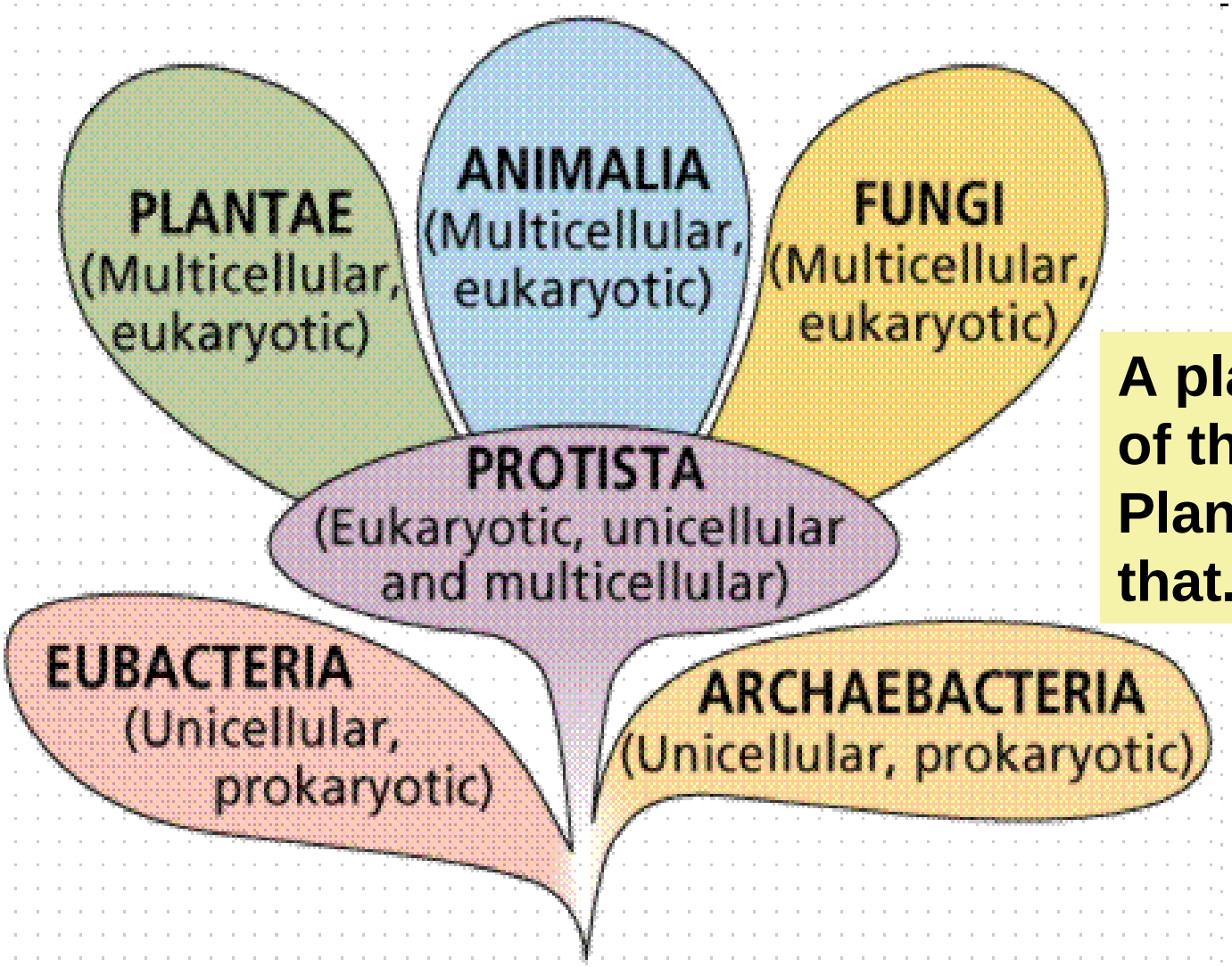
From “Wilhelm Meister’s years of apprenticeship”

What is a plant?

What is it? Plant, fungus, protist?

Is it really a plant?

What is a plant? 5 kingdoms or 6, Sir?

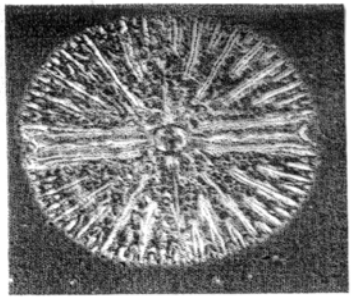


A plant is a member of the kingdom of Plantae and that is that.

What the .. Is a plant??

What the … is a plant?

➔ any member of the kingdom Plantae

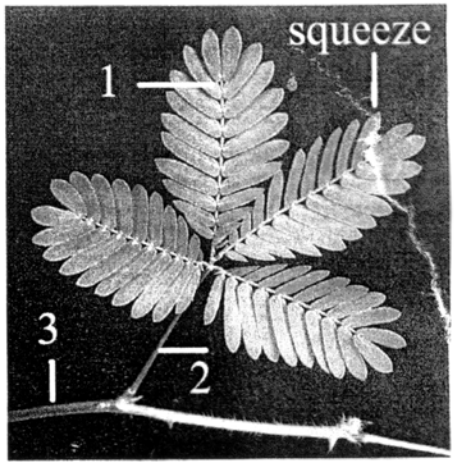


Micrasterias

typically characterized by:

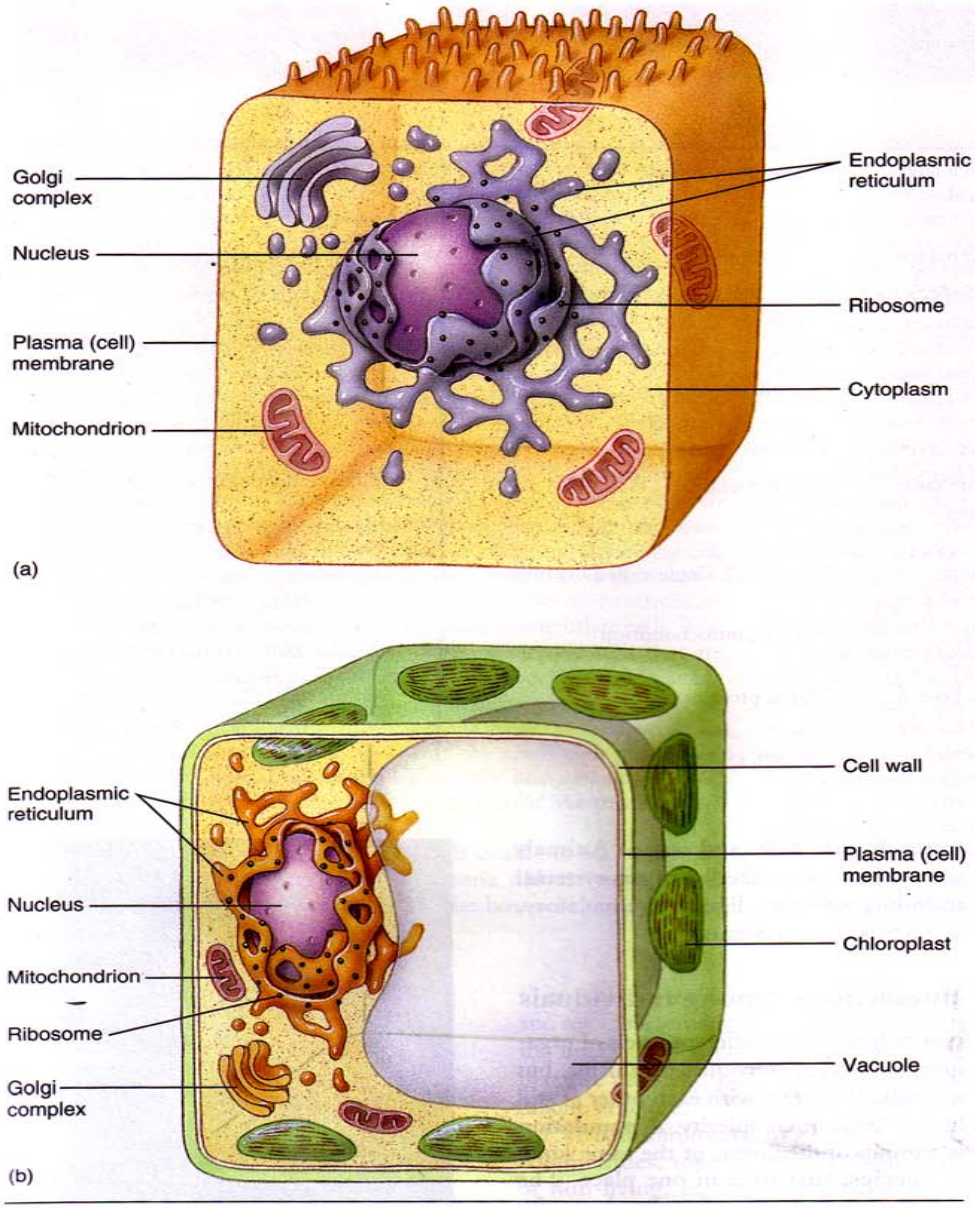
(1) Lack of locomotion (rooted)
(2) absence of sensory organs & a nervous system
(3) synthesizes polymers by photosynthesis
(4) alternation of sexual vs. asexual generations

Ulva lactuca



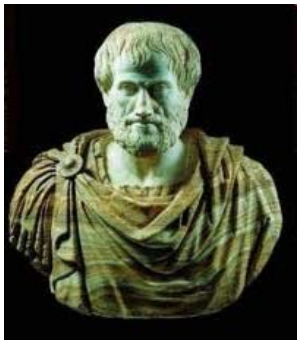
Source: Forensic Botany H. Miller Coyle (ed) CRC 2004

animal versus plant cell ?



name differences !

Aristotle and the beginning of Science



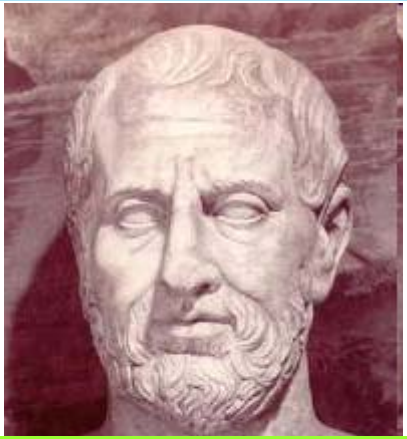
Aristotle was born in in 384 BC, near modern-day Thessaloniki.His father was the personal physician to King Amyntas of Macedon. At 18, he went to Athens to continue his education for 20 years at **Plato's Academy**.

Plato with Aristotle in the academy

Aristotle traveled with **Theophrastos** to the island of Lesbos, where they researched the **botany and zoology of the island**.

Aristotle was invited by Philip II of Macedon to become the tutor to his son **Alexander the Great** & also to two other future kings: **Ptolemy and Cassander**.Aristotle states that the only thing that could justify monarchy, was if the virtue of the king and his family were greater than the virtue of the rest of the citizens Aristotle encouraged Alexander toward eastern conquest.

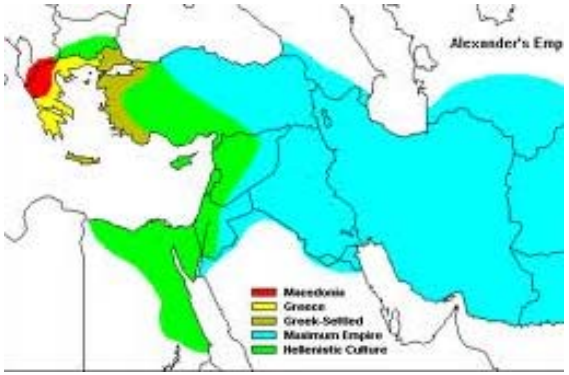
Theophrastos and the beginning of Botany



371 – c. 287 BC . At a young age, he studied in Plato's school. After Plato's death he attached himself to Aristotle. Aristotle designated him as his successor at the Lyceum.

Attached a botanical garden to the Lyceum. His student Alexander send many animal & plant species. His surviving botanical works are: remnants of a book on essential oils **1. *Enquiry into Plants*; 2. *On the Causes of Plants*,**

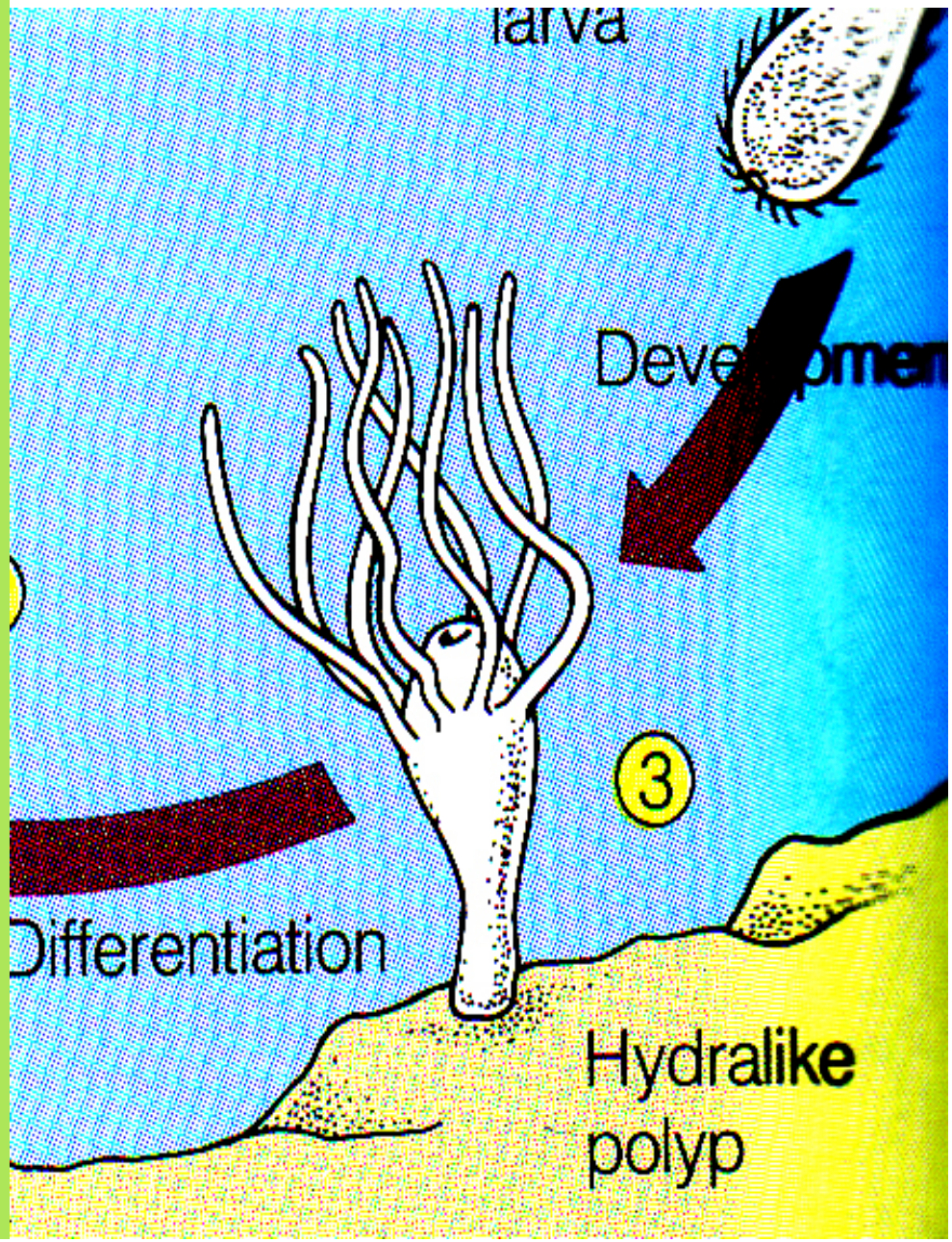
The 1st book deals with the parts of plants; the 2nd book with reproduction and sowing; the 3rd , 4th & 5th books are devoted to trees; the 6th book deals with shrubs; the **seventh book deals with herbs**; the 8th book deals with plants with edible seeds; and the **9th book deals with useful juices, gums, resins, oils. Much** of the information on the Greek plants come from his own observations, plus from the reports on plants of Asia brought back from those who followed Alexander



What is a plant?

Aristotle thought of plants as inverted hydras – primitive water animals which move in inverted position using their tentacles as legs as well as mouth.

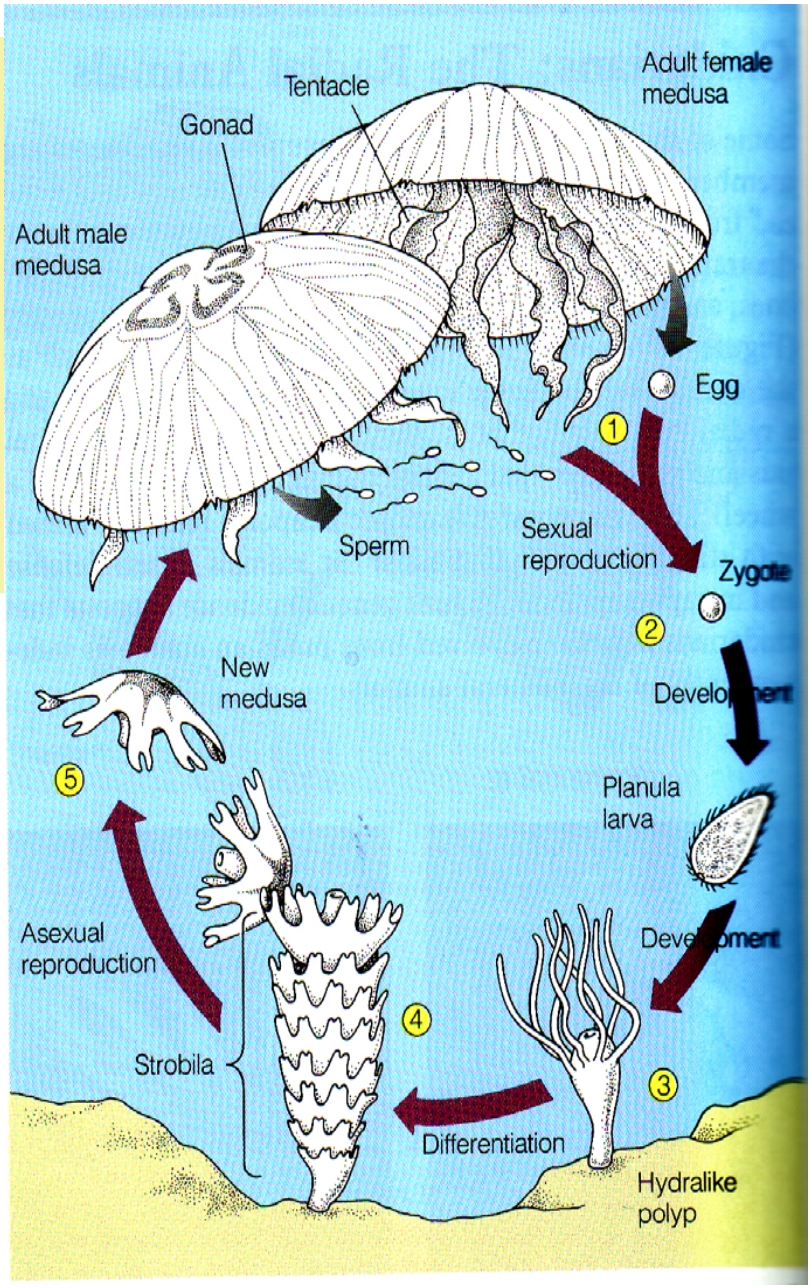
Aristotle thought that plants derive from hydra-like animals that got stuck with their mouth (roots) in the ground in an inverted position = **the first attempt to define the essential differences between the two kingdoms**.



What is a plant?

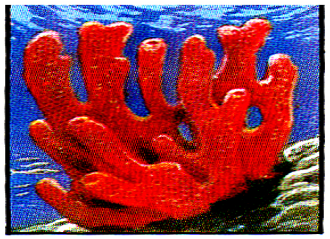
Eggs of jellyfishes do not hatch into new jellyfishes but attach to bottom structures, from where they sprout like plants. After some growth period the **sessile plant-like hydroids** blossom or release small jellyfishes. They have colorful protuberances that look like flowers.

The plant-like hydroids are water animals having slender stalk-like structures sprouting from rocks and coral reefs and with slow movements & **can be easily mistaken for plants**.



Sessile marine animals and protists

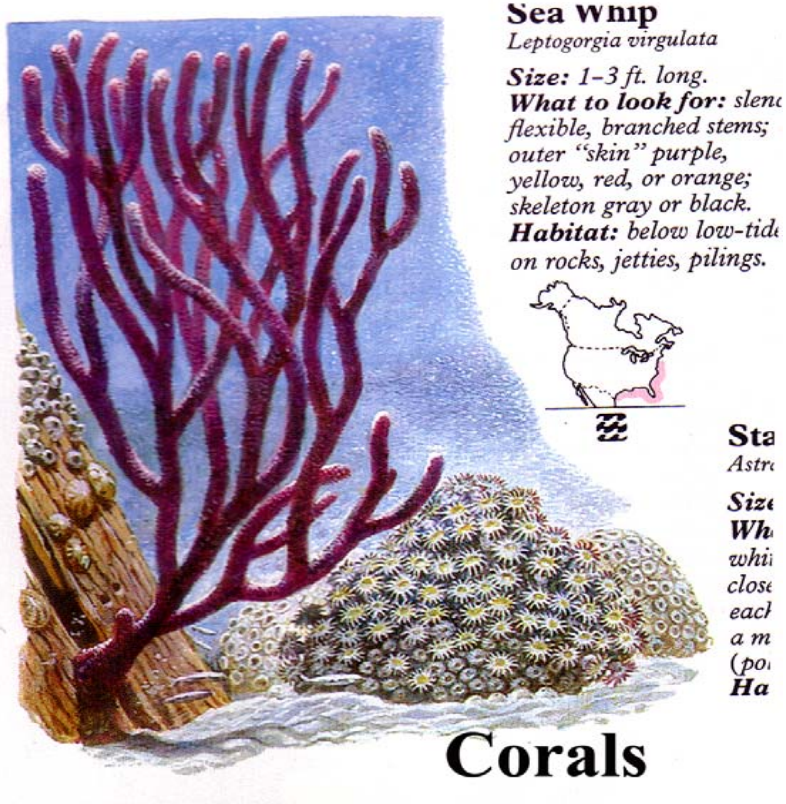
sponges



deeper water

Redbeard Sponge
Microciona prolifera

Size: *2–12 in. tall.*
What to look for: *spreading cl bumps or cups (clumps with upri in deeper water); red to orange (b*
Habitat: *along shores, in bays; o*



Sea Whip
Leptogorgia virgulata

Size: *1–3 ft. long.*
What to look for: *slen flexible, branched stems; outer "skin" purple, yellow, red, or orange; skeleton gray or black.*
Habitat: *below low-tid on rocks, jetties, pilings.*

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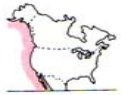
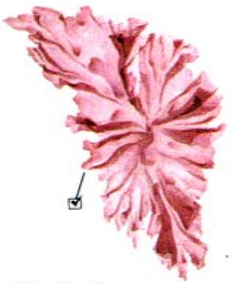
Corals

Red algae



Laver
Porphyra perforata

Size: *6–12 in. long.*
What to look for: *soft, slippery, tissue-thin sheet, variable in color (gray-pink to purple-red or gray-green); ruffled edges.*
Habitat: *rocks or other algae; upper or middle tidal zone.*



Bang's Primitive Red Algae
Bangiales

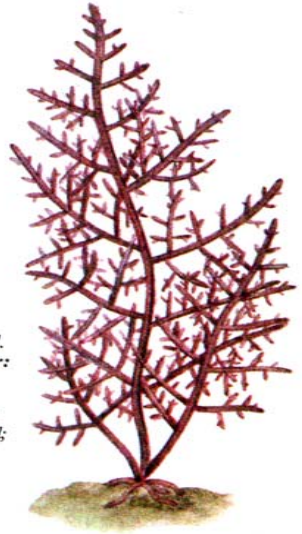
The several species called laver look fragile and shrink markedly when they dry out between tides, but they are surprisingly strong and resistant to tearing. High in protein and iodine, they can be eaten raw or cooked and are used as a food or condiment in the Orient and other places. A Japanese species is one of the few seaweeds that have been cultivated.

Dulse
(Neptune's Girdle)
Rhodymenia palmata

Size: *12–20 in. tall.*
What to look for: *broad-bladed plant, with one blade or several (may have tiny blades along edges); red-purple, leathery.*
Habitat: *rocks, shells, larger algae; tidal areas.*

Rosy-bladed Red Algae
Rhodymeniales

Munching on Dulse is a custom—and an acquired taste—dating from the Middle Ages in northern Europe. Closely related species on the West Coast look much like Dulse; other members of the group are inflated and resemble bunches of grapes or fingers on a glove.



Agar Weed
Gelidium robustum

Size: *4–16 in. tall.*
What to look for: *bushy, erect, deep red plant; stem and branches somewhat flattened; tough but pliable.*
Habitat: *rocks; lower tidal zone and deeper.*

Chenille Weed
Dasya pedicellata

Size: *3–30 in. tall.*
What to look for: *branches few to many, slender, round, with delicate hairs; light to deep red-purple.*
Habitat: *shells, small stones; quiet shallow waters below low-tide line.*

Wormlike Red Algae Nemalionales

Though seaweed botany may seem esoteric, its importance should not be underrated. Consider the cell walls of these and other red algae, which contain gelatinous substances extremely resistant to digestion. Since they are indigestible by man (and therefore noncaloric), manufacturers use them in diet foods.

Vesselled Red Algae Ceramiales

Chenille Weed is an oddity in this group, whose members are mainly small and inconspicuous. Large, feathery, and dramatically colored, it is a favorite for gluing onto paper and making seaweed pictures.

SEAWEEDS

What is a plant?

Plant-like features in hydra: Aristotle revisited

1740 A Trembley, Swiss in Holland found green hydras:

animal or plant? ➔

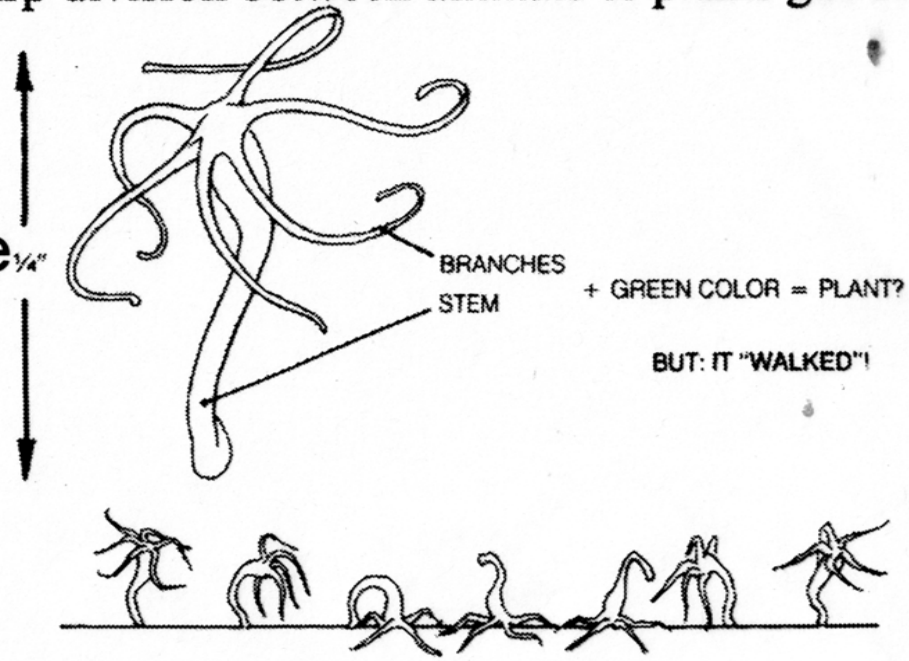
1. green color = plant (today: algal endosymbionts);

2. creature walked somersaulting, oh had he read Aristotle

3. Cut them in half regeneration ➔ plant

4. Captured little water fleas and stuffed them into a mouth ➔ animal

A. Trembley: is this green hydra plant or animal?
sharp division between animals & plants got blurred

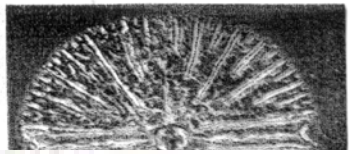


TREMBLEY'S DISCOVERY: ANIMAL OR PLANT?

Rene de Reaumur: discovered animal regenerat
in 1712

What the .. Is a plant??

What the … is a plant?



➔ any member of the kingdom Plantae

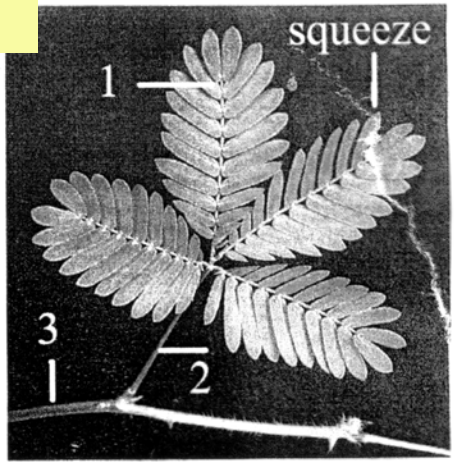
ClipartOf.com/6336

typically characterized by:

(1) Lack of locomotion = a sessile life stile

(3) synthesizes polymers by photosynthesis

(4) alternation of sexual vs. asexual generations



Source: Forensic Botany H. Miller Coyle (ed) CRC 2004

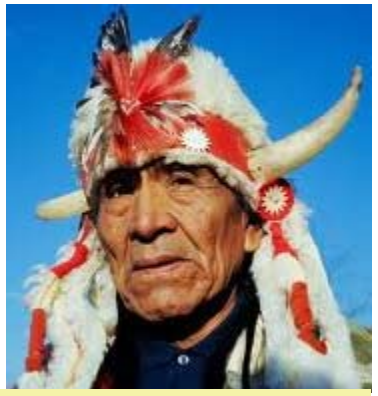
Sessile? But plants spread faster than animals

Plants travel faster and more effectively than animals with their clumsy devices like fins, wings and stick-legs. 1. Evidence plants are first to appear on sterile islands

Tree ferns are among the first to settle on the lava of new islands like this one called “Son of Krakatau”. This is easy to understand since fern spores can fly from continent to continent.

Coconut landing on the shore of a new island. When it is not shaded (photoscopic seed) it will germinate and make a new colony of palms without help of humans

The plantain ***Plantago major*** seed contains mucilage like the linseed. When wet it attaches to any surface and is transported along even by barefoot people. North American Indians took appearance of this plant as a sign that white trappers had invaded their territory.

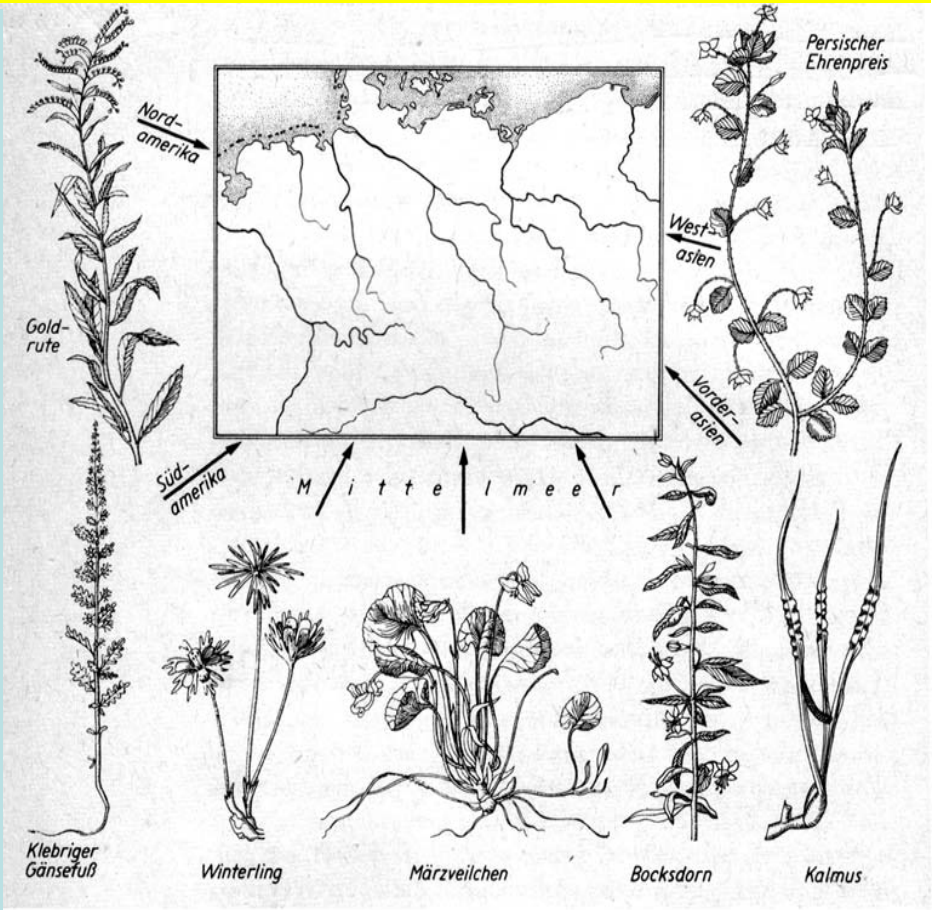


Plants travel as seeds (embryos), animals as adults.

Plants do not know that they are supposed to be sessile

Weedy plants are those who travel & settle beyond their place of origin. They ar called **“foreign invaders”** in America & **“neophytes”** in Europe Many escaped from Botanical gradens. Same is true for every continent!

Europe is open to Asia & through humans to Mediterranean + America
From NAm: *Elodea canadensis, Solidago canadensis, mimulus guttatus, Amaranthus retroflexus, Oenothera biennis, Erigeron canad.*
From Asia: *Acorus calamus = sweetflag, Impatiens parviflora, Datura stramonium, Viola odorata*
From S Europe: *Brassica nigra, Amoracia lapathifolia, Tulipa sylvestris (wild tulip)*



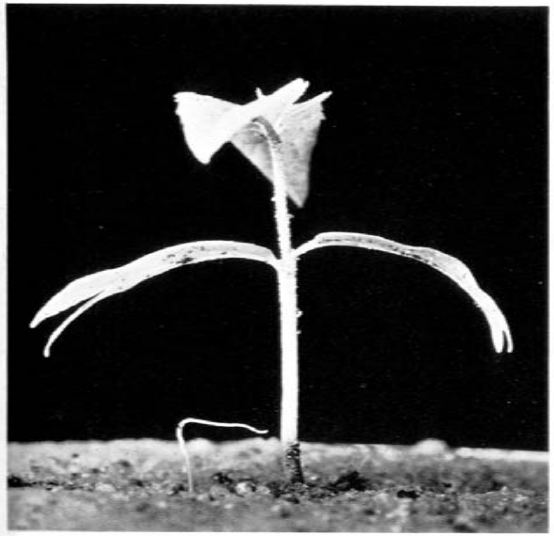
mmigration of neophytes into Central Europe

Neophytes have **superior** adaptability, flexibility & ecological tolerance

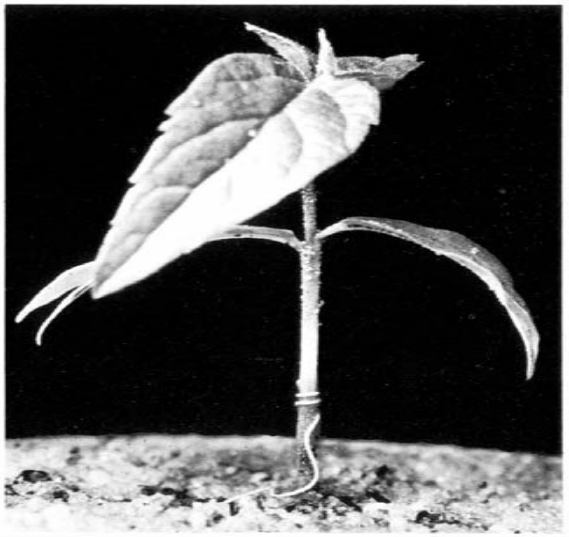
The only plants that does the locomotion ….

Cuscuta (**Dodder**) about 100species of yellow, orange or red (rarely green) parasitic leafless (minute scales) plants placed in the **morning glory family, Convolvulaceae.**

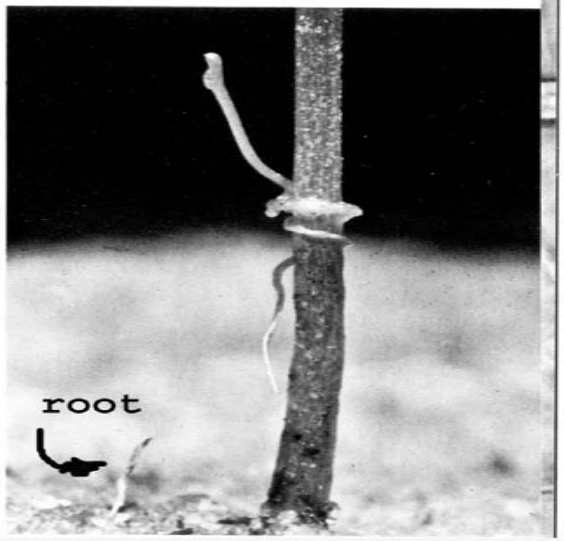
The **seeds** are minute and produced in large quantities. They have a hard coating, & survive in soil for 5–10 years. **Germination** can occur without a host, it zooms in on the **smell** of nearby plants



1. germination with flexible stem smells the host plant



2. after 12 h it is already solidly attached to the host



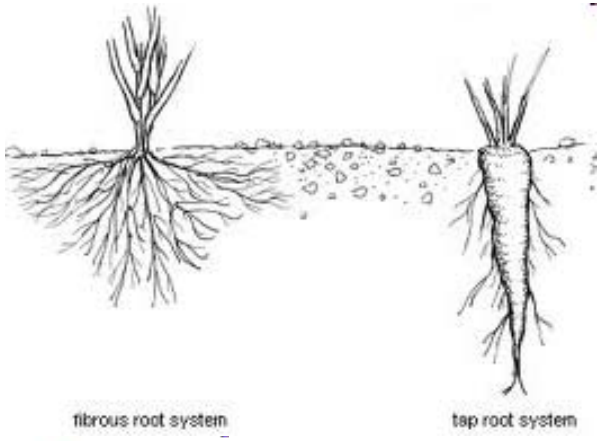
3. One week later it has haustoria in the host & abundons root

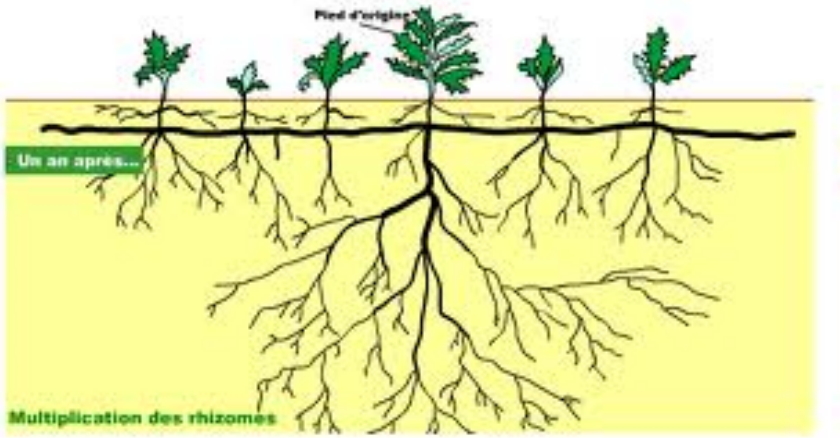
What makes a plant different from an animal like us?

" Has no head, no ears, it is green but so is the frog .. comes always in pots, & really loves dirt"

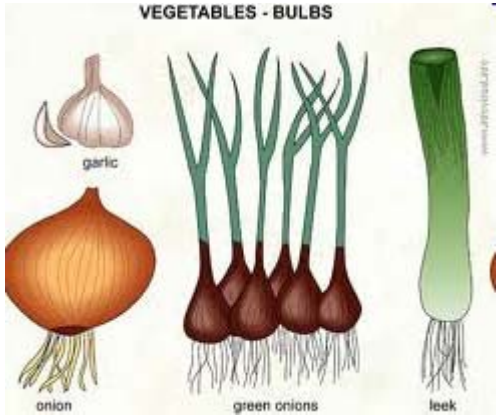
Plants have a hidden part called **Root (1)**

It is not obvious from the look of a plant to guess what kind of root it has: tap root, fibrous, rhizome, bulb etc.





Hops grows from rhizomes



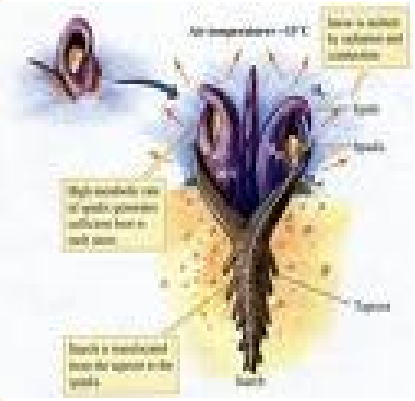
Conifer root with mycorrhiza

Ginger rhizome

What is a Plant; the hidden part is important

What we see of a plant is not necessary all, plants differ often more by what is beneath the earth than what you can see above it. The subterranean part is also often more important, since all geophytes/cryptophytes survive the winter with the perennial parts that are below the earth. These parts may reflect the fact that the first higher plants on the dry continents were more inside the earth than above it!

Bloodroot
Sanguinaria



Skunk cabbage
Symphocarpus

Pasque flower
Anemone patens

While many macroscopic algae **have** chlorophyll + **leaf-like & stem-like structures** (fonds & stipes), they & the fungi surely miss out on **roots, an organ** that seems to be **specific for higher plants.**

What is a Plant; the hidden part is important

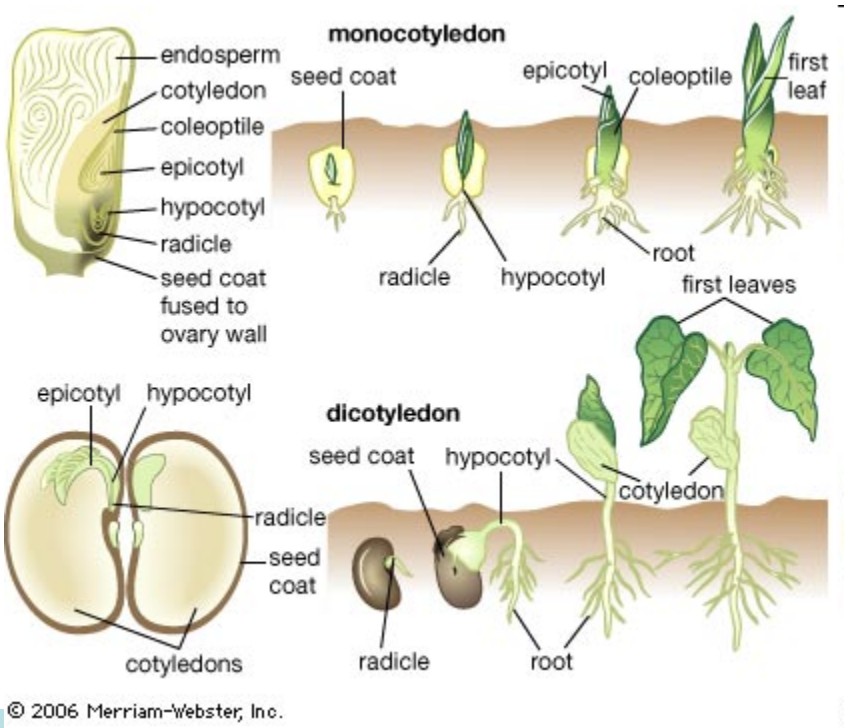
All geophytes/cryptophytes survive the winter with the perennial parts that are below the earth. These parts may reflect the fact that the first higher plants on the dry continents were more inside the earth than above it!

In the winter the only living (or surviving) part of herbal plants is the root, bulb, rhizome below the surface.

Contrary to perennials, **in annual plants the** roots **do not survive the winter.**

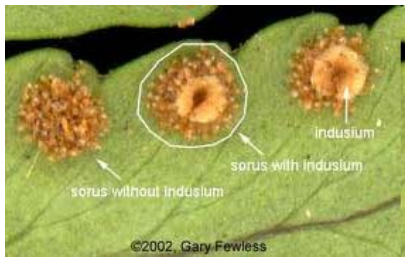
2. Higher plants invented survival + prop. units called Seeds

A **seed** is a small, but complete embryonic plant enclosed in a **seed coat**, usually with some **stored food** (exception the smallest orchid seeds). It is the product of the ripened female ovule and the fertilizing male pollen and hence a product of sexual propagation with its genes-mixing effect increasing the genetic diversity of the offspring.



Lower plants have a propagation unit called spore. A spore is a reproductive unit for dispersal and surviving unfavorable conditions. Spores form part of the life cycles of many bacteria, algae, fungi and **lower plants like mosses and ferns.**

The difference between spores and seeds is that spores have very little stored food resources compared with seeds.



Fern sporangia called sori are packages containing many spores

How long can seeds live? Germination rate drops to 50 % after how many years .....

RSI = time after which germination rate drops to 50 % of initial.

Relative storability index[a]

Crop	Category 1 (1 to 2 yr.)	Category 2 (3 to 5 yr.)	Category 3 (>5 yr.)
Agronomic			
	Bermuda grass	Barley	Alfalfa
	Cotton	Ky. Bluegrass	Sugar beet
	Field corn	Fescue	Clover
	Millet	Oats	Vetch
	Peanut	Rape seed	
	Soybean	Rice	
	Sunflower	Wheat	
Vegetable			
	Green bean	Broccoli, cabbage, cauliflower	Beet
	Lettuce	Sweet corn	Tomato
	Onion	Cucumber	
	Pepper	Melon	
		Pea	
		Spinach	
Flower			
	Begonia	Alyssum	Hollyhock
	Coreopsis	Carnation	Morning glory
	Pansy	Coleus	Salpiglossis
	Primrose	Cyclamen	Shasta daisy
	Statice	Marigold	Stocks
	Vinca	Petunia	Zinnia

[a]The relative storability index is the expected 50 percent germination in a seed lot stored under favorable ambient conditions. Storage life would be longer under controlled low temperature conditions.

Adapted from Justice and Bass 1979

Hartmann HT et al. "Plant Propagation - principles and practises. Prentice Hall N Y 1997