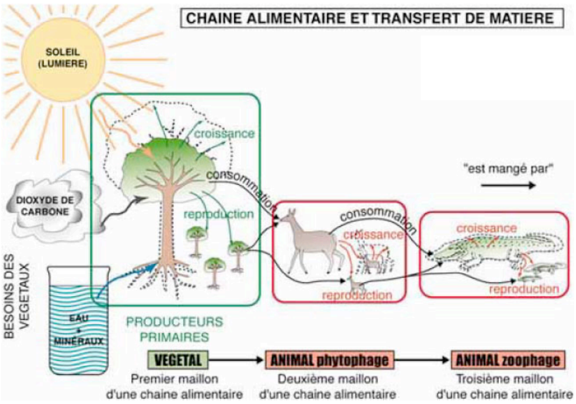
La série végétale

Claire Remacle
Génétique des microorganismes

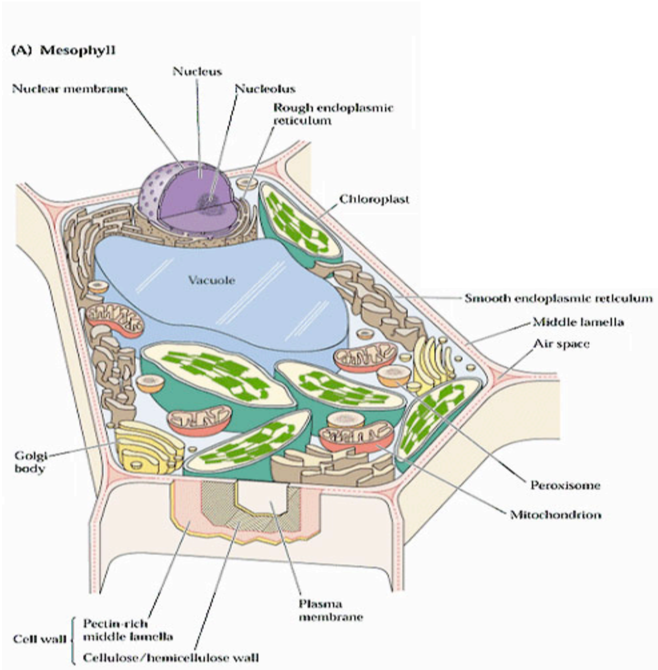
1

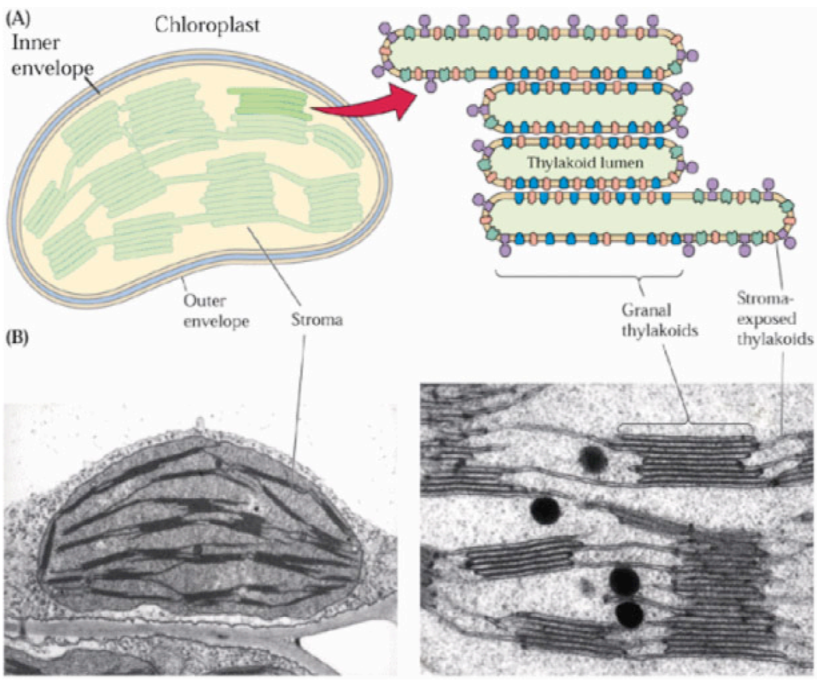


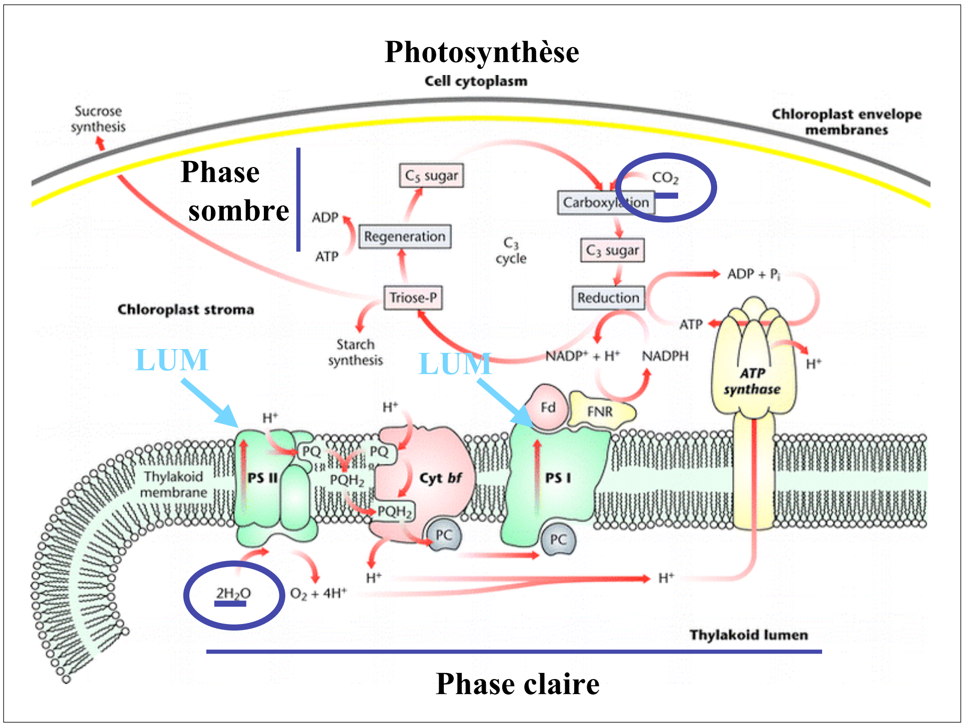
Énergie lumineuse
Complexes photosynthétiques

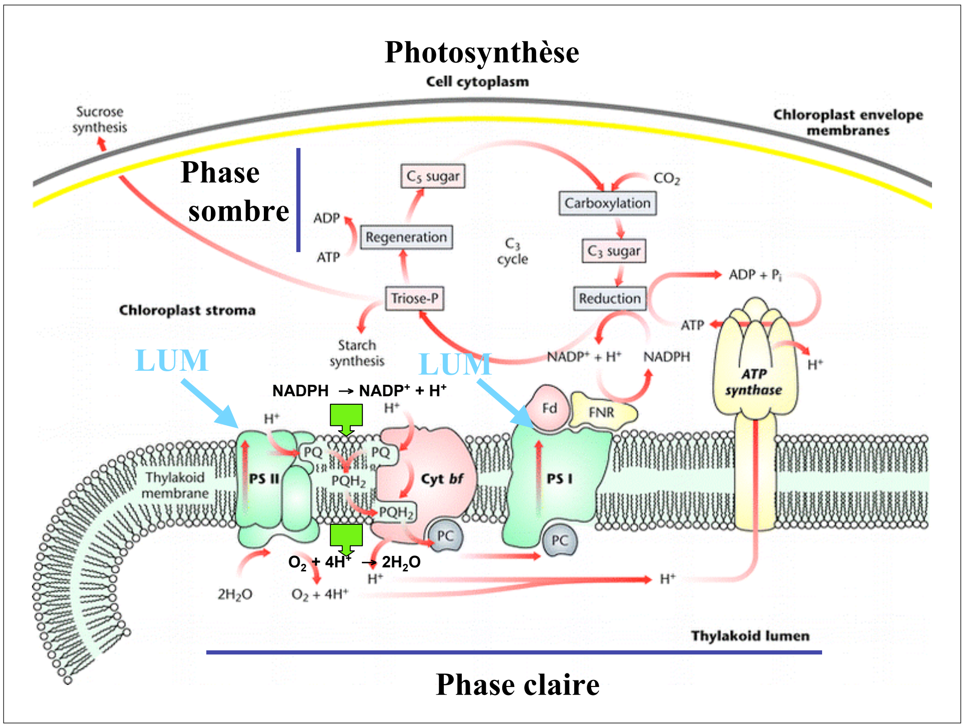
$$6\ CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 6\ O_2$$

2


(A) Mesophyll
Nucleus
Nuclear membrane
Nucleolus
Rough endoplasmic reticulum
Chloroplast
Vacuole
Smooth endoplasmic reticulum
Middle lamella
Air space
Golgi body
Peroxisome
Mitochondrion
Plasma membrane
Cell wall
Pectin-rich middle lamella
Cellulose/hemicellulose wall


(A)
Chloroplast
Inner envelope
Thylakoid lumen
Outer envelope
Stroma
Granal thylakoids
Stroma-exposed thylakoids
(B)


Photosynthèse
Cell cytoplasm
Sucrose synthesis
Chloroplast envelope membranes
Phase sombre
C5 sugar
CO2
Carboxylation
ADP
Regeneration
ATP
C3 cycle
C3 sugar
ADP + Pi
Triose-P
Reduction
Chloroplast stroma
ATP
Starch synthesis
NADP+ + H+
NADPH
LUM
LUM
ATP synthase
H+
Fd
FNR
PQ
PQ
Thylakoid membrane
PS II
PQH2
Cyt bf
PS I
PQH2
PC
PC
2H2O
O2 + 4H+
H+
Thylakoid lumen
Phase claire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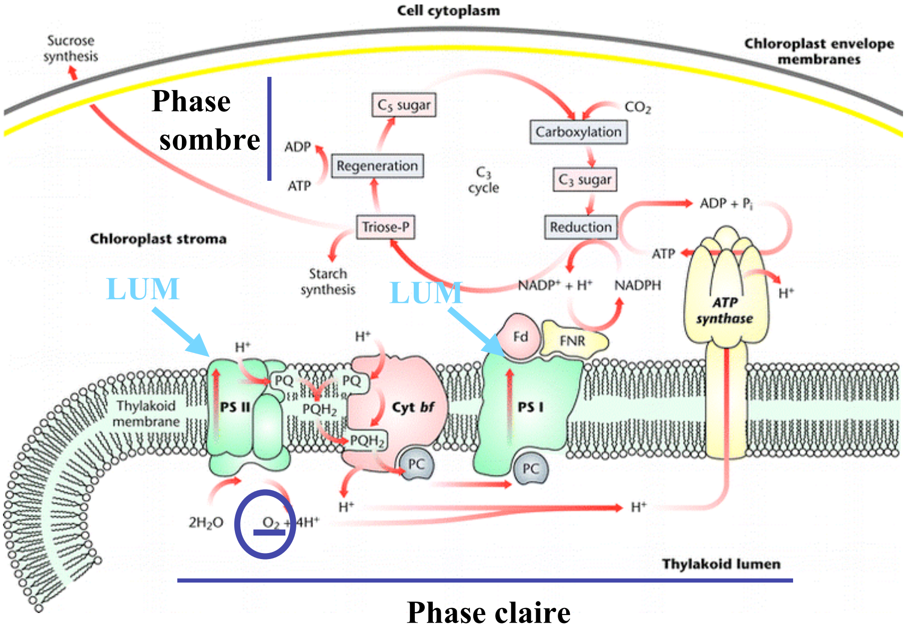
Fd
FNR
PQ
PQ
Thylakoid membrane
PS II
PQH2
Cyt bf
PS I
PQH2
PC
PC
O2 + 4H+ → 2H2O
2H2O
O2 + 4H+
H+
Thylakoid lumen
Phase claire

La photosynthèse est un processus extrêmement complexe et on n'est loin d'avoir tout découvert!

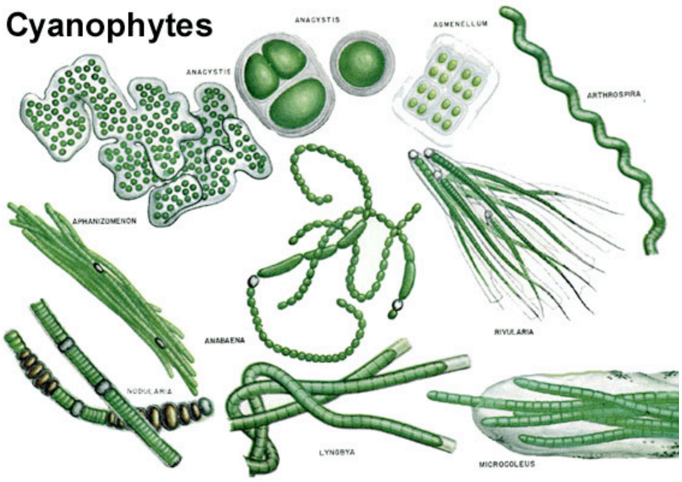
Prix Nobel

Paul D. Boyer and John E. Walker (1997, Chemistry): Elucidation of enzymatic mechanism underlying the synthesis of adenosine triphosphate (ATP).
Rudolph Marcus (1992, Chemistry): Electron transfer theory: included application to photosynthesis.
Hartmut Michel; Robert Huber; and Johannes Deisenhofer (1988, Chemistry): X-ray structure of bacterial reaction center.
Peter Mitchell (1978, Chemistry): Oxidative and photosynthetic phosphorylation: chemi-osmotic theory.
Robert Burns Woodward (1965, Chemistry): Total synthesis of chlorophyll, vitamin B12, and other natural products.
Melvin Calvin (1961, Chemistry): Carbon-dioxide assimilation in photosynthesis
Richard Kuhn (1938, Chemistry): carotenoids; vitamins
Paul Karrer (1937, Chemistry): Carotenoid structure; flavins; vitamin B12
Hans Fischer (1930, Chemistry): Chlorophyll chemistry; heme synthesis
Richard Martin Wilstatter (1915, Chemistry): Chlorophyll purification and structure, carotenoids.

Photosynthèse



Phase claire



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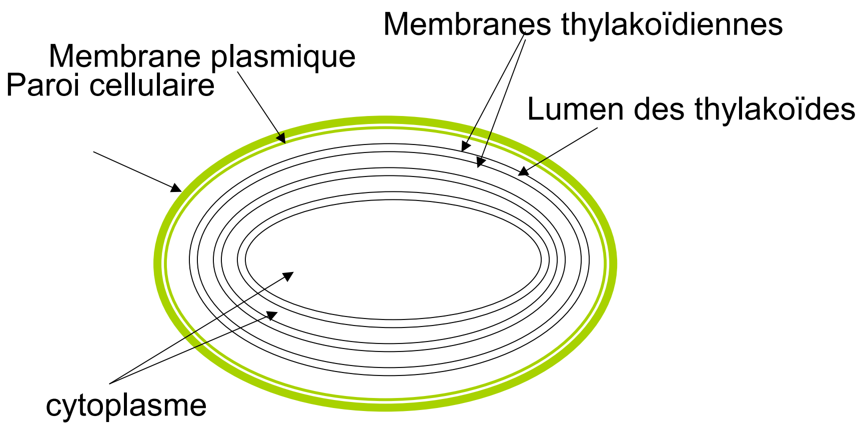
Une cyanobactérie



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Stromatolithes en Australie

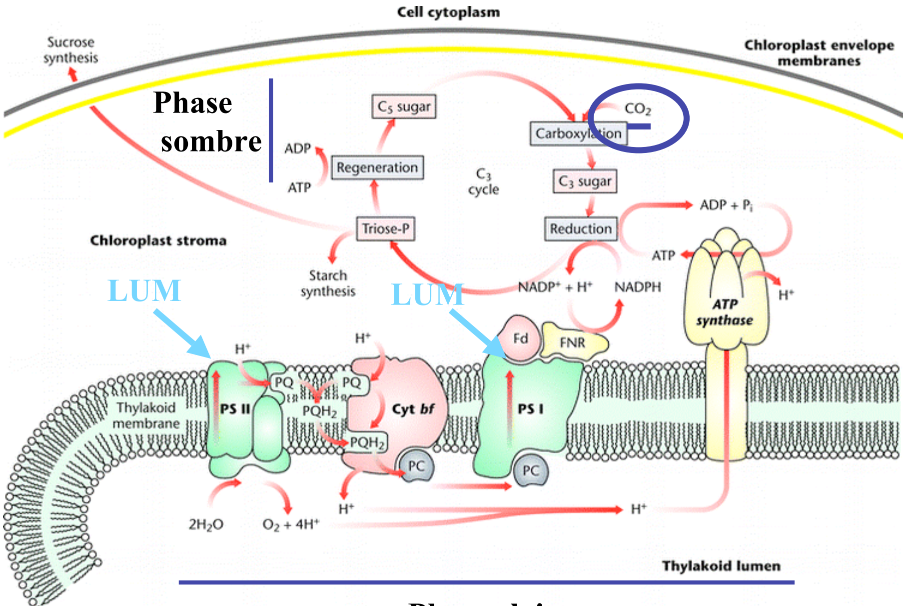
Cyanobactéries:
apparues il y a environ 3 milliards d'années

Atmosphère réductrice
→
Atmosphère oxydante

'Bloom' de cyanobactéries dans un lac

cyanotoxines: neurotoxines, hépatotoxines, facteurs de prolifération des cancers (CDC: http://www.cdc.gov/hab/cyanobacteria/facts.htm)

Photosynthèse



Phase claire

L'augmentation du CO_2 atmosphérique va-t-il contribuer à une augmentation de la biomasse des organismes photosynthétiques?

New Phytol. 2009;182:331-46.
Coppicing shifts CO2 stimulation of poplar productivity to above-groundpools: a synthesis of leaf to stand level results from the POP/EUROFACEexperiment.
Liberloo M, Lukac M, Calfapietra C, Hoosbeek MR, Gielen B, Miglietta F, Scarascia-Mugnozza GE, Ceulemans R.
University of Antwerp, Research Group of Plant and Vegetation Ecology,Department of Biology, Campus Drie Eiken, Universiteitsplein 1, 2610 Wilrijk, Belgium

! Modifications du régime des pluies, désertifications, etc.
+ problème de déforestation

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Les cyanobactéries (procaryotes)

→ la série végétale

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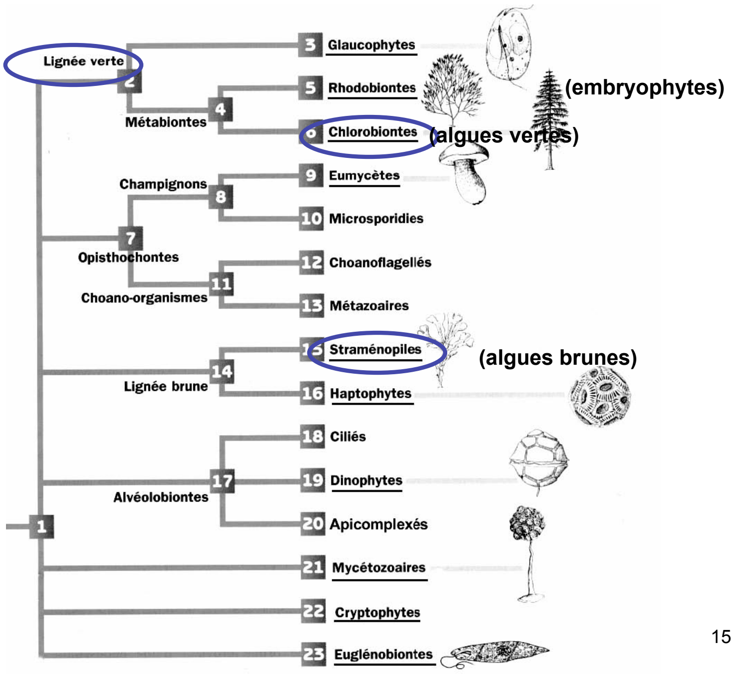

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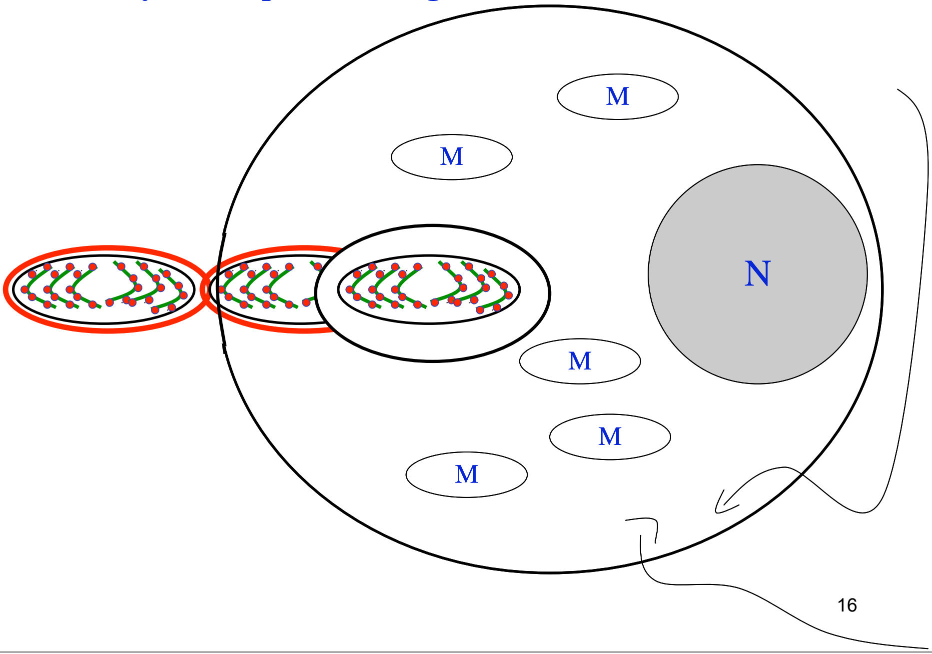
L'endosymbiose primaire (algues vertes)



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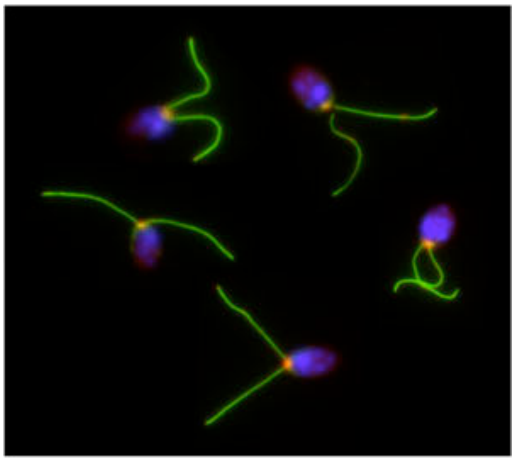
Algues vertes : endosymbiose primaire

Chlamydomonas reinhardtii: génome entièrement séquencé (125 Mb)
(Science October 12, 2007) 'The *Chlamydomonas* genome reveals the evolution of Key **animal** and **Plant** Functions'



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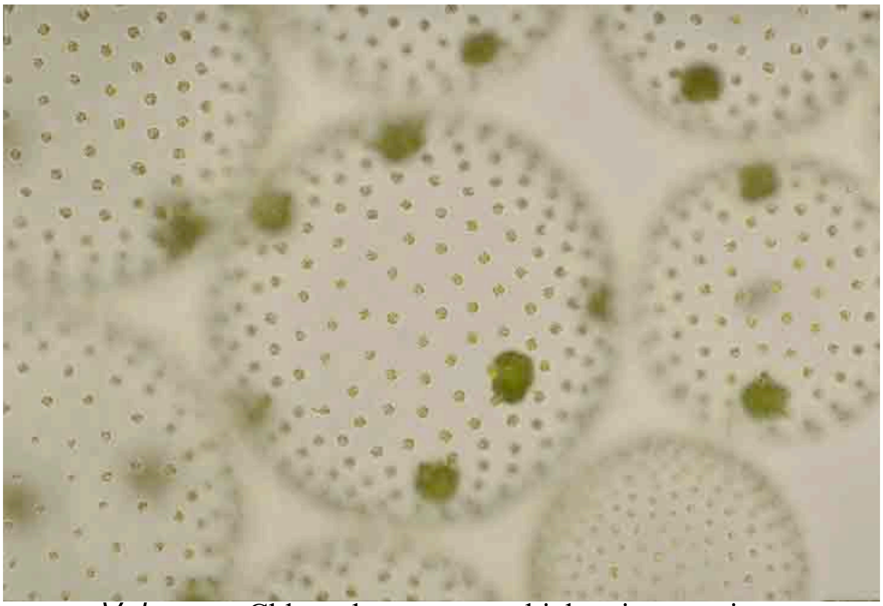

Volvox sp Chlorophyceae coenobiale microscopique

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Ulva rigida

Acetabularia caliculus

Caulerpa taxifolia

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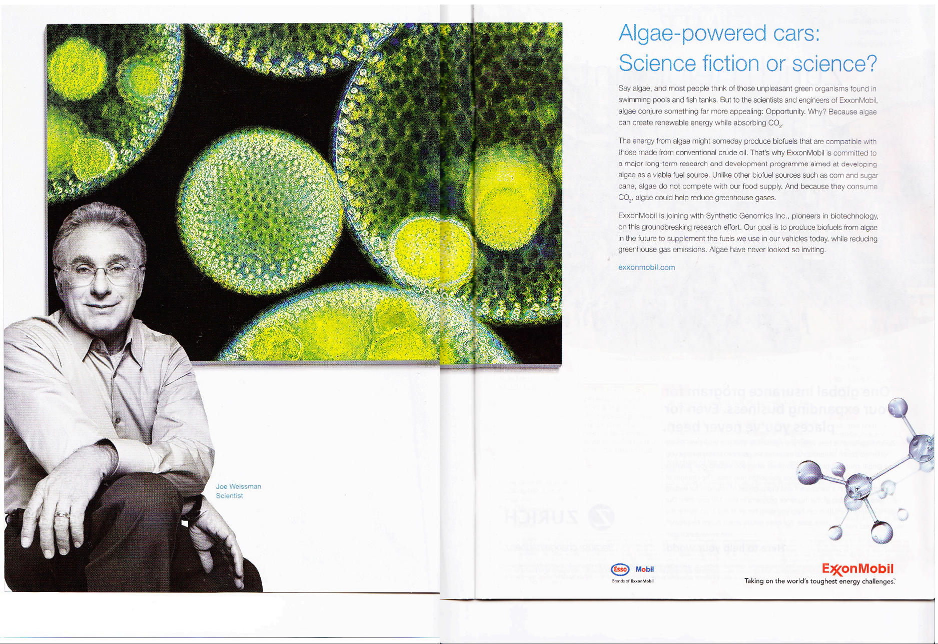
Time, 29 October 2009



→ biodiesel de demain?

Biodiesel de 1ere génération: agrocarburants

maïs, canne à sucre, blé (Biowanze en Hesbaye), betterave

- Extraction des triglycérides, trans-estérification et production de biodiesel
- Fermentation des déchets et production de biométhane

  - Hausse des prix des denrées alimentaires
  - Utilisation massive d'engrais, d'eau pour les cultures

FAO: désapprouve l'utilisation des plantes vivrières pour les biocarburants

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Algues unicellulaires (microalgues): biodiesel de 2e génération

- on ne les fait pas croître sur des terres arables mais dans des étendues d'eaux qui peuvent être saumâtres, salées (inutilisables comme réserve d'eau potable)

- le rendement photosynthétique est très élevé et en très peu de temps on peut avoir une biomasse importante (jusqu'à 6 doublements/jour)

- fixe le CO_2 (diminue l'effet de serre)

biomasse: extraction des triglycérides
fermentation et biométhane

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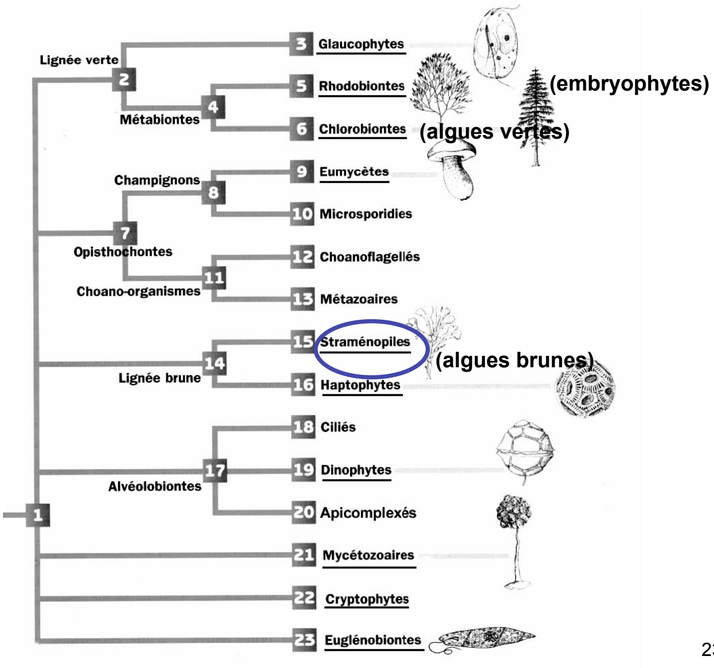

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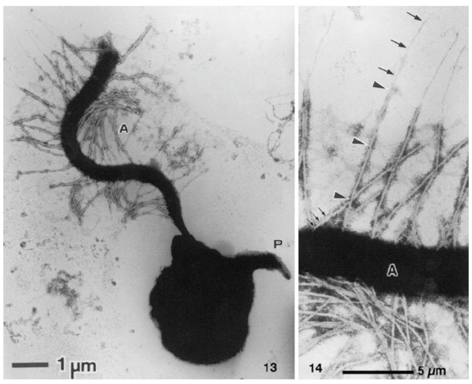
Les algues brunes (Straménopiles)



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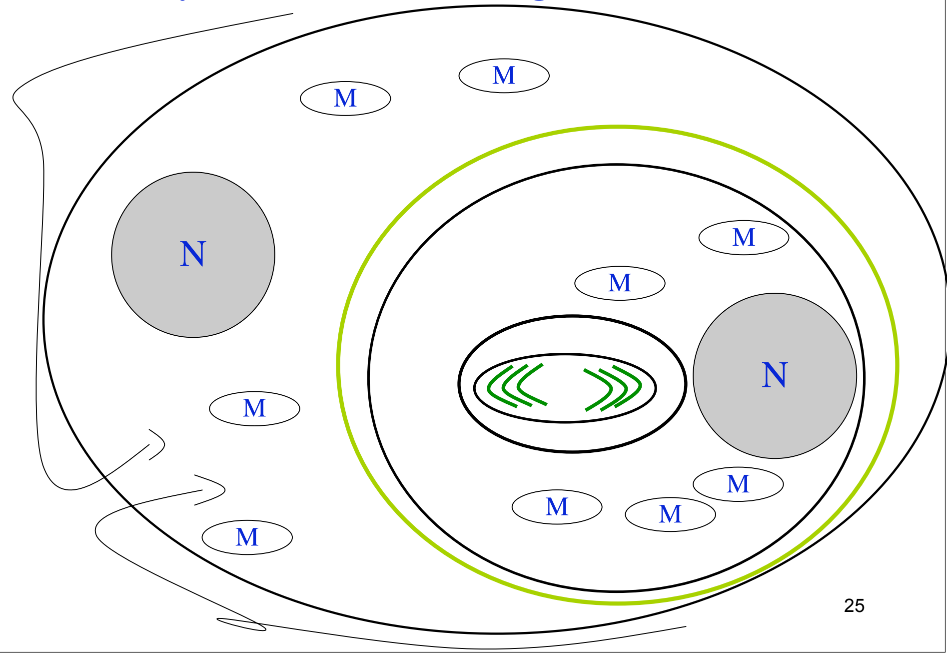
L’endosymbiose secondaire (les algues brunes)



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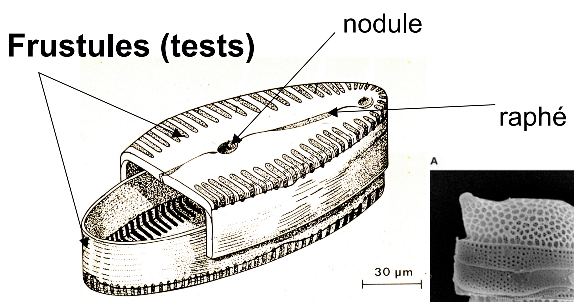
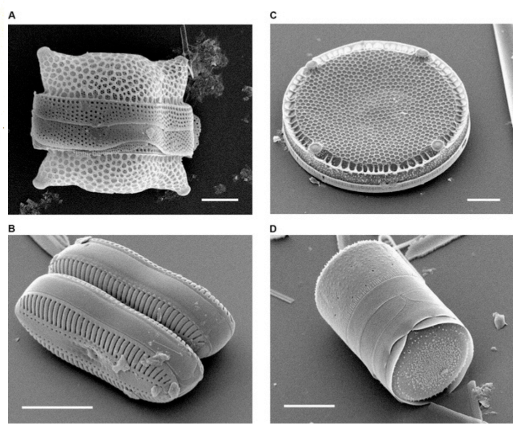
Les diatomées





Paroi composée de cellulose imprégnée de silice

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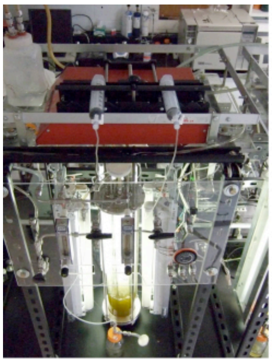

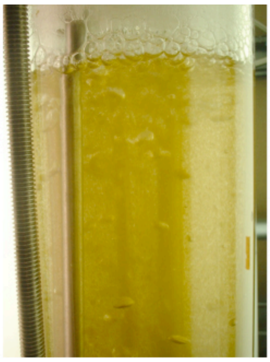

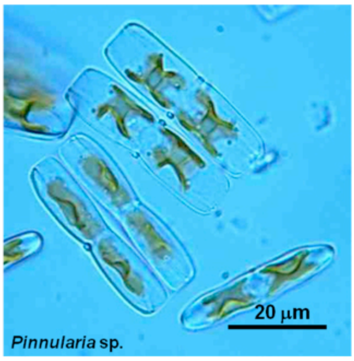

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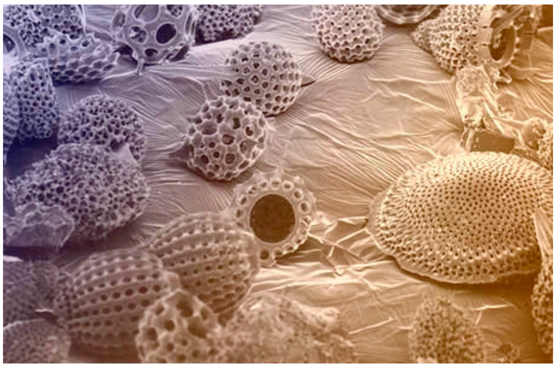
Alfred Nobel, la dynamite et les diatomées



Dynamite: 75% nitroglycérine, 24.5% diatomite, 0.5% de carbonate de calcium

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Application biotechnologique: récupérer la silice pour la fabrication du verre.

Procédé 'vert': fixation du CO_2 atm et diminution de l'effet de serre.

Les algues brunes

Laminaire

Paroi cellulosique imprégnée d'alginate

Sargassum muticum
Grande-Bretagne

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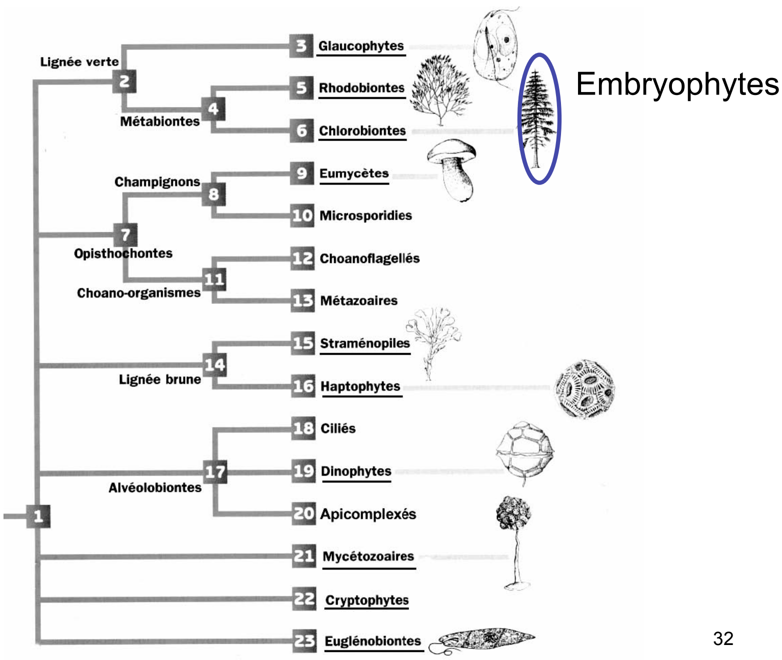

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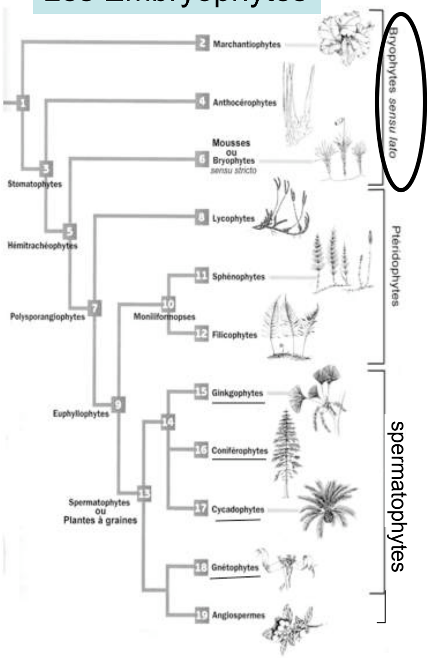
Les Embryophytes



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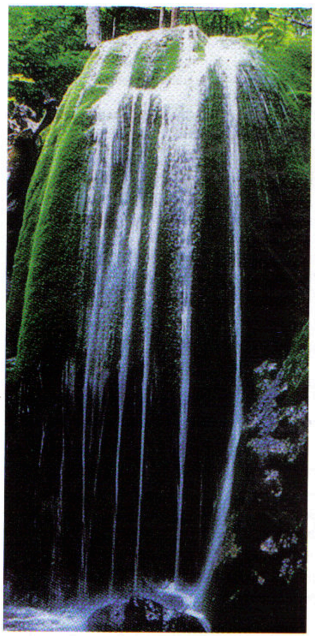
Les Bryophytes *s. l.*

S'affranchissent du milieu aqueux:
- Cuticule (stomates)

Jamais de grande taille: pas de système vasculaire, pas de lignine

Gamétophyte (n) est dominant
Le sporophyte (2n) est parasite du gamétophyte

Présence d'archégones (oosphère unique) et d'anthéridies (spermatozoïdes)



Embryophytes : alternance de phases

spores —mitose→ gamétophytes —mitose→ gamètes

↑ méiose ↓ fécondation

sporange ← sporophyte ← zygote

mitose

35

---

spores —mitose→ gamétophyte(s) —mitose→ gamètes

↑ méiose ↓ fécondation

sporange ← sporophyte ← zygote

mitose mitose

Embryophytes

Bryophytes | gamétophyte dominant

Ptéridophytes
Spermatophytes (Gymnospermes et Angiospermes) | sporophyte dominant

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Les vraies mousses ou Bryidées

Sporophyte

Polytrichum

Gamétophyte: feuilles à symétrie radiaire

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Les Sphaignes

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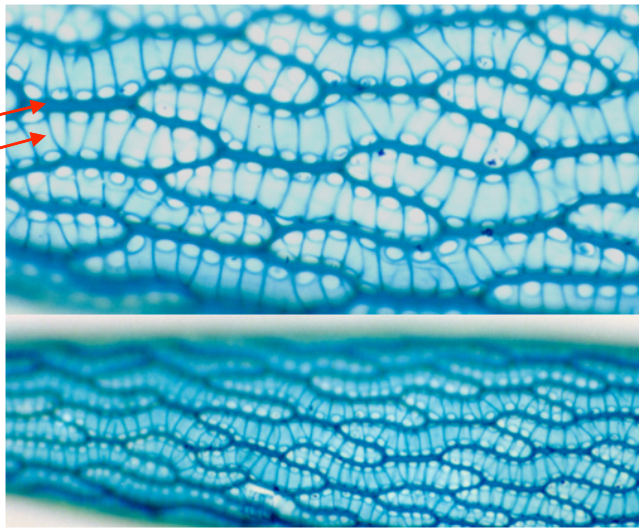
Les feuilles des sphaignes n'ont qu'une cellule d'épaisseur. Ces cellules sont soit vivantes, soit mortes et dans ce cas percées de pores (cellules hyalines). Ces cellules hyalines peuvent accumuler de grandes quantités d'eau.



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tourbe

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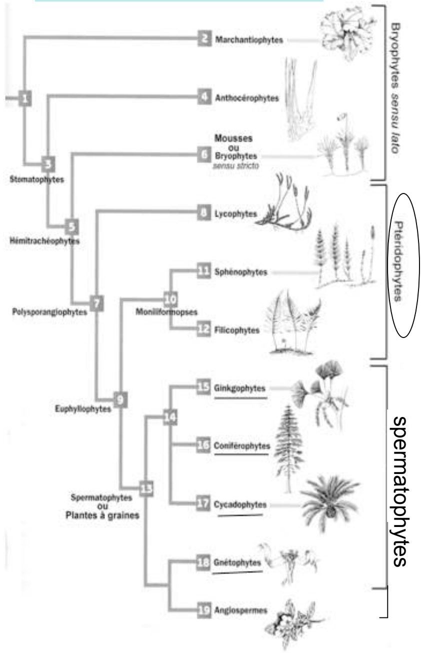
Les Embryophytes



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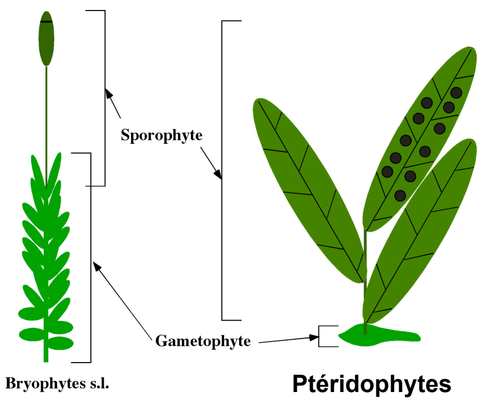
Les Ptéridophytes



Sporophyte dominant

Présence de vaisseaux pour acheminer la sève (minérale et organique), plus grande taille que les bryophytes

Pas de graines

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Ptéridophytes fossiles

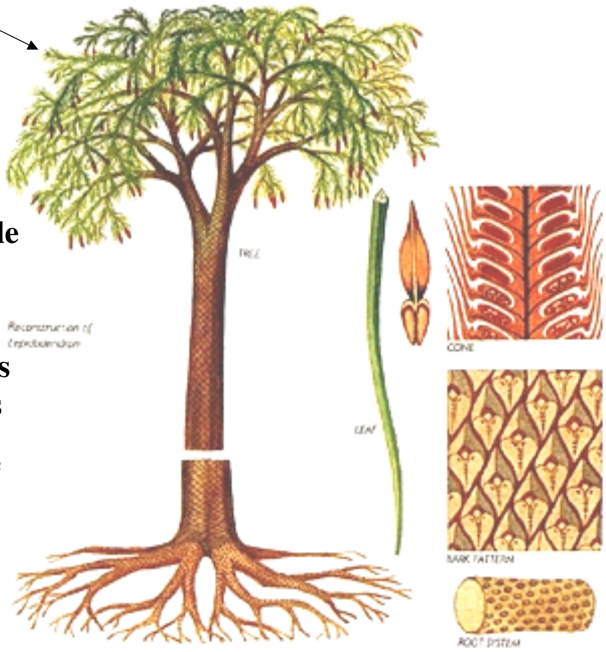
Feuilles
Origine: trichome?

Lepidodendron

Lycophyte arborescente fossile (Carbonifère; +/- 350 à 300 MA)

Hauteur: plusieurs dizaines de mètres

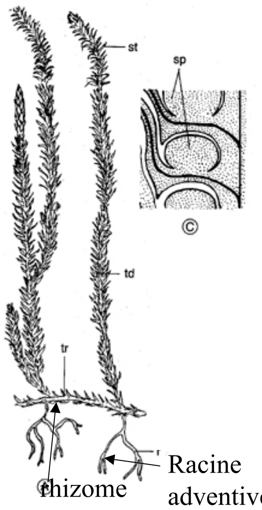
90% de la matière première en charbon est constituée de lycophytes



Ptéridophytes actuelles

strobiles

Lycopodium



rhizome

Racine adventive

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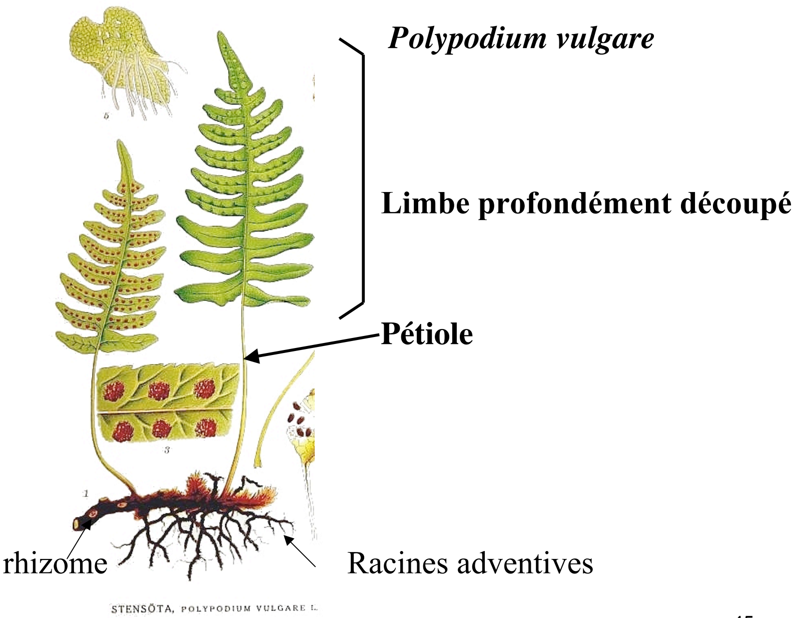

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Pteridium aquilinum **(Fougère aigle)**

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Fougère arborescente

Dicksonia antartica **(Tasmanie)**

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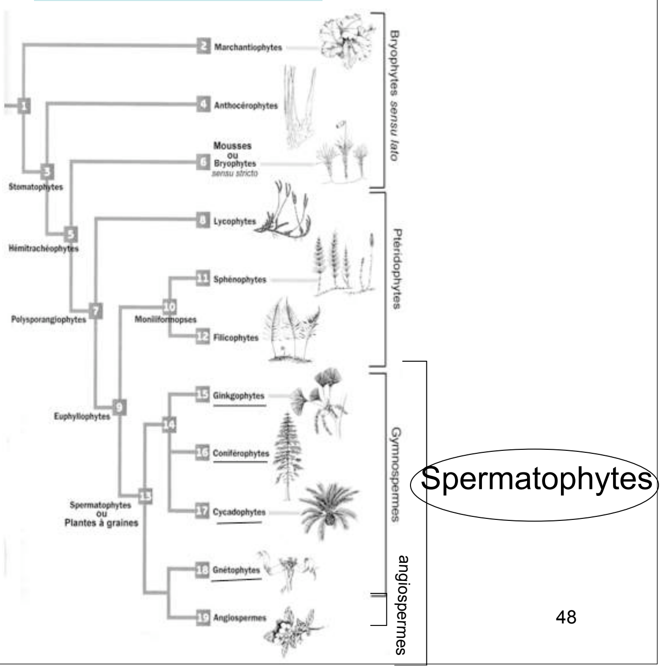
Les Embryophytes



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Les Spermatophytes

Les plantes les plus abondantes sur Terre (250 000 espèces)

Apparues au Tertiaire

Les mieux adaptées aux conditions climatique actuelles

Présence d’ovules et de graines

Vaisseaux conducteurs avec croissance secondaire (permettant une croissance en épaisseur)

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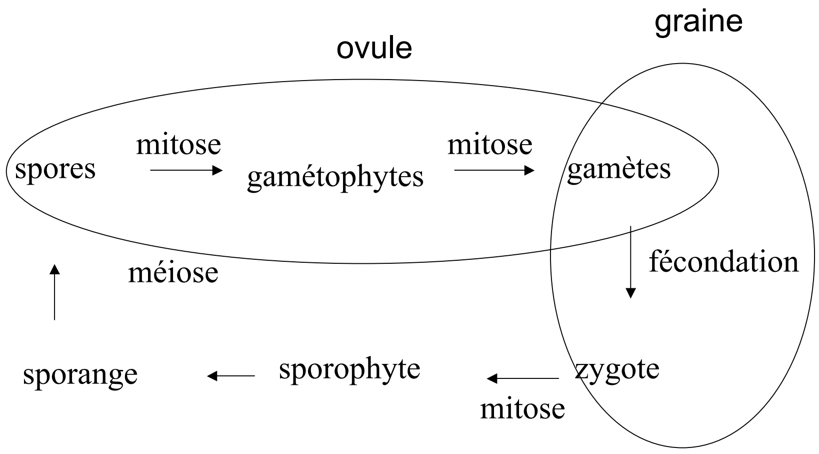

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Ovule

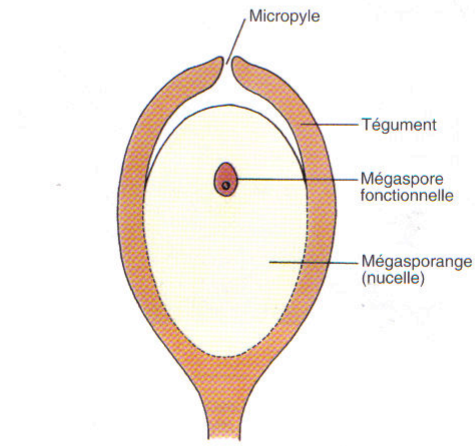

Figure 20-2

Coupe longitudinale d'un ovule formé d'un mégasporange (nucelle) entouré d'un tégument avec une ouverture, le micropyle, à son apex. Une seule mégaspore fonctionnelle persiste à l'intérieur du mégasporange (qui n'est pas disséminé) et donnera naissance à un mégagamétophyte qui reste dans le mégasporange. Après la fécondation, l'ovule mûrit en graine et deviendra l'unité de dissémination.

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Une graine est un ovule fécondé, contenant un embryon

Le palmier de Mathusalem

NEWSCRIPTS

A date with destiny

THE ANCIENT ROMANS CALLED THE Judean date palm *Phoenix dactylifera*—"the date-bearing phoenix"—because the tall, thin trees with curling, bushy tops thrived in the desert where all other plants perished. The tree has been extinct since the Middle Ages, but it looks like those Romans were onto something.

The *San Francisco Chronicle* reports that scientists in Israel have managed to coax a small seedling to grow from a 2,000-year-old Judean date seed. It is the oldest seed ever known to produce a viable young tree, beating out a lotus plant grown from a 1,200-year-old seed in China.

The ancient date seeds were discovered 30 years ago during an archaeological excavation at King Herod's palace on Mount Masada, near the Dead Sea. Following the Roman conquest of Palestine, the Masada site was a last stand for a small band of Jewish rebels who spent years fighting off legions of Roman soldiers before committing mass suicide in A.D. 73. At that time, forests of Judean date palms flourished in the region, and presumably the Masada defenders snacked upon their fruits, which were legendary for their succulence and medicinal properties.

The seeds had been sitting in a drawer at Israel's Bar-Ilan University when Sarah Sallon, director of the Louis L. Borick Natural Medicine Research Center at Jerusalem's Hadassah Hospital, convinced the botanical archaeologists at Bar-Ilan to let her take three. Sallon handed them off to botanist Elaine Solowey, head of the sustainable agricultural department at Arava Institute for Environmental Studies at Kibbutz Ketura, in the southern Negev. Solowey has a reputation for nurturing rare and near-extinct plants.

"I thought the chances of this experiment succeeding were less than zero," Solowey told the *Chronicle*. She soaked the seeds in warm water to soften their coats and treated them with the growth hormone gibberellic acid to induce germination. Solowey then added a rooting hormone as well as an enzyme-rich fertilizer. She potted them on Jan. 25—the date of this year's Jewish festival of trees.

Five weeks later, a small date shoot had fought its way through the soil. The plant, which has been nicknamed Methuselah, is about a foot tall now. It has grown six leaves, one of which was snipped off and sent away for DNA analysis. Radiocarbon dating indicates that the seeds are 2,000 years old, give or take half a century. "I know that date seeds can stay alive for several decades. To find out that they can stay alive for millennia is astonishing," Solowey added.

"If it lives, it will be years before we eat any dates," Solowey told the *New York Times*. "And that's if it's female. There's a 50-50 chance. And if it's male, it will just be a curiosity."

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Chemistry in the dark

WE CAN ONLY SPECULATE THAT IT WAS a sleepless night of congestion that prompted David Cummings of Cleveland, Tenn., to write to us about an observation he made while using Breathe Right nasal strips that he's puckishly named the "Cummings effect."

Breathe Right nasal strips are packaged similarly to Band Aids, except, Cummings notes, "these packages are opened more easily...two separate strips of paper are sealed together with a single Breathe Right strip between them." The pack, Cummings learned, utilizes a cold seal made of natural rubber latex. "One end of the package has flared tips," Cummings continues. "Simply pull the two flared ends, the packaging peels apart, and a strip falls out." So, what's the big deal, you may ask? Cummings answers: "Try this in the dark."

Cummings kindly sent the Newscripts gang a few packages of Breathe Right strips so that we could witness the Cummings effect for ourselves. Locked away in our darkened offices, we noticed that small bursts of light appeared within the packages as we pulled them apart.

"The Cummings effect is a cold-light luminescence," Cummings explains. "I have tried to come up with some innovative uses for the product and effect, with limited results. It could be used in that rare situation when the airplane must land and the runway lights are out. Thousands of people could line the runway and open packages to generate cold light to guide the plane."

This week's column was written by **Bethany Halford.** *Please send comments and suggestions to newscripts@acs.org.*

Chemical and Engineering News, June 27, 2005

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Science 13 June 2008:
Vol. 320. no. 5882, p. 1464
DOI: 10.1126/science.1153600
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BREVIA

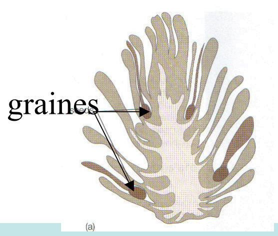
Germination, Genetics, and Growth of an Ancient Date Seed

Sarah Sallon,[1] Elaine Solowey,[2] Yuval Cohen,[3] Raia Korchinsky,[3] Markus Egli,[4] Ivan Woodhatch,[4] Orit Simchoni,[5] Mordechai Kislev[5]

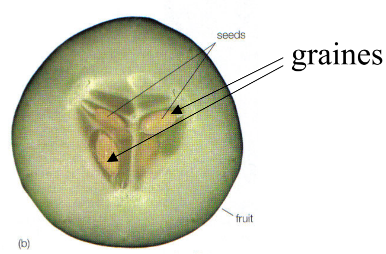
An ancient date seed (Phoenix dactylifera L.) excavated from Masada and radiocarbon-dated to the first century Common Era was germinated. Climatic conditions at the Dead Sea may have contributed to the longevity of this oldest, directly dated, viable seed. Growth and development of the seedling over 26 months was compatible with normal date seedlings propagated from modern seeds. Preliminary molecular characterization demonstrated high levels of genetic variation in comparison to modern, elite date cultivars currently growing in Israel. As a representative of an extinct date palm population, this seedling can provide insights into the historic date culture of the Dead Sea region. It also has importance for seed banking and conservation and may be of relevance to modern date palm cultivation.a

Spermatophytes
2 sous-embranchements
Sous-embranchement des Gymnospermes

| PART IV Diversity of Plants, Prokaryotes, Proti



Sous-embranchement des Angiospermes



Gymnospermes

L'if (*Taxus baccata*)

Angiospermes

La série végétale