Plants can fly !

Seeds come in dispersal units: embryo , food supply, coat, plus

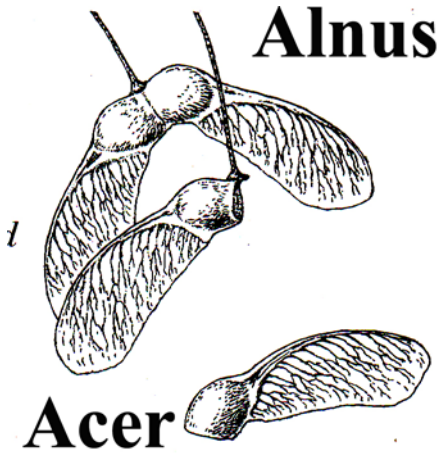
parachutes: lettuce (Lactuca) dandelion (Taraxacum), thistle (Cirsium)

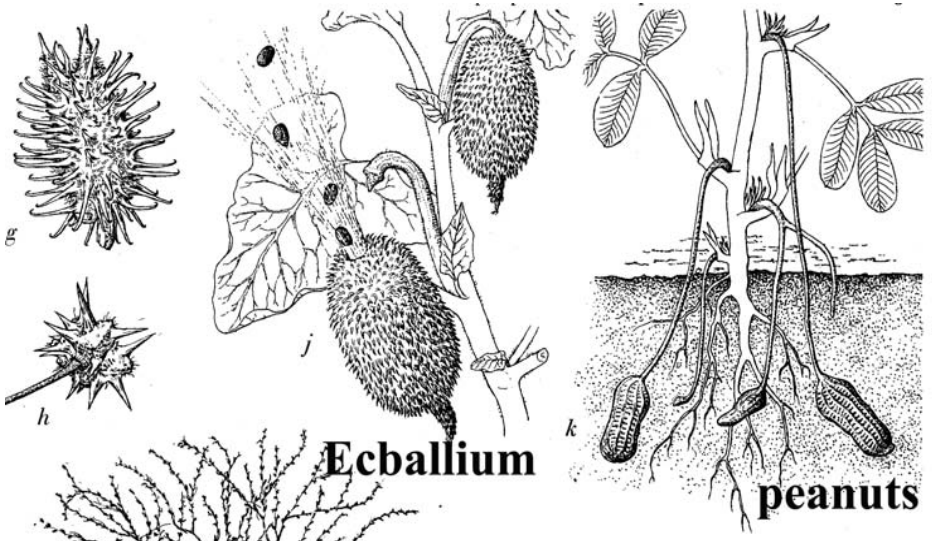
wings: maple Acer, alder Alnus, tumbleweeds

floats: coconut

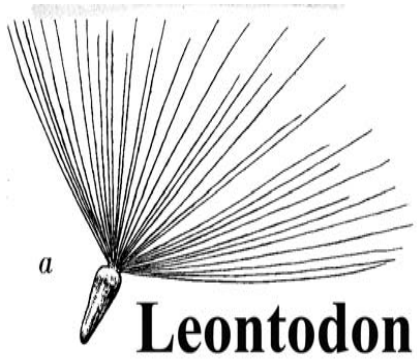
bribes: beans, bloodroot etc carry elaiosomes or oil bodies for ant-dispersal

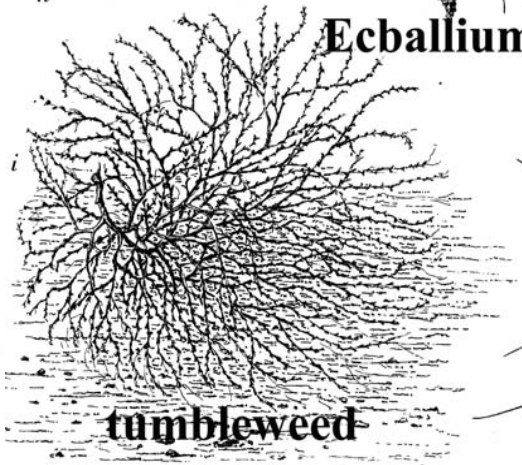
glues: mistletoes, squirting cucumber





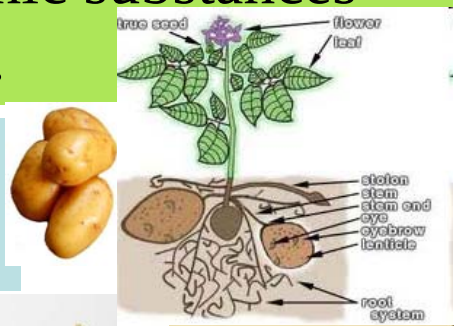
Elaiosomes from Sanguinaria c.
release oleic acid (dead ant sign.)
linoleic acid (food or brood sign.)





Vegetative Propagation – animals don't do this at home (3)

Plants consider vegetative propagation the safer method. When they have to choose between asexual and sexual propagation, the clearly vote for the first one. There are many plants that rarely produce flowers: One reason for this behavior is that the assimalated organic substances are drawn to the geophytic organs rather than the flower.



Potatoes *Solanum (Lycopersicum) tuberosum*. In large potato fields you find very few plants that are flowering.

Horseradish *Cochlearia armoracia* flowers but hardly ever produces seeds since the growth of storage roots has absolute priority.

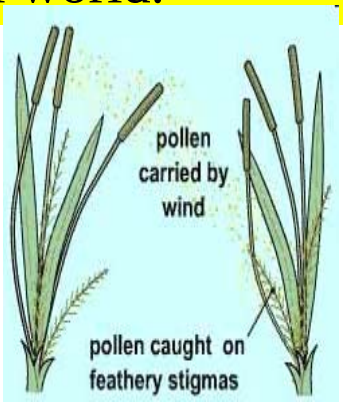
Buttercups of *Ranunculus ficaria* flower in early spring but hardly produce any fruits. They propagate by small visible bulblets that form near leaf nodes at the stem.

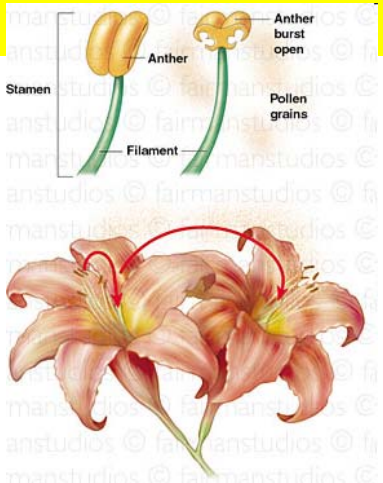
Jerusalem artichoke, Topinambur *Helianthus tuberosum*. Flowers in late summer but never succeed making seeds store inulin in tubers

Higher plants invented a new kind of condemnable Sex

Before artificial insemination, **fertilization in animals always required the intimate presence of both partners at the same location**. Since plants have roots and cannot move even for sex, they found new ways to bring the male gametes (pollen) to the female gametes (ovules). One nice collateral of this is the invention of flowers, color, smell = a better, more beautiful world.

Plants use either wind or animals (insects, spiders, birds, bats, humans you name it) to get the pollen with the male gametes to the female organs (=stigmas).





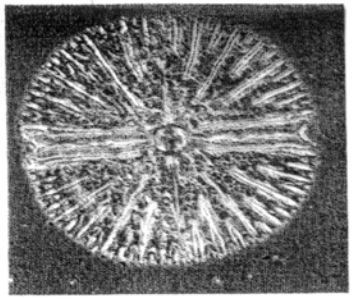
The new mechanism allows one plant to fertilize another that is miles or in some cases (jet stream) even continents away. **A major breakthrough in remote sex allowing a high degree in diversity over large areas and populations.**

Before mail order of animal sperm was invented the fertilization of ovules depended on the slow **swimming speed of male spermatozoa – a severe handicap.**

What the .. Is a plant??

What the … is a plant?

➔ any member of the kingdom Plantae



Ficrasterias

typically characterized by:

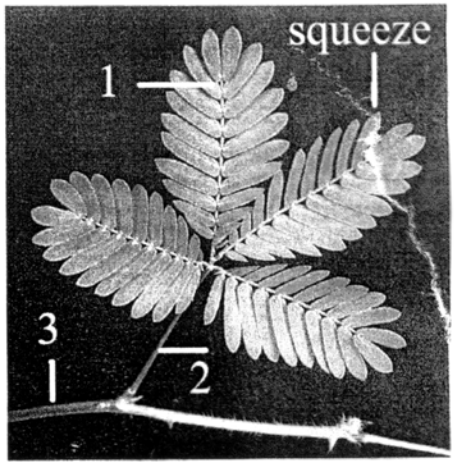
(1) Lack of locomotion

(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

Plants propagate by strange zombie-like bodies: **seeds (2)**

Seeds come in dispersal units: embryo , food supply, coat, plus

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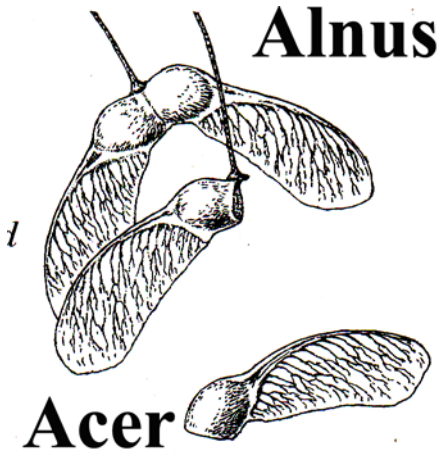

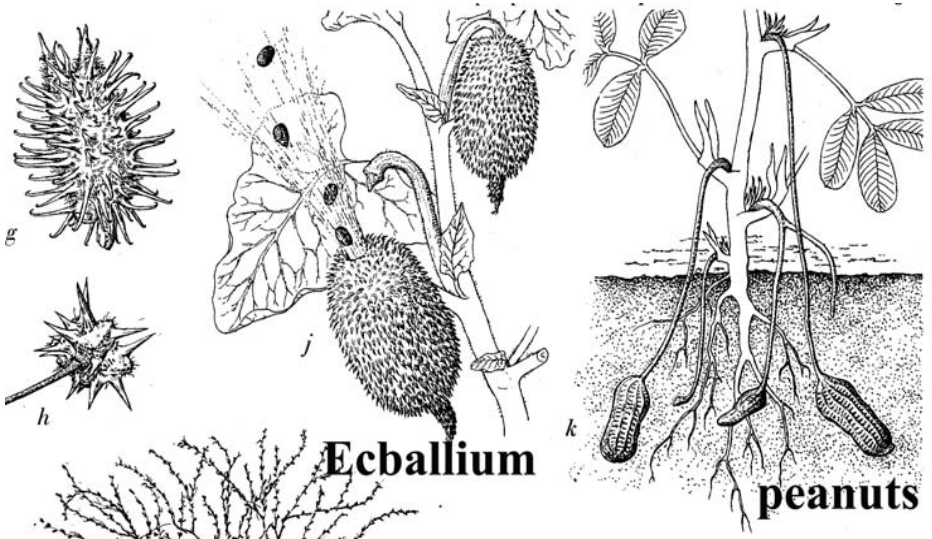

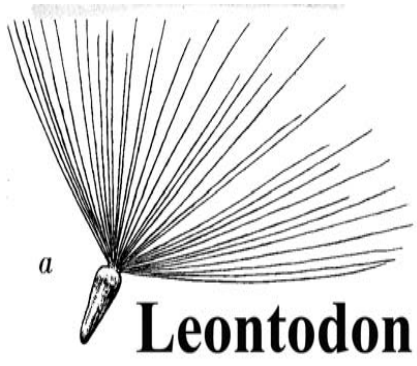

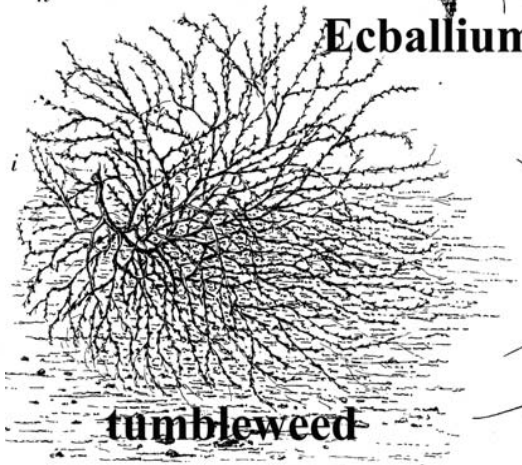

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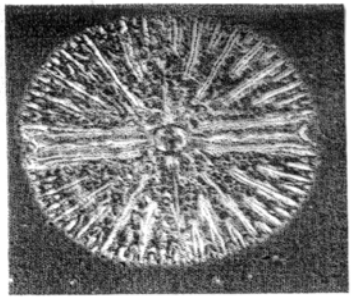

Ficrasterias

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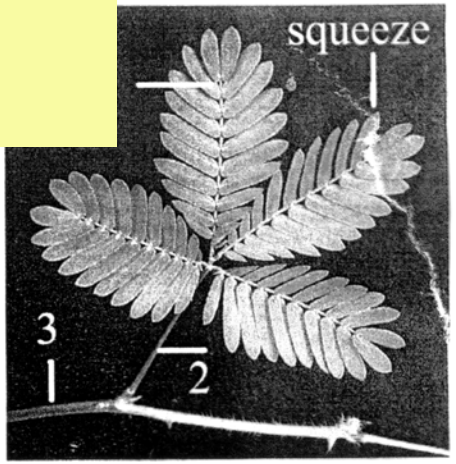
(1) Lack of locomotion (rooted)

Ulva lactuca

(2) No sensory organs & nervous system

photosynthesis

(4) alternation of sexual vs. asexual generations



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

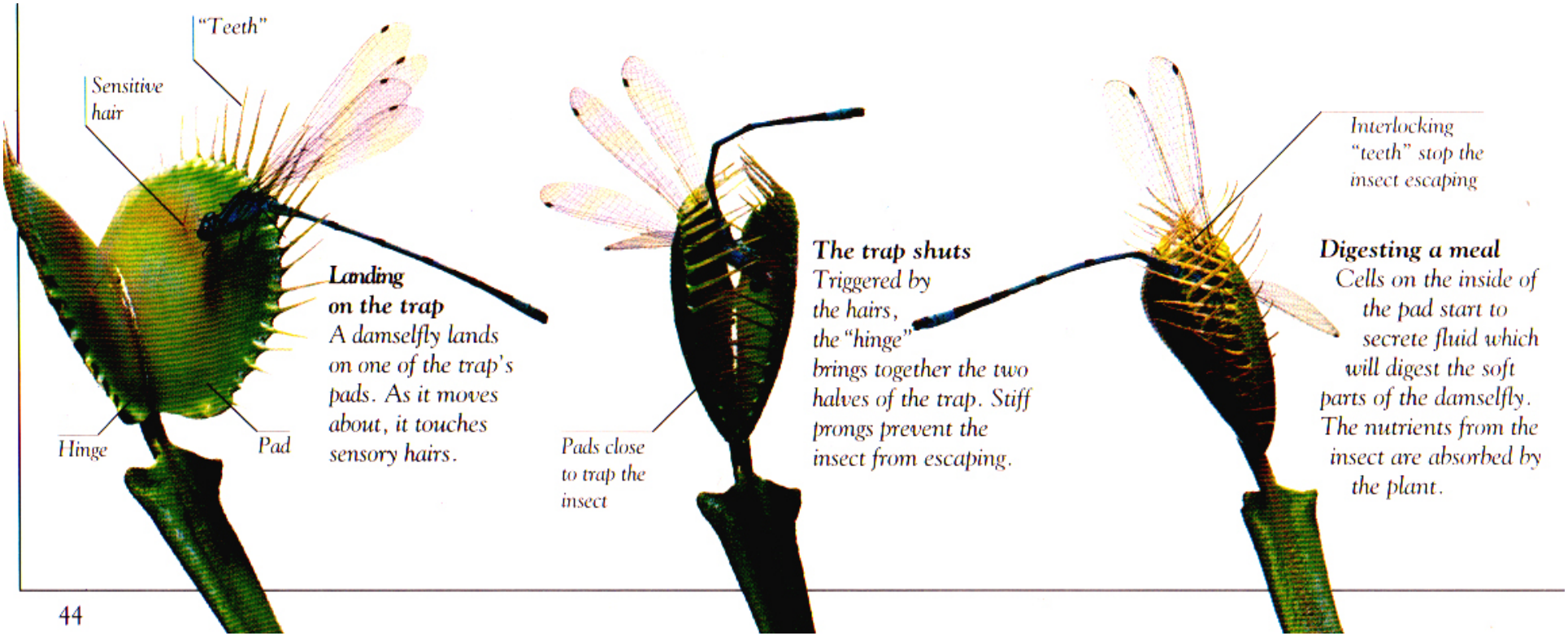
Plants that can smell! *discovered in 2006*

Cuscuta or dodder is a gneus of at least 100 yellow to red species of parasitic plants. Recent genetic reasearch place this gneus in the morning glory family Convolvulaceae. Dodder appears as a leafless, chlorophyll-deprived shoot (leaves are reduced to small scales) without a root. After dodder germinates and finds a plant to climb it abandons its earthly root for haustoria.

The dodders stem elongates quickly & waves slowly (circumnutation) in the air checking for odors from potential victims.
.Runyon, Mescher & De Moraes (Science Vol. 313: 2006) at Penn State demonstrated that **dodder uses volatile chemical cues to locate host plants.** ***Cuscuta pentagona*** showed positive tropistic growth towards a volatiles from tomato plants.

When confronted with a **choice between tomato and wheat**, the dodder made a quick move towards the poor tomato plant. Ah, c'est la vie!

Plants can feel and respond faster than insects

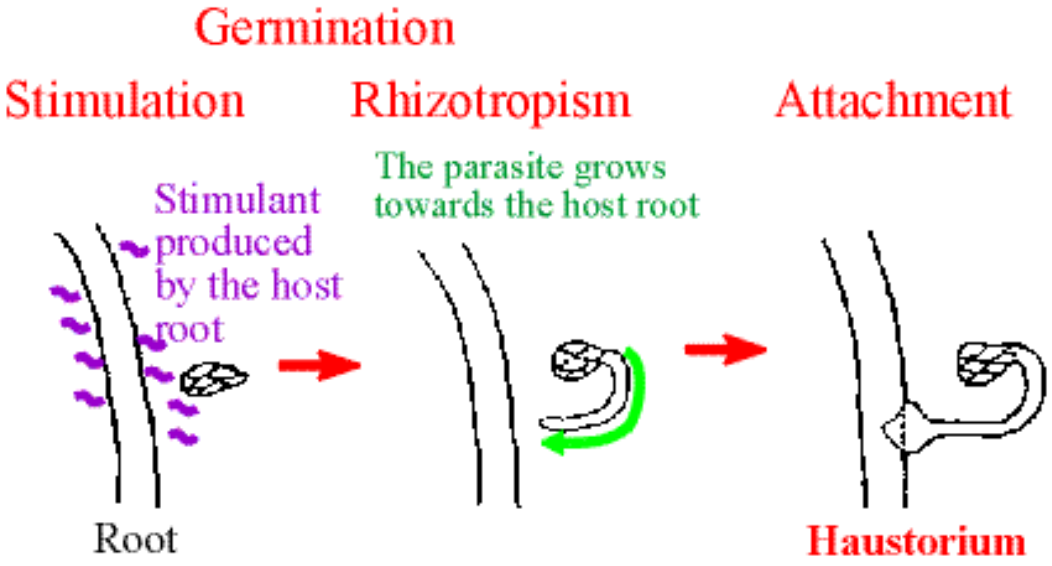


The Venus flytrap ***Dionaea muscipula***, is a living fossil of a carnivorous plant that catches and digests animal prey. When an insect or spider crawling along the leaves contacts a hair, the trap closes if there is a second contact within twenty seconds of the first strike. Counting "two" strikes in sequence makes it likely that the cause is a moving object that is alive. Plants can count!

Leaflet folding in *Mimosa pudica* photographed at 2 s-intervals after touching the leaf tip closest to the observer with a wooden stick of r = 0.5 mm.

Plants that can taste!

Underground development and early development stages of the parasite



Seeds of *Orobanche*, *Striga* and *Alectra* are dormant and require a period of afterripening in warm, dry storage, followed by conditioning in a warm, moist environment. Then they will **respond to germination stimulants in the soil.** Chemcial signal ; **non-volatile ➔ taste**

Features usually not associated with plants

Plants can adapt to be **predators** of animals (carnivorous plants, Dionea, Nepenthes) or plants (dodder Cuscuta, strangler figs Ficus)

Plants can form lenses to **focus light** not for a sharper vision but for more efficient light light use in photosynthesis.

Plants can adapt to very **fast movements** based on their ability to contract tissues through rapid turgor loss. Animal cell contraction is based on protein interaction (e.g. actin/myosin) which plants use only for intracellular streaming etc.

Plants **move quickly over large distances** (Indians could tell of encroachment of their territory by whites by appearance of plantain

Plants can use **mimicry in phenotype & odor** to force animals (insects most but also YOU) to participate in their reproduction

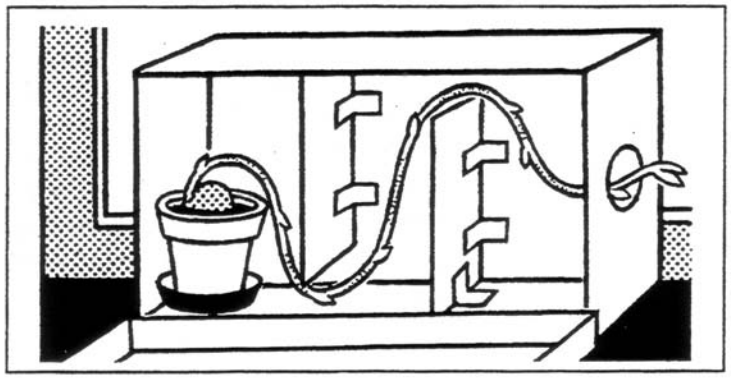
Plant behavior ?

Many books deal with animal behavior (Ethology). Although plants can move in certain directions they are rooted; i.e. unable to translocate (1). Although plants respond to stimuli, this response does not involve a brain or nervous transmission (2). ***Do these two facts exclude behavior***?

The science of **"Plant behavior"** has not been established. It needs the implementation of rigorous tests of features like

recognition of "self": asexually propagating plants like strawberries will not intrude into each other's root space. What happens if you disconnect the runners and create individual plants?

"Plant intelligence": It needs more than just to show that plant will find a hole from where the light penetrates into a dark box. It needs offering of real choices equivalent to the maze of rat testing.



Plant Electricity:
The Shocking Truth!

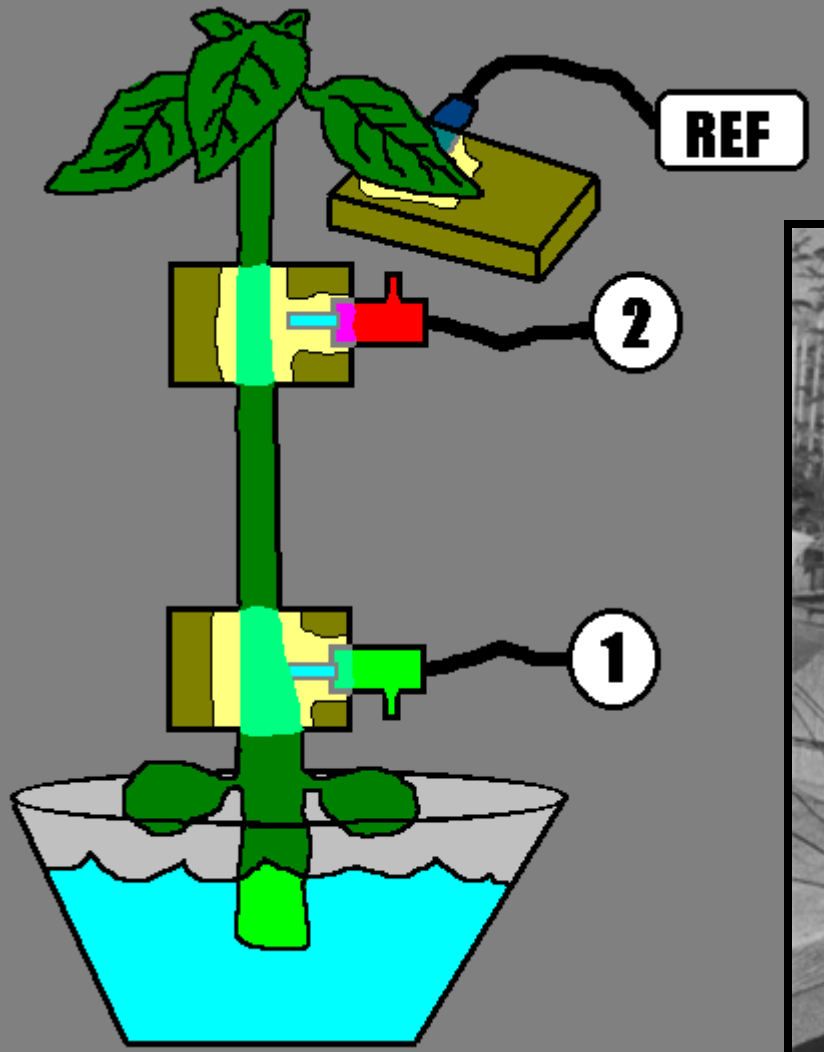
***Mimosa pudica*,**

the “Sensitive Plant”

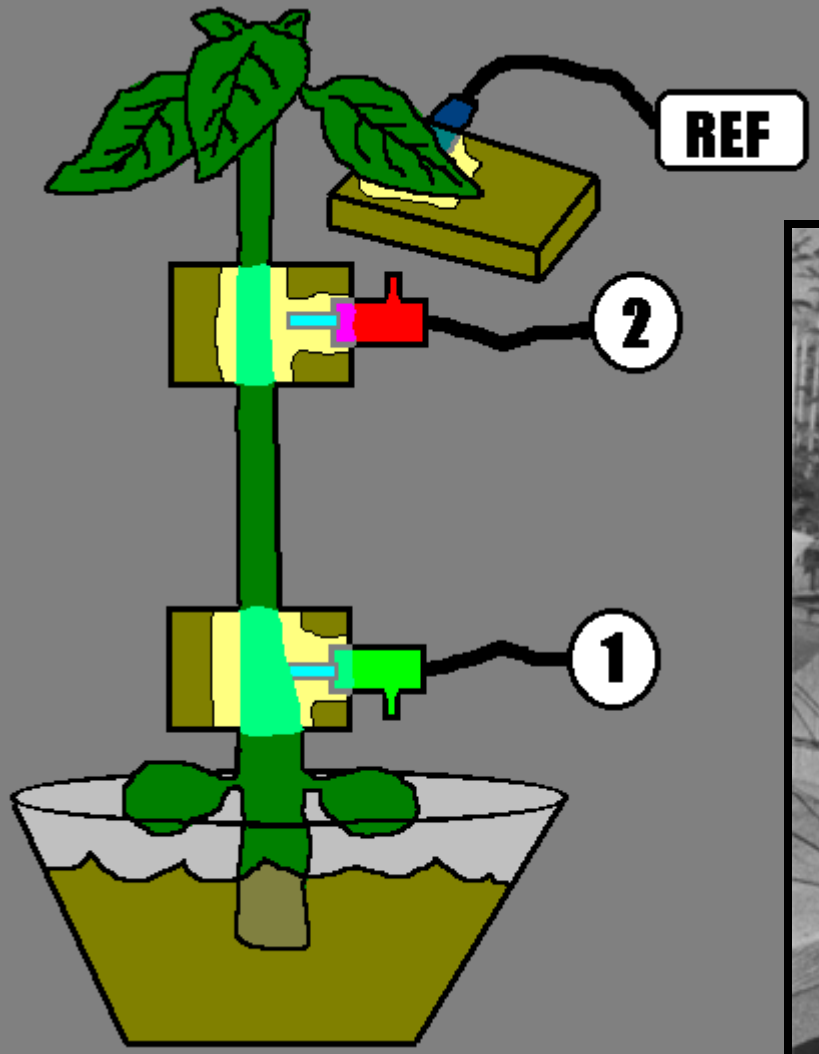
Dionaea muscipula

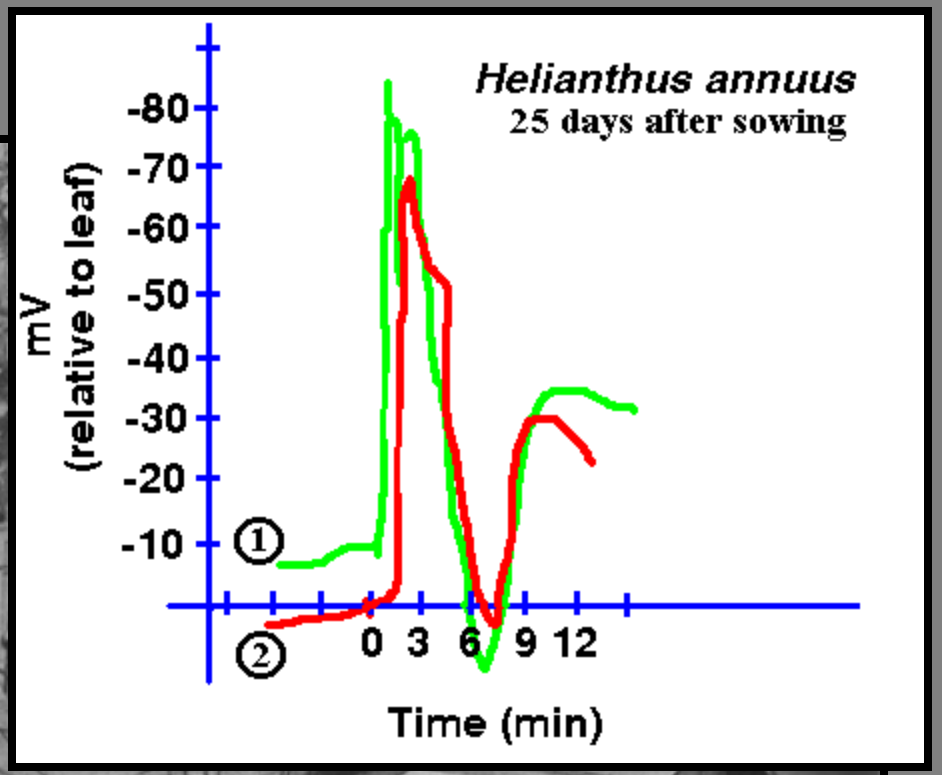
“Venus Flytrap”

Measuring Electrical Responses



Measuring Electrical Responses





Plant Ethology? - Do plants have behavior?

Behavior of animals is defined as either *inherited sequence of actions triggered by defined clues & situations & directed to a certain purpose* ***(instincts, fixed-action patterns; I)*** *+ changeable actions qualifying as* ***learned*** **behavior** (II)

reflexes: touch of certain spots, nerves (**clue**) involuntary muscle contraction

instincts: red color (**clue**) triggers attack of stickling fish, pecking of seagull chick

learned behavior:

habituation (animal learns to ignore repeated stimuli that are w/o consequence

trial-&-error learning = conditioning Pavlov's dogs connecting bell with food

all training systems that rely on punishment or reward (child care)

time orientation: how to read the time of the day / year; **social behavior**: rang

feeding behavior: how to find food while avoiding predators

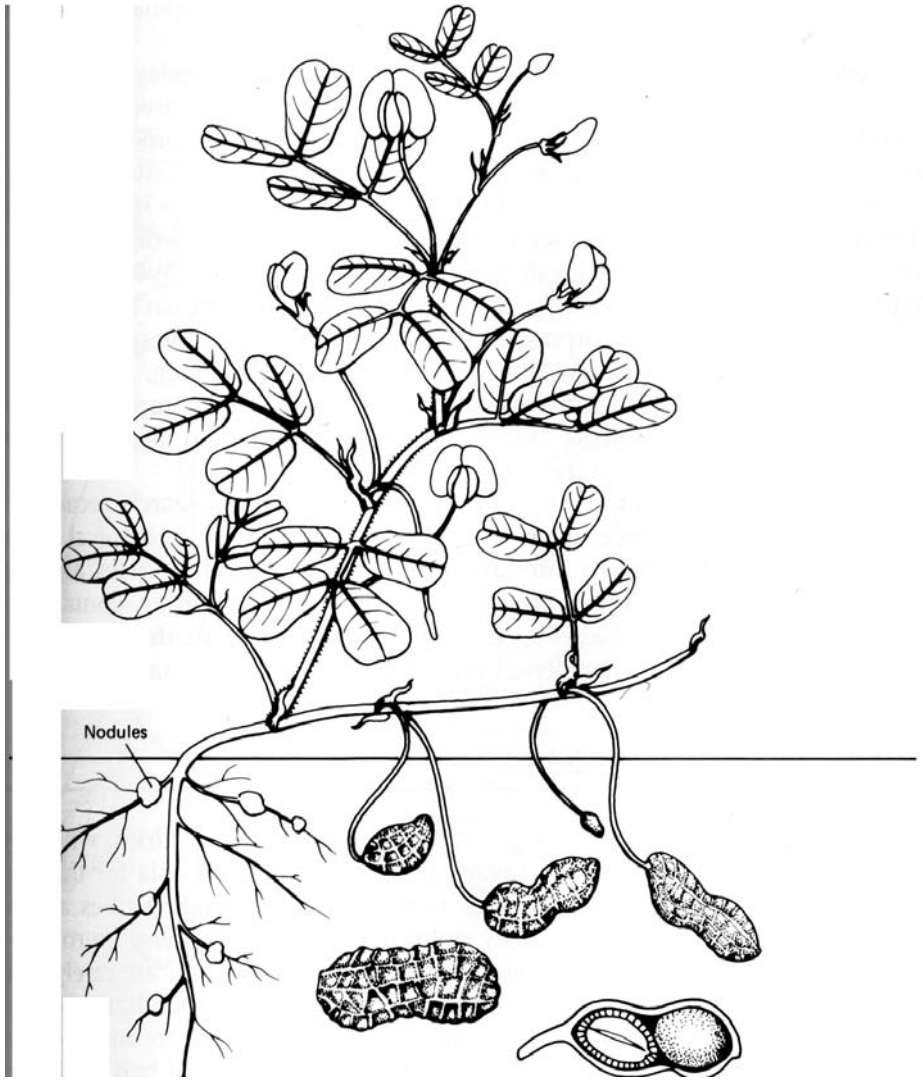
Which examples fit plant behavior?

Establish criteria qualifying behavior! Test these criteria for sleep movements of leaves, fall burial of buds in Rubus, leaf abscision in autumn, heliotropism, phototropism, gravitropsim, timing of flower opening & closure, of scent release, color change of petals, sensing of support in vines, tendrils, climbing epiphytes, parasites, hemiparasites

Principles & concepts of plant ethology?

Ethology was useful in establishing common lines of animal behavior but was always polluted by the idea that humans are something special, that human thinking applies to animals (anthropology). It never attempted to define general principles & its presence in other kingdoms. **This still has to be done by anybody to explore this area!**

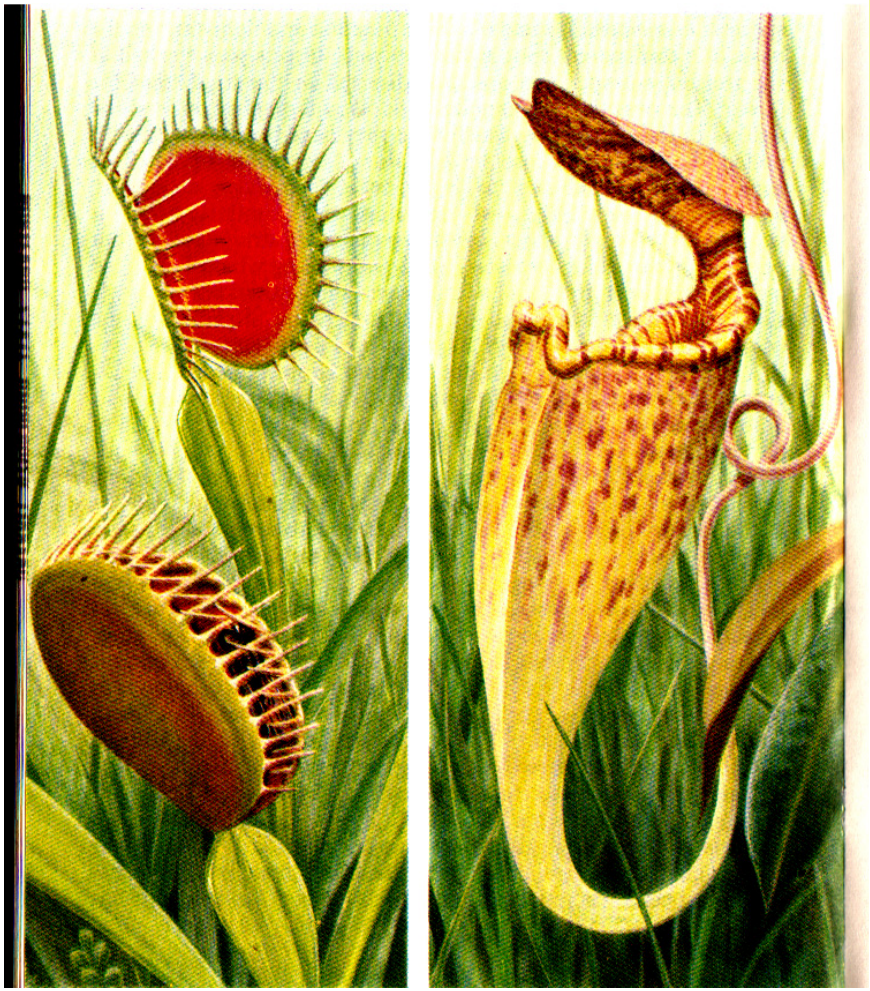
After fertilization, the flower pedicels of peanuts curve down grow deeper into the safe soil



Insects as N-rich particles from the air

Dionaea & Nepenthes

mimic flowers to attract insect



Insectivorous plants are an example of how far evolution can drive plants towards animal-like behavior

(Darwin: Dionaea - most animal-like plant!"

1. Simulate flowers in color, smell

2. Increase movement speed to .. . … insect standards

3. Digest animal matter in cavities . . . that resemble stomachs in shape, . . low pH + proteinases that are . . . . . identical to those of animals.

Wolfgang Wickler (1974) Mimicry in Plants and Animals. McGraw-Hill, N.Y.

Principles & concepts of plant ethology!

Reflexes: Although plants do not have muscles & nerves they show reflexes like the Venus fly trap, mimosa, Oxalis & many others.

Plants change their lifestyle switching from annual to biennial life style, from sexual propagation to asexual propagation, to vivipary, from insect pollination to cryptogamy (violets)

Recognition of Self: it was found that fungal hyphae can manage to find food in a maze, that they recognize other hyphae as self or non-self (serious stuff), that similar rules apply to roots that were first part of the same plant and later part of a separated individual. Plants gave readings on a lie detector (GSR = galvanic skin resistance, not generally accepted)

Mimicry: Plants show many kinds of purposeful mimicry: seeds of rye (wheat mimicry), Commelina vulgaris (flax mimicry), bee orchid (insect mimicry), window plants (stone mimicry) to iraise their odds in selection

Irritability in Plants - behavior

Some plants show fast movements, others show the same but slower + therefore draw less attention. Some still wait to be discovered, e.g. think of the nice undulating wave in wheat fields or grass prairies.

"Hydroscopic movements" occur both in living & dead pl parts (TG): Teeth in moss spore capsules, spores of mossess & horsetails, *Erodium* seeds, bean & pea pods, " Rose of Jericho", dried composite heads like Carline thistle, show that the plant is master of this construction.

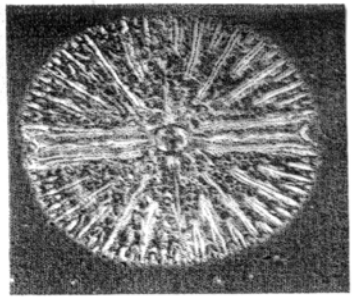
"Turgor movements" are rapid leaf movements in *Dionea muscipula* Venus flytrap, Mimosa pudica, the compass plant *Desmodium gyrens*, but also rapid movements of the style of *Centaurea cyanus* Bachelor button, stamens of Berberis bend inward to dust the bees.
Compare this to the slow sleep movements of leaves in Phaseolus, Oxalis

"Contraction movements" are known to be the basis of animal muscle cells and their movements but are considered rare in plant cells that have a stiff cell wall around them. In Spirogyra – a green alga – the protoplasm contracts but it has no consequences for the cell length.

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 organ

(3) Lives through Photosynthesis

(4) alternation of sexual vs. asexual generations

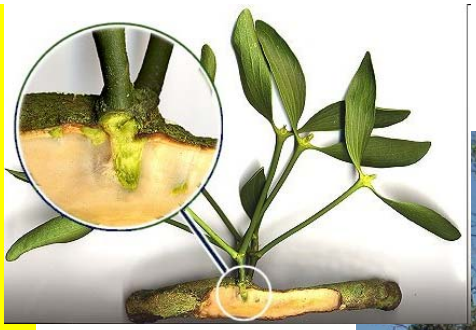
Source: Forensic Botany H. Miller Coyle (ed) CRC 2004

Parasitic Plants

A **parasitic plant** derives some or all of its sustenance from another plants or fungi (4,100 species in approximately 19 families). **Parasitic plants have a modified root, the haustorium** that penetrates the host plant and connects to the xylem, phloem.

1 Facultative parasite – a parasite that can complete its life cycle independent of a host & has a huge range of hosts (***e.g. Pedicularis***)

2. Holoparasite – a plant that has no chlorophyll & is completely parasitic on other plants (***Rafflesia, Cuscuta, mistletoe***) **3. Hemiparasite** – a plant that is parasitic under natural conditions and is also photosynthetic to some degree. Hemiparasites may just obtain water and mineral nutrients from the host plant. Obtain at least part of their organic nutrients from the host as well (***Castilleja, Mycelis muralis, snow plant Sarcodes***)



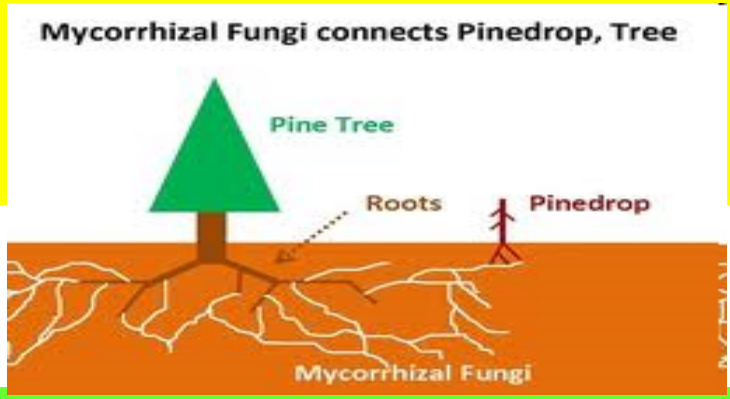




Beware of chlorophyll-free plants ➔ they are like animals

Pinedrop = *Pterospora andromedea* grows in coniferous forests native to North America. It is in the family **Ericaceae.** The upper portion of the red stalk has a series of yellowish, bell-shaped flowers face downward.

They exist for most of their lifecycle as a mass of fleshy roots in relationship with mycorrhizal fungi that is described as either parasitic by different experts. They are thus described as mycorrhizal heterotrophs.



Coralroot orchids, C***orallorhiza***, are leafless, relying entirely upon symbiotic fungi within their coral-shaped roots for sustenance. Because of this dependence they cannot be successfully cultivated. Most species do not produce chlorophyll, and do not depend on photosynthesis for energy.

Holoparasites have virtually no chlorophyll & are completely parasitic & include 4,100 species in 19 families of flowering plants

Beware of chlorophyll-free plants ➔ they are like animals

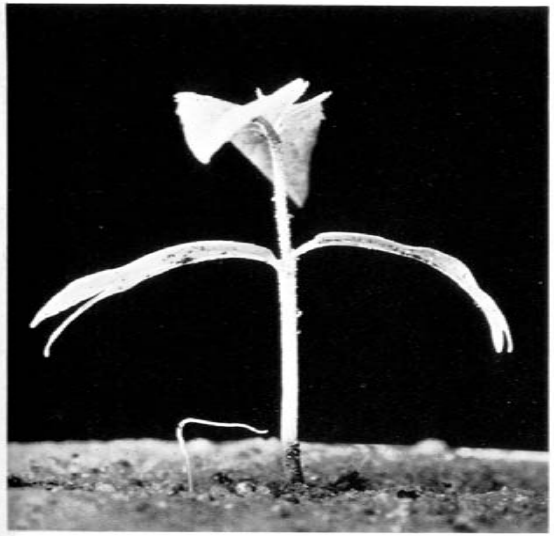
Indian Pipe *or Monotropa uniflora*, also known as the **Ghost Plant**, is a herbaceous perennial, classified within the **Ericaceae**. It is native to temperate regions of Asia & North America. Unlike most plants, it is white and does not contain chlorophyll. Instead of generating energy from sunlight, it is parasitic, more specifically a myco-heterotroph. Its hosts are certain fungi that are mycorrhizal with trees, meaning it ultimately gets its energy from photosynthetic trees. It can grow in very dark environments as in the understory of dense forest. The complex relationship that allows this plant to grow also makes propagation difficult.

The Snow Plant *or Sarcodes sanguinea* is a flowering plant in the heath family. It is a parasitic plant that derives sustenance and nutrients from mycorrhyzal fungi that attach to roots of trees. Mycorrhizal fungi are themselves symbiotic parasites that help plants fix nitrogen from the atmosphere in exchange for nutrients from plant roots.

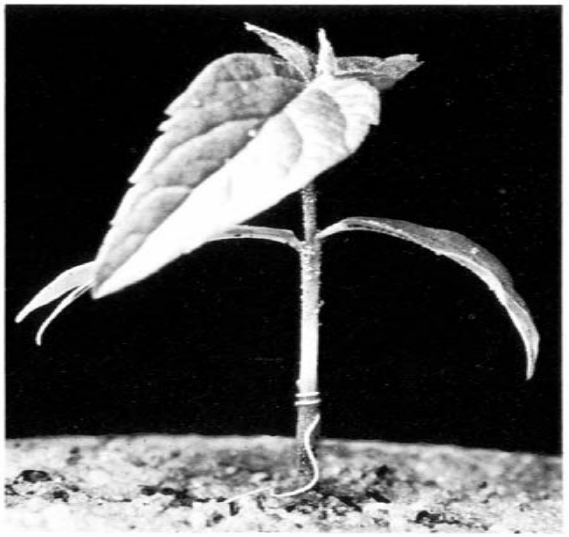
The only plants that does the locomotion ….

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

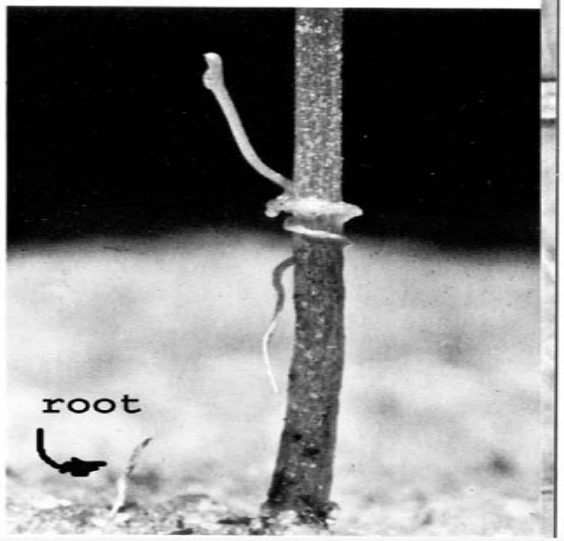
The **seeds** are minute and produced in large quantities. They have a hard coating, & survive in soil for 5–10 years. **Germination** can occur without a host, it zooms in on the **smell** of nearby plants



1. germination with flexible stem smells the host plant

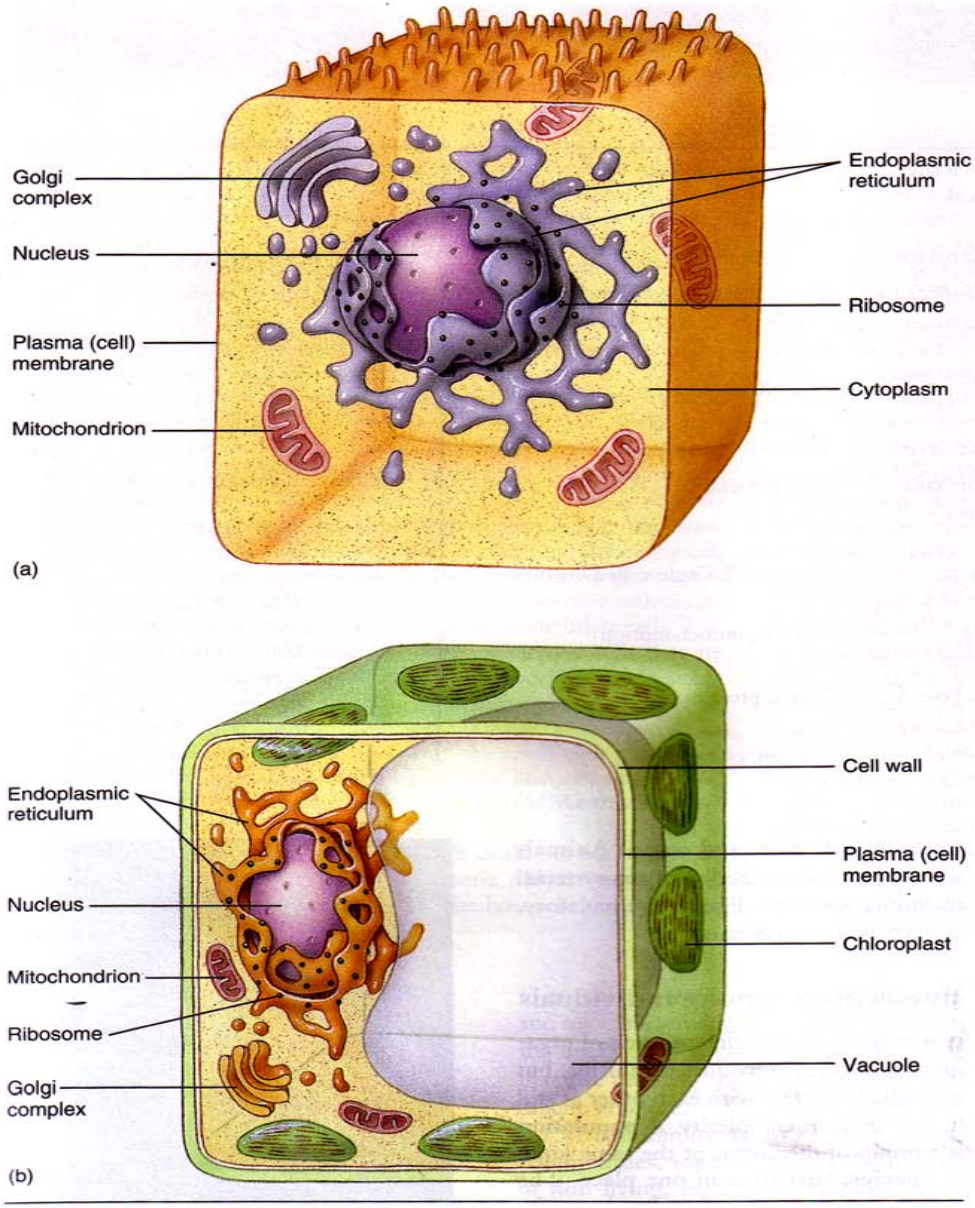


2. after 12 h it is already solidly attached to the host



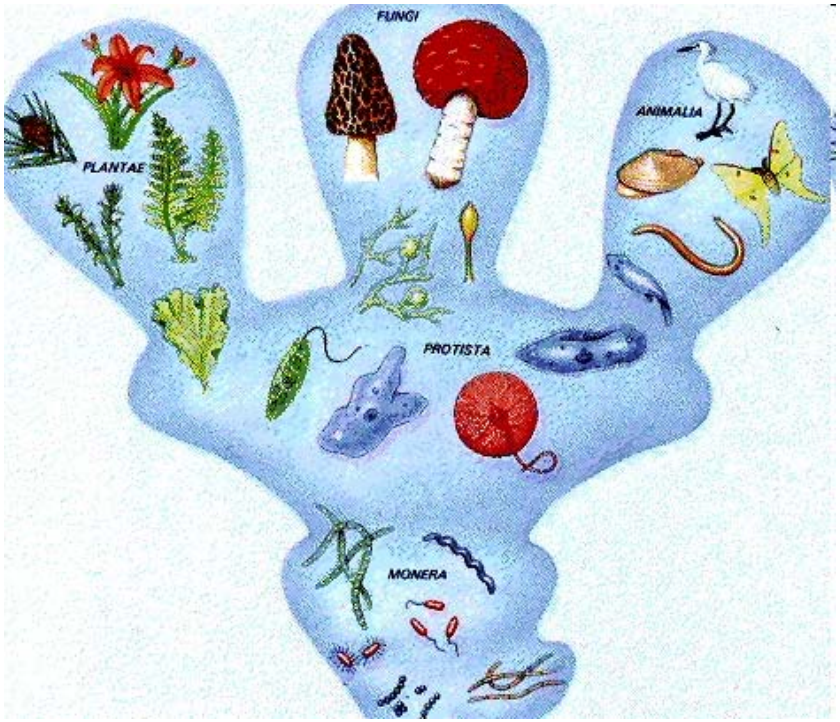
3. One week later it has haustoria in the host & abundons root

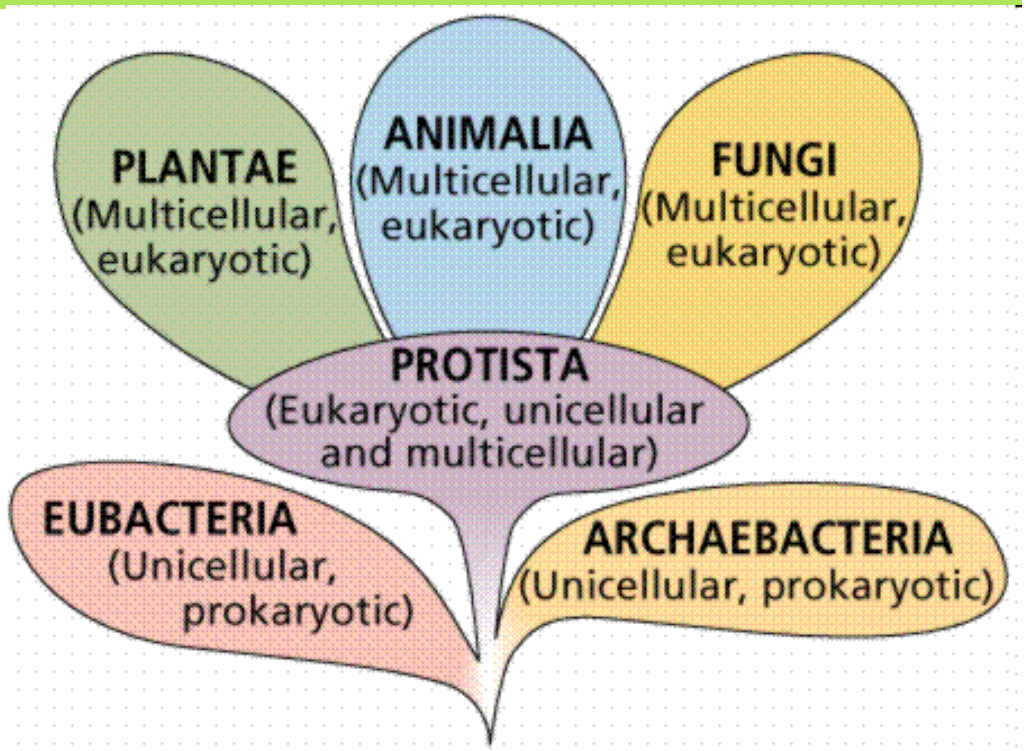
animal versus plant cell ?

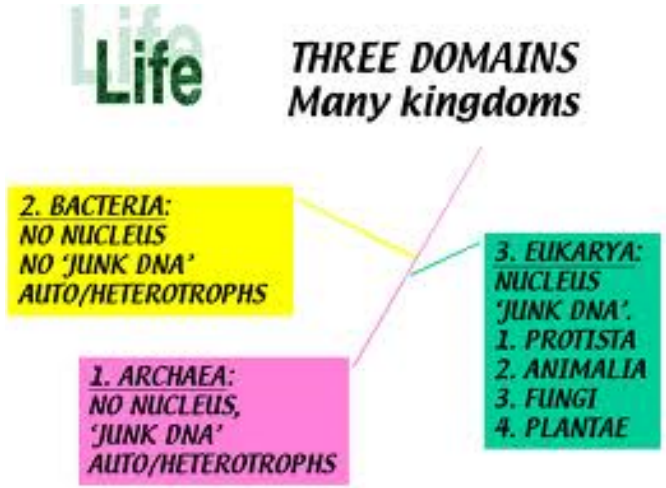


name differences !

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







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

What is that?

Is that a plant? Is that a fungus? Is that a lichen? What the …halloh!

Star stinkhorn *Aseroë rubra*, an Australian/Pacific **species of fungi** which spread to Europe & North America

The ghost plant *Monotropa uniflora*, also Indian pipe is chlorophyll-free **parasitic herbaceous perennial plant**, in the Ericaceae like heather & huckleberr

Frog Pelt or Peltigera neopolydactyla - A large, loosely appressed leaf lichen; lobes broad, 10-25 mm wide; upper surface hairless, olive-green to pale or dark

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http://waynesword.palomar.edu/ww0504.htm

What is that?

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Spanish moss (*Tillandsia usneoides*) closely resembles its namesake (*Usnea*, or beard lichen), but in fact it is not biologically related to either mosses or lichens. Instead, it is **an angiosperm plant in the family Bromeliaceae** that grows hanging from tree branches in full sun or partial shade

Usnea is a lichen (a composite organism made from algae and fungi) and is referred to as **Old Man's Beard.** It looks very similar to Spanish moss, so much so that the latter plant's Latin name is derived from it (*Tillandsia usneoides*, the 'Usnea-like Tillandsia').

Personal Botany

What is a plant to you?

This question addresses your way of relating to plants.

Did I forget something that you consider important?

Do you need the mystery of plants, forests, jungle, meadows or fields?

Do you need woods or Parks to wind down? Can you live in the prairies?

Do you consider plants as mystic beings that are your direct teachers? Ayahuasca?

Do you need the medicine that grew in the earth within the root of a special plant?


the plants
they tell me fings
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