

Concepts of Biology: BIOL 111

Study guide for Exam 4

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Lectures 27–33

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Outline

1 Questions and answers

1.1 Exam 3

Results of Exam 3: statistic summary

Summary:

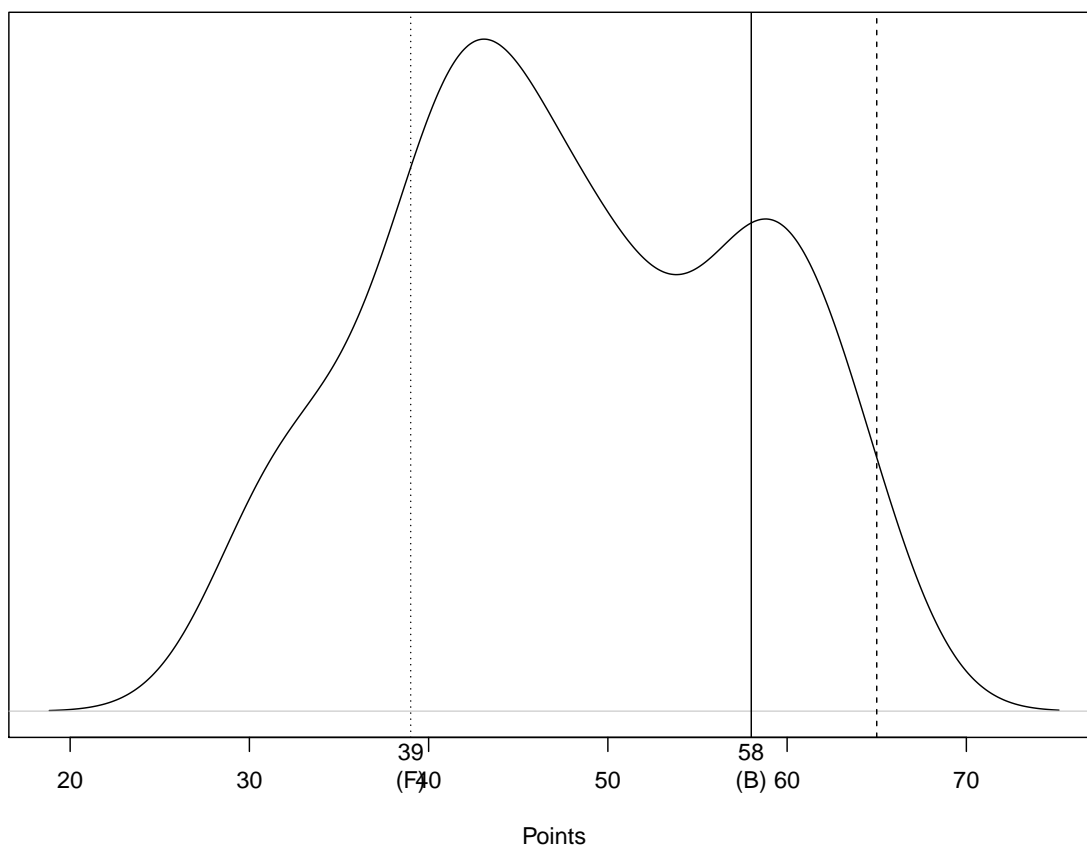
| Min. | 1st Qu. | Median | Mean | 3rd Qu. | Max. | NA's |
|-------|---------|--------|-------|---------|-------|------|
| 29.00 | 41.00 | 47.00 | 47.69 | 57.00 | 65.00 | 18 |

Grades:

| F | D | C | B | max |
|----|----|----|----|-----|
| 39 | 46 | 52 | 58 | 65 |

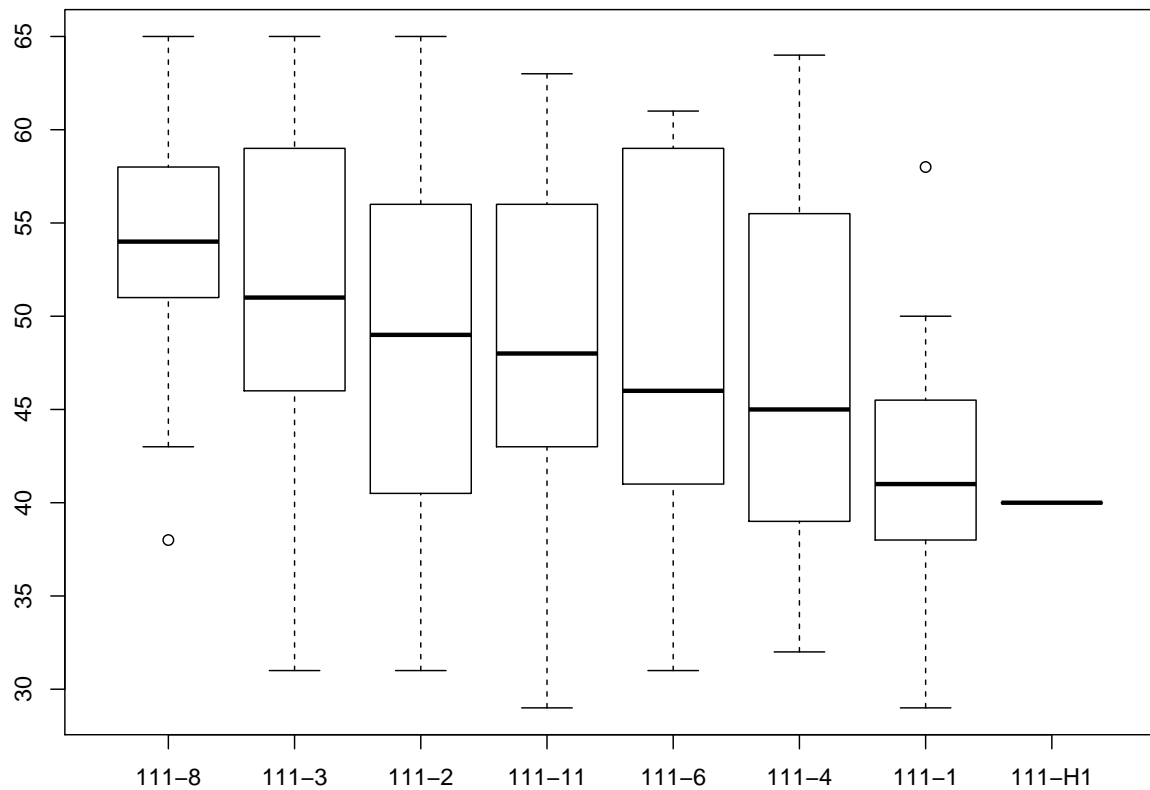
Results of Exam 3: the curve

Density estimation for Exam 3 (Biol 111)



Results of Exam 3: sections

Competition between Biol 111 sections (Exam 3)



Results of Exam 3: five questions

- For fertilization, ferns need:
 - A. **Water**
 - B. Wind
 - C. Insects
- What is the horizontal transfer of DNA?
 - A. Transfer of DNA from mother to daughter cells
 - B. **Transfer of DNA between cells of different species**
 - C. Transfer of DNA between cells of one tissue
- Multicellular organisms:
 - A. **Could function without both reproductive cells and tissues**
 - B. Always have specialized reproductive cells
 - C. Always have specialized tissues
- How to name eukaryotes without tissues?
 - A. Plants

B. Monera

C. **Protists**

- Closed gut occurs:

A. In arthropods

B. In chordates

C. **In anthozoans (corals)**

2 Where we are?

Three main phyla of plants

- **Bryophyta**: mosses
- **Pteridophyta**: ferns and allies (like clubmosses and horsetails)
- **Spermatophyta**: seed plants (including conifers and flowering plants)

Meiosis

- Chromosome formula: $XX \longrightarrow X + X \longrightarrow I + I + I + I$
- **The goal of meiosis** is to counterbalance the syngamy
- Meiosis changes genotype of cells because: (1) chromosomes are **recombined** and (2) chromosomes exchange their genetic material

Stages of meiosis

A. First division: reductive part

- Prophase I: homologous chromosomes form pairs (**synapses**) and start to exchange DNA (**crossing-over**)
- Metaphase I
- Anaphase I: homologous chromosomes will go *independently* to different poles
- Telophase I becomes Prophase II, without interphase (and typically without cytokinesis)

B. Second division: equal part (similar to mitosis)

- Prophase II
- Metaphase II
- Anaphase II
- Telophase II

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Research article

An inside-out origin for the eukaryotic cell

David A Baum^{1,2*} and **Buzz Baum³**

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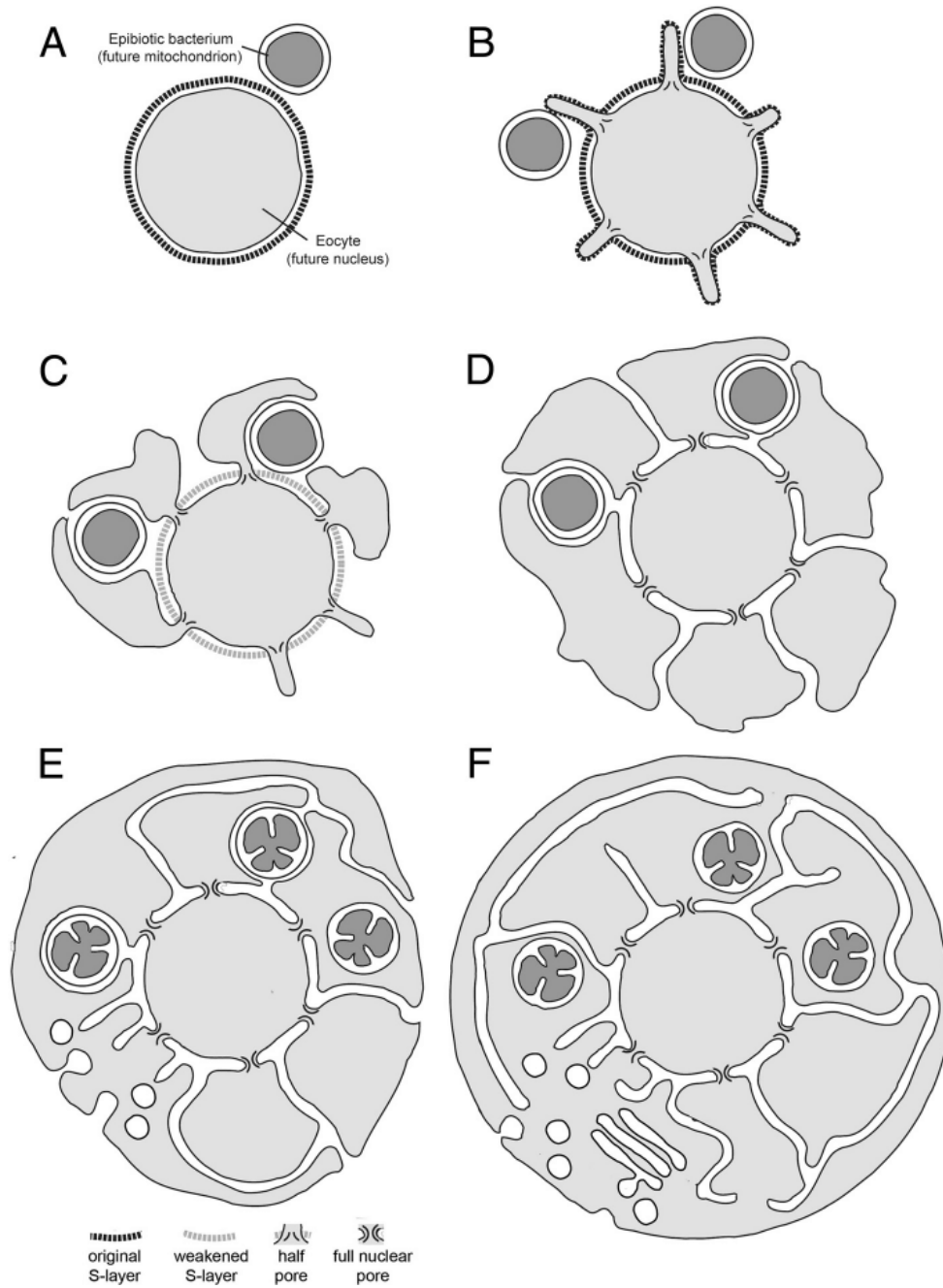
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Just a possibility...



3 Genetics and inheritance

3.1 Life cycle

Life cycle of unicellular organism

Life cycle of multicellular organism

Summary

- Plant body and its tissues is the result of adaptation for the life on land

- The life cycle is the sequence of events between two syngamies
- Gender is the result of division of labor between two gametes: female gametes invest in resources whereas male invest in numbers

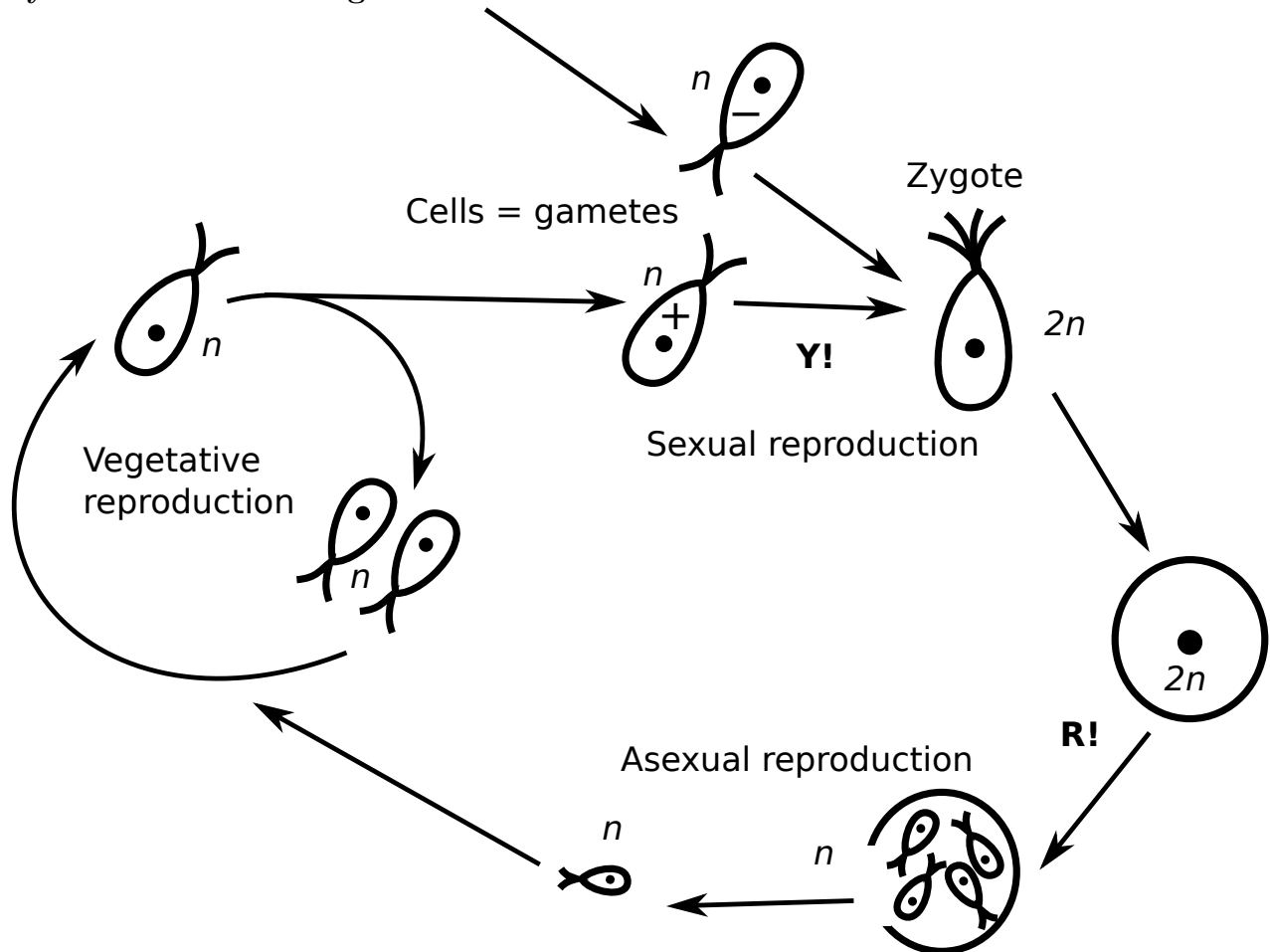
For Further Reading

References

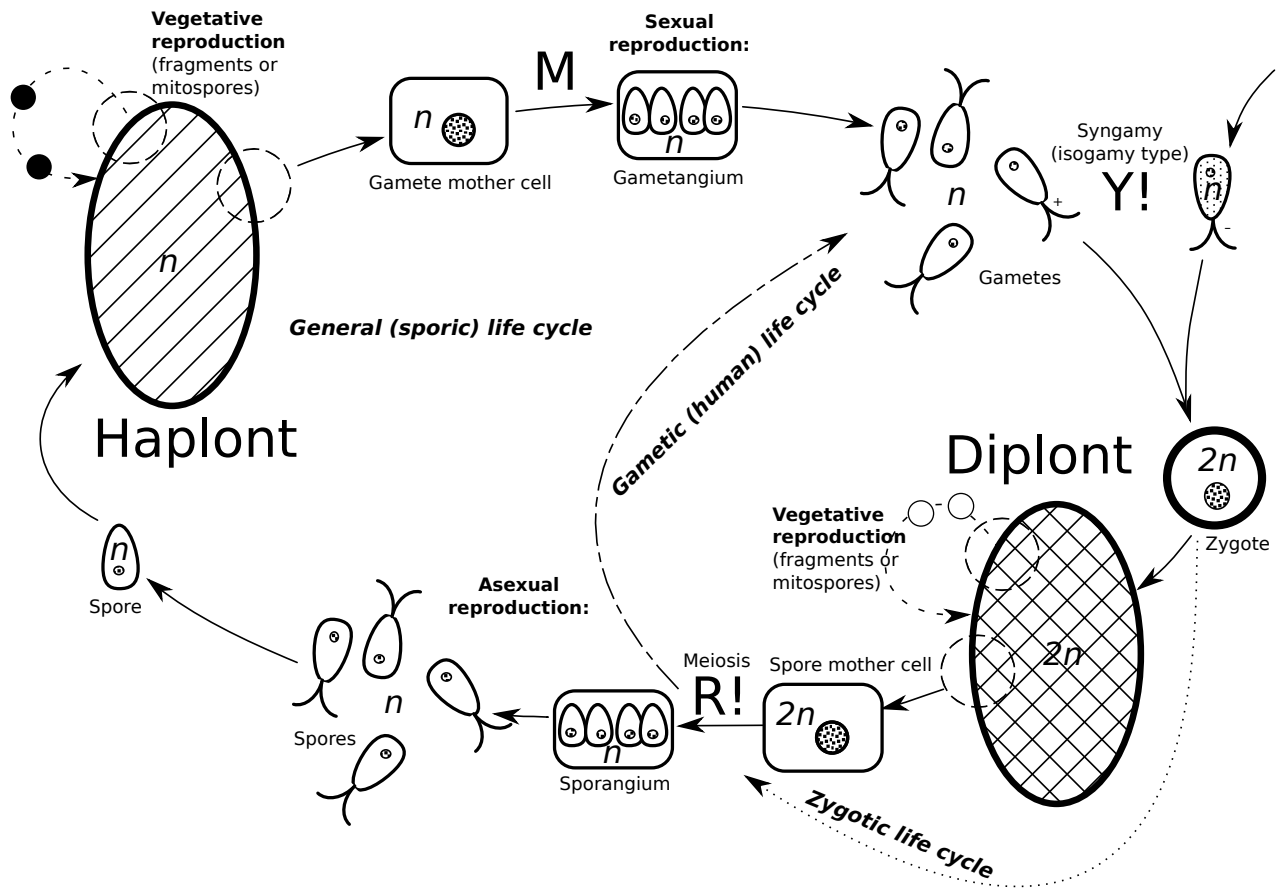
- [1] Life cycle. http://en.wikipedia.org/wiki/Biological_life_cycle
- [2] Syngamy. <http://en.wikipedia.org/wiki/Syngamy> (only intro)

Outline

Life cycle of unicellular organism



Life cycle of multicellular organism



4 Genetics and inheritance

4.1 Life cycle

Terms associated with life cycles

- mitosis, meiosis (R!), syngamy (Y!)
- vegetative reproduction (cloning)
- result of syngamy: zygote
- participant of syngamy: gamete
- smaller gamete: male, bigger gamete: female
- movable male gamete: spermatozoon (sperm), motionless female gamete: oocyte (egg cell)
- haplont and diplont
- spores
- sporic life cycle and gametic life cycle

4.2 Gregor Mendel

Pea

- Self-pollinated: to cross, one needs to pollinate it artificially

- Contrasting characters (flower color, seed coat color, seed coat surface, plant height, pod wall color etc.)
- Pure lines: always produce the same characters

First and second generations

- First: all the same
- Second: 3/4 like one parent and 1/4 like another parent

Theory and explanation

- Two different factors (variants of one character): *two variants (**alleles**) of one **gene***
- Factors are paired in plant but separated in gametes: *meiosis*
- One factor is dominant: *one variant is working DNA, the other is not*

Genes and characters

- Genotype and phenotype
- Homozygous and heterozygous plants
- 3/4 and 1/4 is the result of **combining probabilities**

Experiment with two characters (dihybrid crossing)

- First generation: all same
- Second generation: 9/16 like one parent, 1/16 like another and two new groups (3/16 and 3/16) with intermediate combinations of characters—**recombinants**

Theory and explanation

- Different characters are separating between gametes independently: *anaphase I of meiosis*
- This is because different characters are located in different places: *in different pairs of chromosomes*

Summary

- While in the life cycle of plants (“sporic”), diplont and haplont interleave, in animal life cycle (“gametic”) haplont is reduced.
- Mendelian (classic) genetics is based on segregation, dominance and independent assortment

For Further Reading

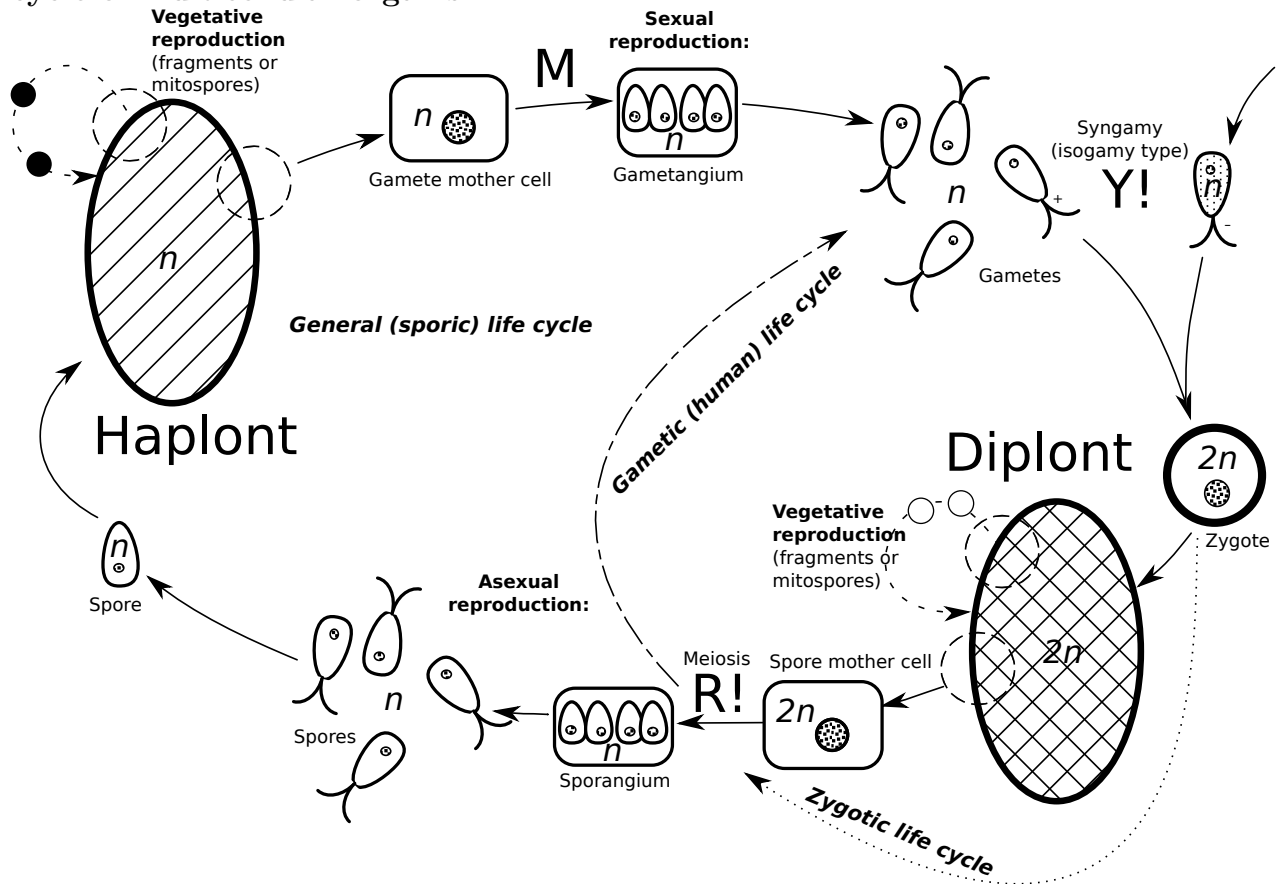
References

- [1] Mendelian genetics. http://en.wikipedia.org/wiki/Mendelian_inheritance

Outline

5 Where we are?

Life cycle of multicellular organism



Mendel's theory and explanation

- Two different factors (variants of one character): *two variants (alleles) of one gene*
- Factors are paired in plant but separated in gametes: *meiosis*
- One factor is dominant: *one variant is working DNA, the other is not*
- Different characters are separating between gametes independently: *anaphase I of meiosis*
- This is because different characters are located in different places: *in different pairs of chromosomes*

6 Inheritance

6.1 Genes and chromosomes

Thomas Hunt Morgan and fruit fly

- Grey with normal wings \times black with reduced wings: in first generation, all same (gray normal) but in second generation only two groups: 3/4 gray normal and 1/4 black reduced!

- BUT if you count thousands of fruit flies, few recombinants may be found
- WHY?

Linkage and crossing-over

- If genes are located in the same chromosome, they are **linked** and will not be inherited independently
- However, linkage could be broken in **crossing-over** (it runs in prophase I of meiosis)

Sex and chromosomes

- One gender has the pair where chromosomes are non-equal
- Deviating chromosome is sex chromosome, it contains small number of genes
- Two variants are possible: XY (mammals, fruit fly, ginkgo tree) and ZW (birds, butterflies)
- In both cases, sexes are 1:1
- The gender where chromosomes are equal often has the second chromosome inactivated (i.e., Barr body in human female cells)
- The gender where chromosomes are non-equal is more susceptible to mutations because all mutations in main chromosome will be manifested (it has no counterpart)

7 Life in Paleozoic era

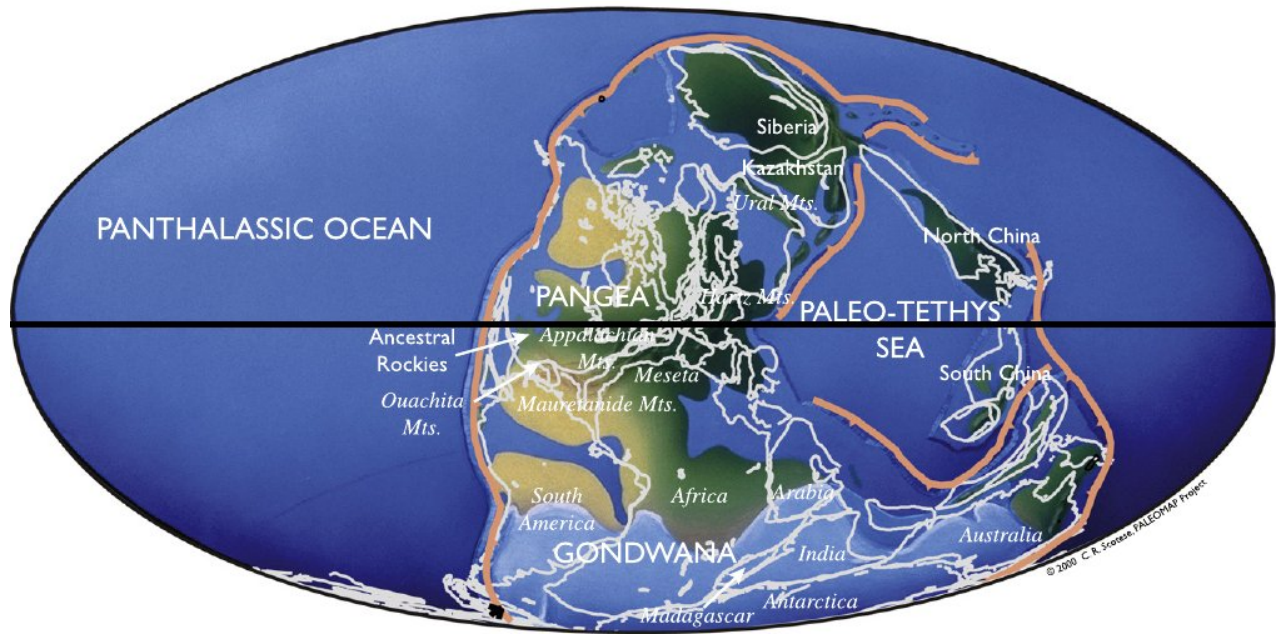
7.1 From Carboniferous to Permian

From Carboniferous to Permian

- Devonian period: 419 Mya
- Carboniferous period: 358 Mya
- Permian period: 299–252 Mya

Carboniferous period

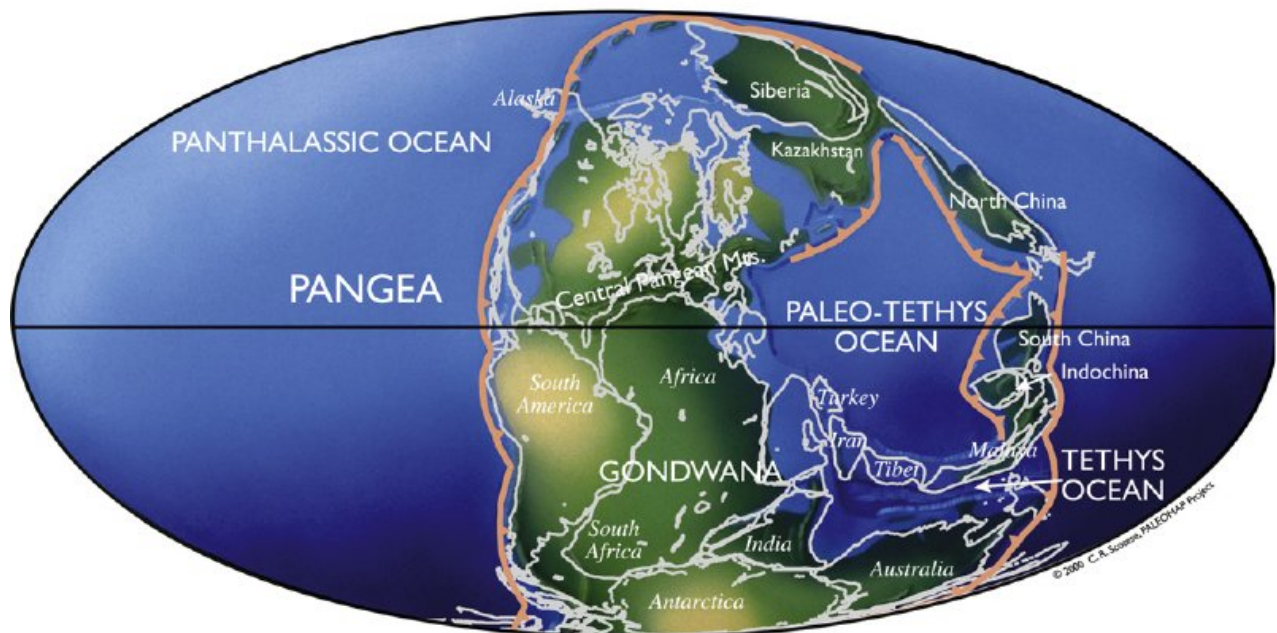
306 Ma Carboniferous



- Hot, wet tropical climate in Europe and North America (Laurasia), dry arctic forests in Siberia (Angarida)
- Pteridophyte and primitive seed plants forests dominated tropics, insects started to fly
- Reptiles appeared

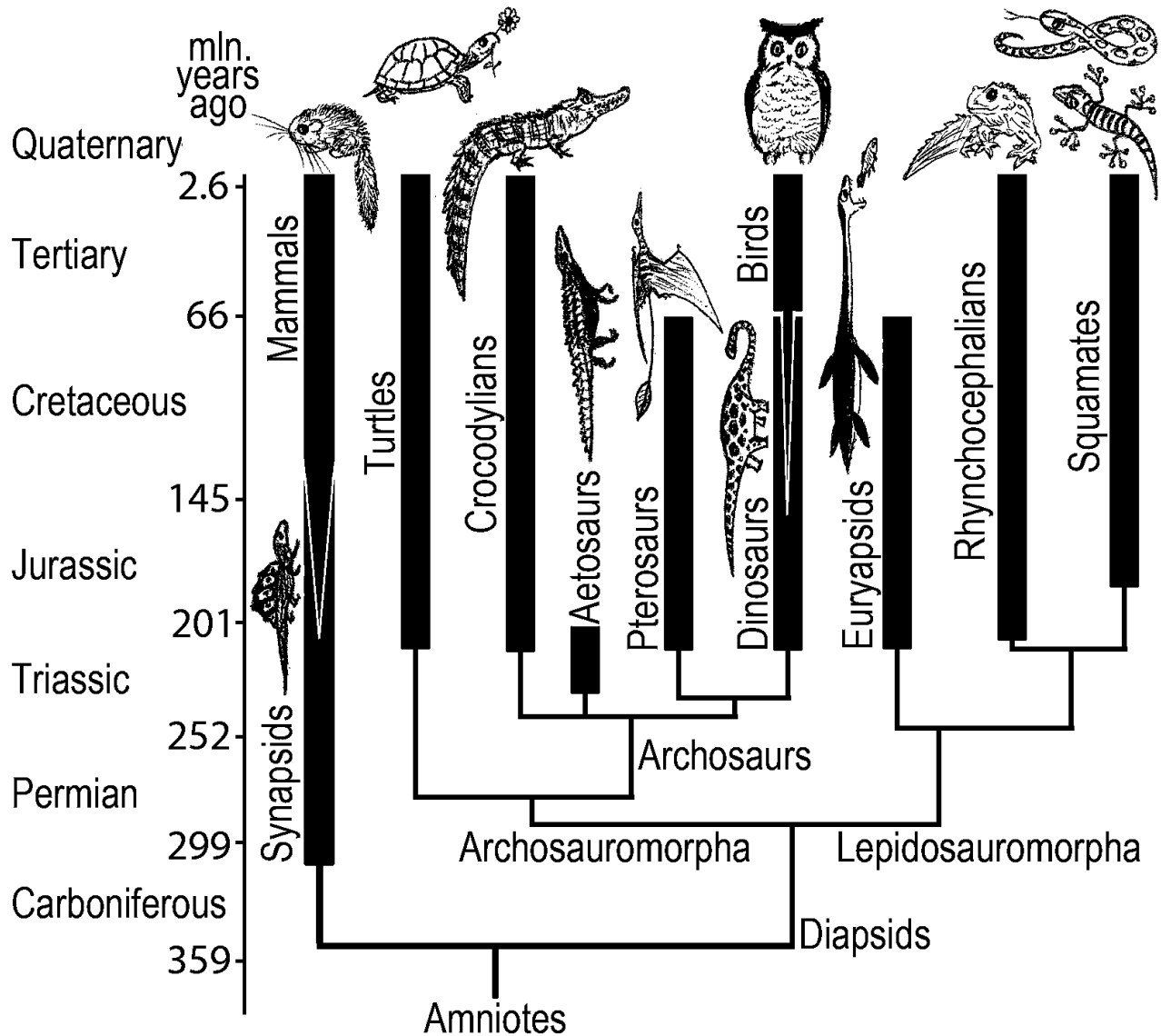
Permian period

255 Ma Permian



- Last period of Paleozoic era, ended with a mass extinction in the sea and also on land
- Pangea formed, with a giant central desert
- Primitive synapsid reptiles dominated the land

Following the movie: reptiles, mammals and birds



Summary

- Chromosome (Morgan) approach added linkage, crossing-over and sexual chromosomes to the principles discovered by Mendel

For Further Reading

References

- [1] Linkage. http://en.wikipedia.org/wiki/Genetic_linkage
- [2] Sex chromosomes. http://en.wikipedia.org/wiki/Sex_chromosome
- [3] Permian. <http://en.wikipedia.org/wiki/Permian>

Outline

8 How plants got their seeds

8.1 Origin of seed plants

Life cycle of land plants

- Sporic life cycle with interleaving generations
- Diploid stage grow directly on the haploid stage and even parasitizes on it (e.g., in mosses)
- Originates from the life cycle of algae: diploid stage was an adaptation to the distribution of spores
- Eventually, diploid stage begin to dominate the life cycle

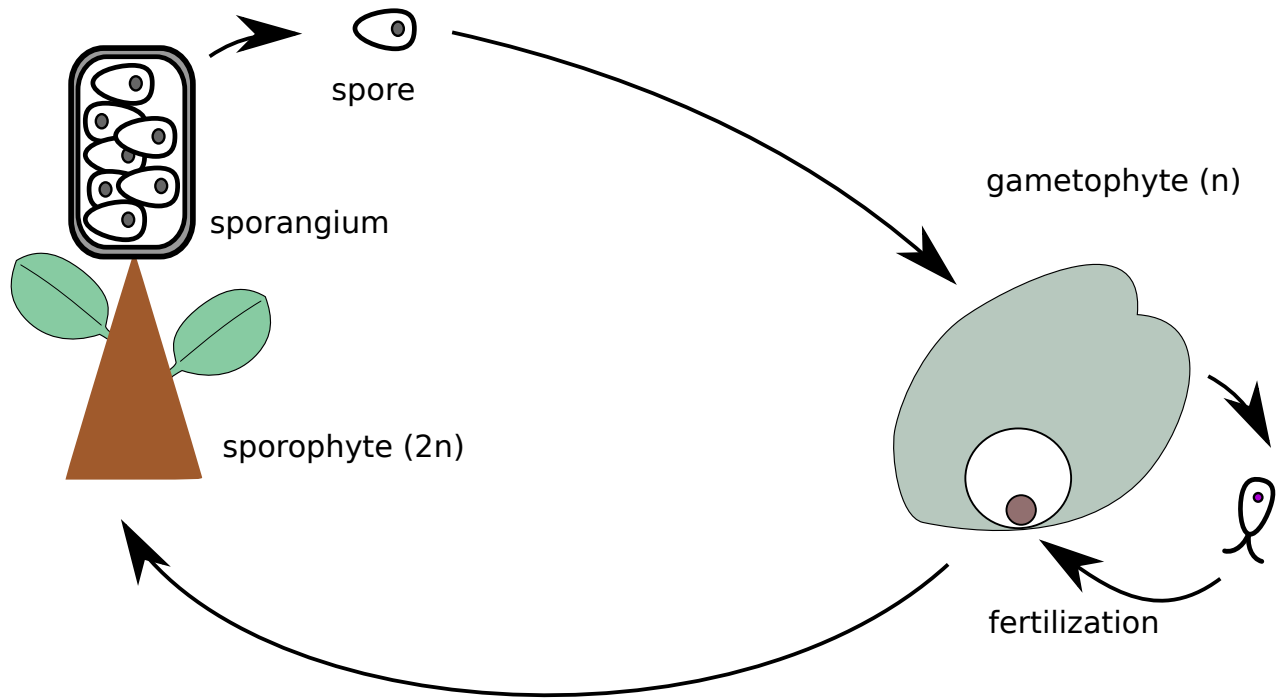
The conflict between size and reproduction

- Competition for the light resulted in growing up; growing up resulted in *secondary thickening*—trees appeared
- Seed plants started as trees, and these trees were diploid stage
- Haploid stage still existed and probably was a minute *prothallium*
- Diploid stage followed the *K*-strategy (slow and smart) whereas haploid prothallium followed the *r*-strategy (random explosions)
- This is a conflict: diploid stage cannot adapt better because free haploid stage was too cranky, it became a hindrance on the way of evolution
- Decision: take haploid stage on the diploid stage and grow it inside

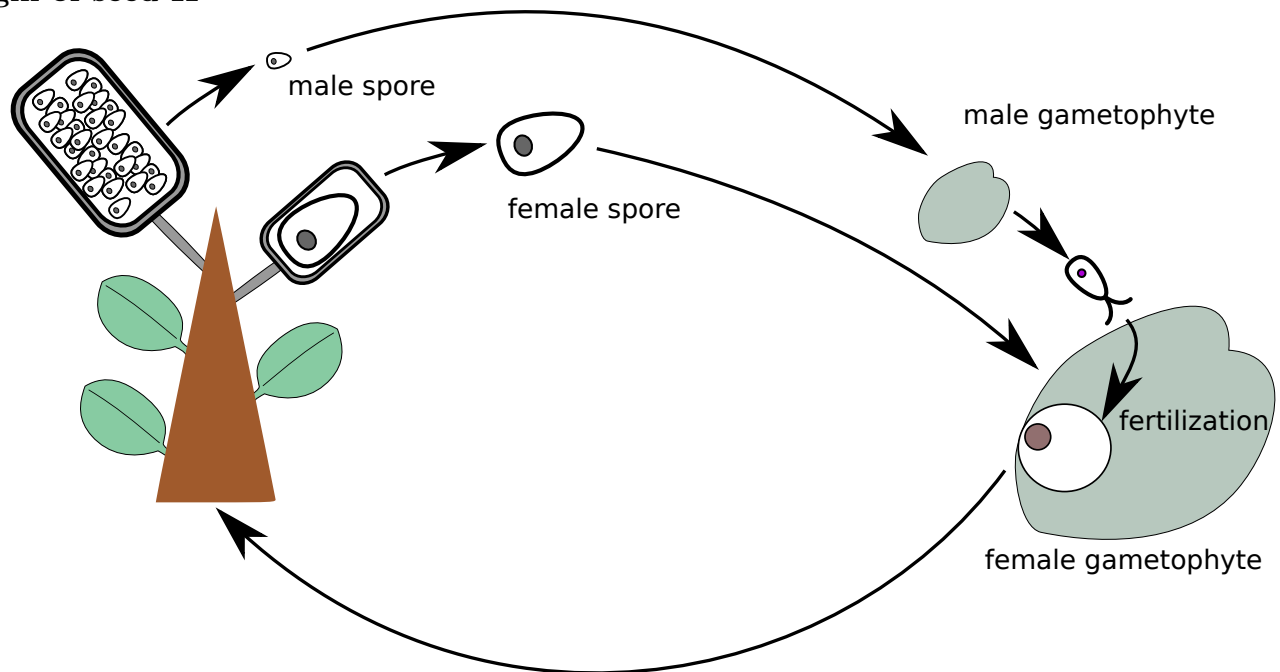
The seed

- Seed is the chimeric organ consists of three parts: mother diploid tissue (seed coat), daughter diploid (embryo) and female haploid stage (endosperm)
- Main problems: need for pollination, extremely slow growth (two years in pine tree, up to five years in cycads)

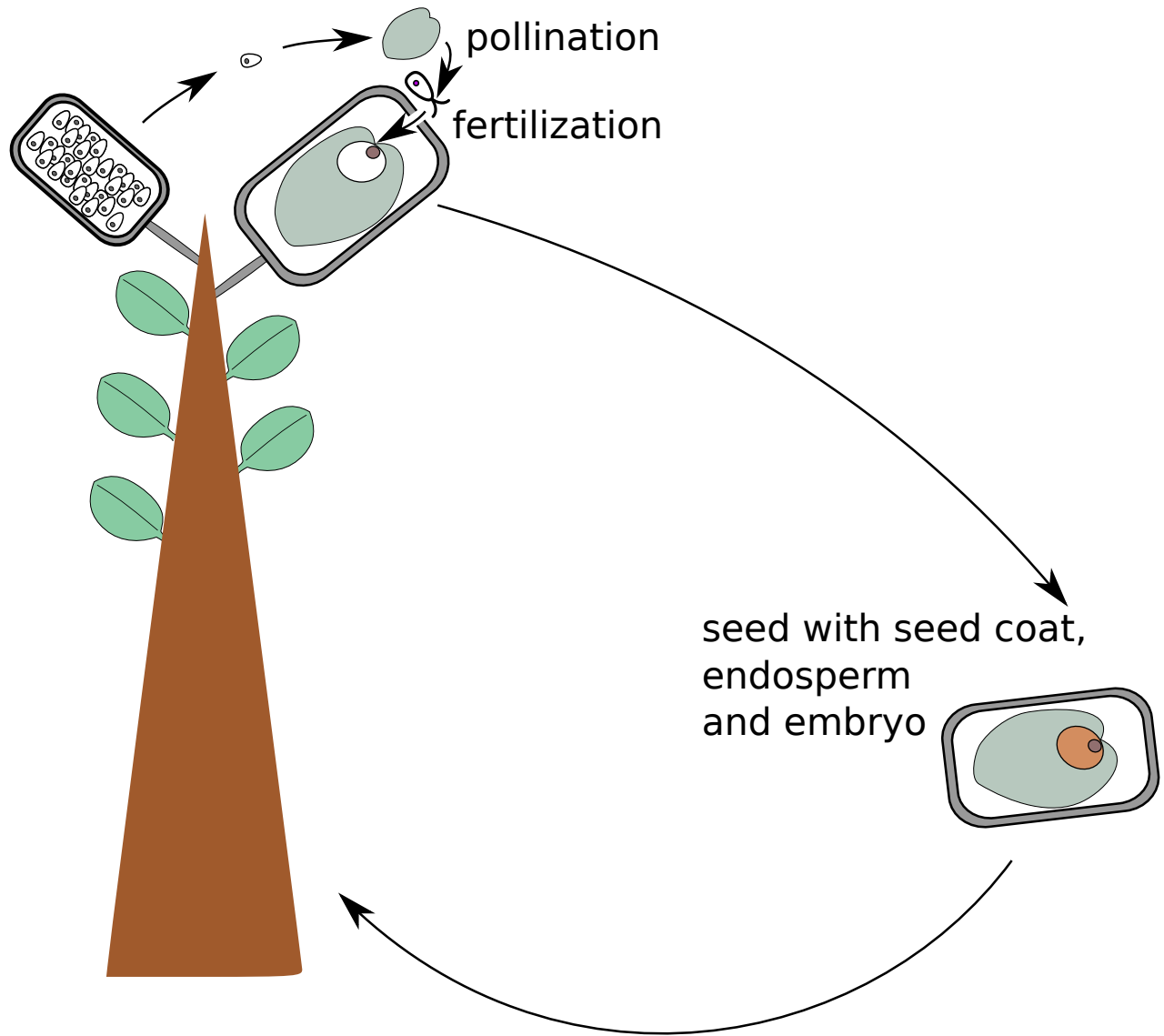
Origin of seed I



Origin of seed II



Origin of seed III



9 Jurassic park

9.1 From Triassic to Cretaceous

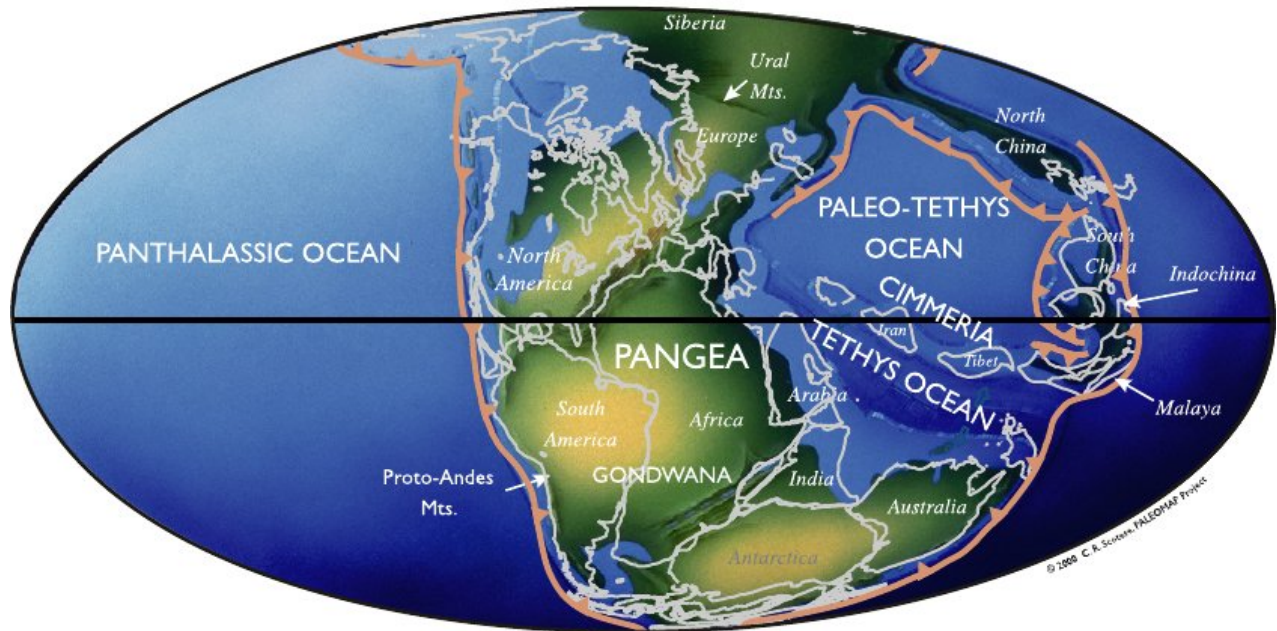
From Triassic to Cretaceous

Mesozoic era:

- Triassic: starts 252 Mya
- Jurassic: starts 201 Mya
- Cretaceous: starts 145 Mya, ends 66 Mya

Triassic period

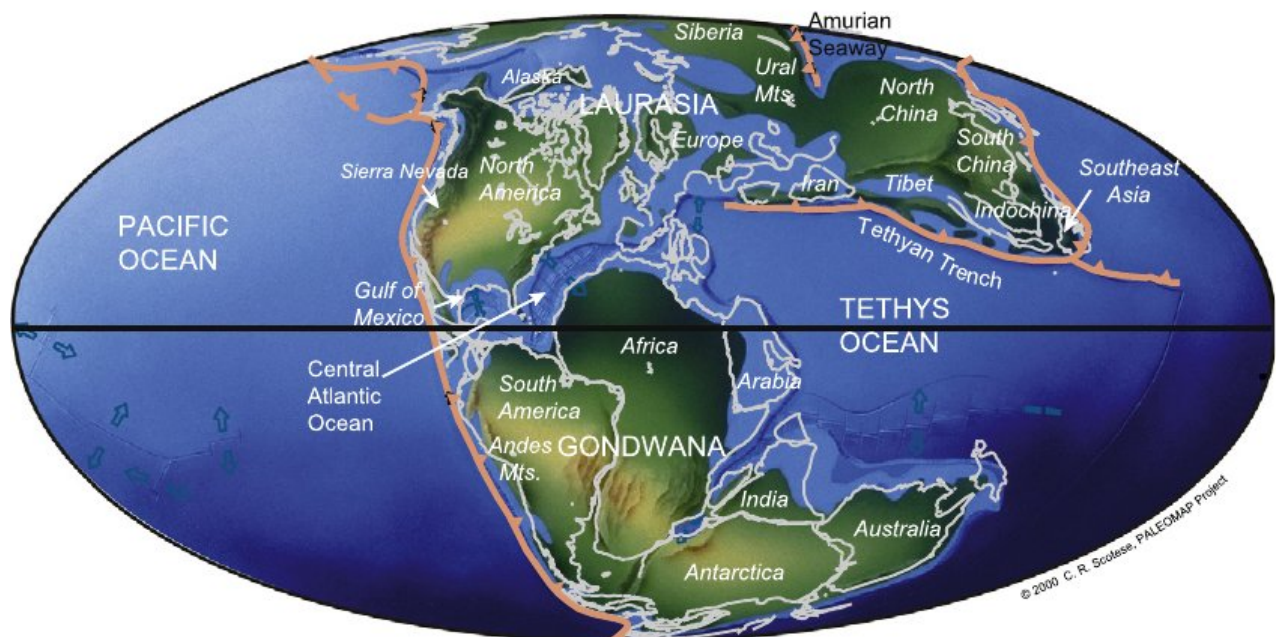
237 Ma Triassic



- Pangea broke (part of Africa adhered to North America)
- Climate becoming wetter
- Grasshopper-like insects radiated
- Synapsid reptiles declined, dinosaurs and pterosaurs appeared

Jurassic period

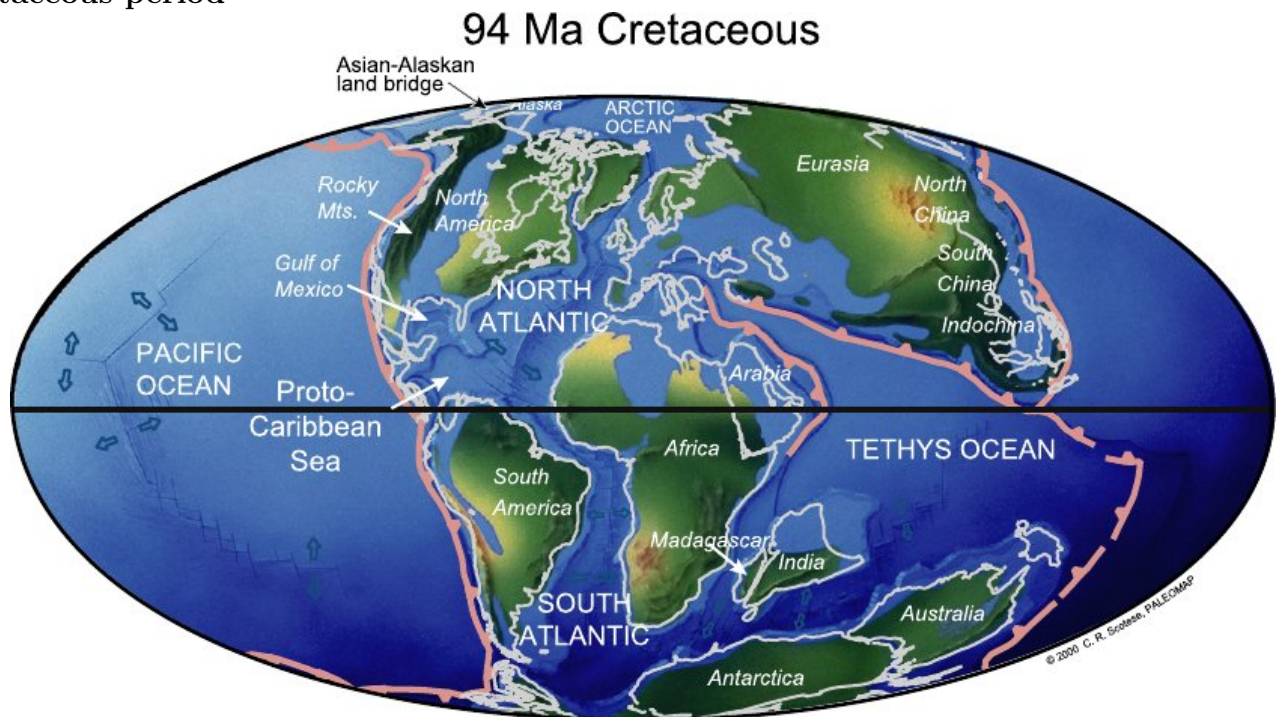
152 Ma Jurassic



- Atlantic ocean and Rocky mountains appeared
- Peak of dinosaur diversity
- Birds appeared as a lineage of small flying dinosaurs

- In the sea, ammonites and primitive fish dominated

Cretaceous period



- High level of water (second high after Devonian), warm climate even on North and South poles, sea in North Dakota
- Flowering plants appeared and rapidly colonized all land
- Butterflies and flies appeared
- Terrestrial dinosaurs slowly declined and finally disappeared in the very end of period

Subdivisions of Cretaceous

| System | Series | Stage |
|------------|-----------|---------------|
| Paleogene | Paleocene | Danian |
| Cretaceous | Upper | Maastrichtian |
| | | Campanian |
| | | Santonian |
| | | Coniacian |
| | | Turonian |
| | | Cenomanian |
| | Lower | Albian |
| | | Aptian |
| | | Barremian |
| | | Hauterivian |
| | | Valanginian |
| | | Berriasian |
| Jurassic | Upper | Tithonian |

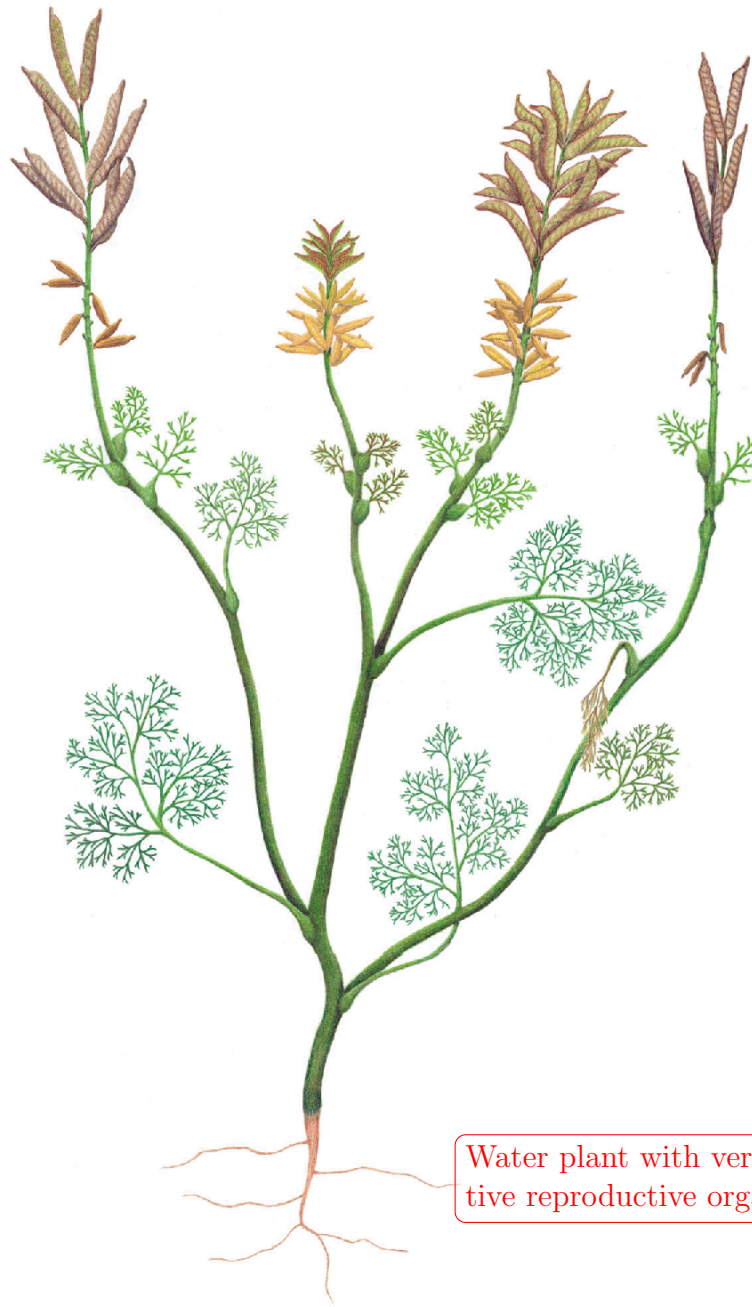
- Hauterivian: first flowering plants (pollen)
- Barremian/Aptian: Famous Yixian formation (China)
- Maastrichtian: end of dinosaur age

9.2 Jurassic and Cretaceous flora and fauna

Terrestrial flora

- Spermatophyta
 - Non-angiosperm seed plants (“gymnosperms”)
 - Magnoliopsida (angiosperms, flowering plants)
- Pteridophyta

Archaeofructus (discovered in 2002, Yixian)



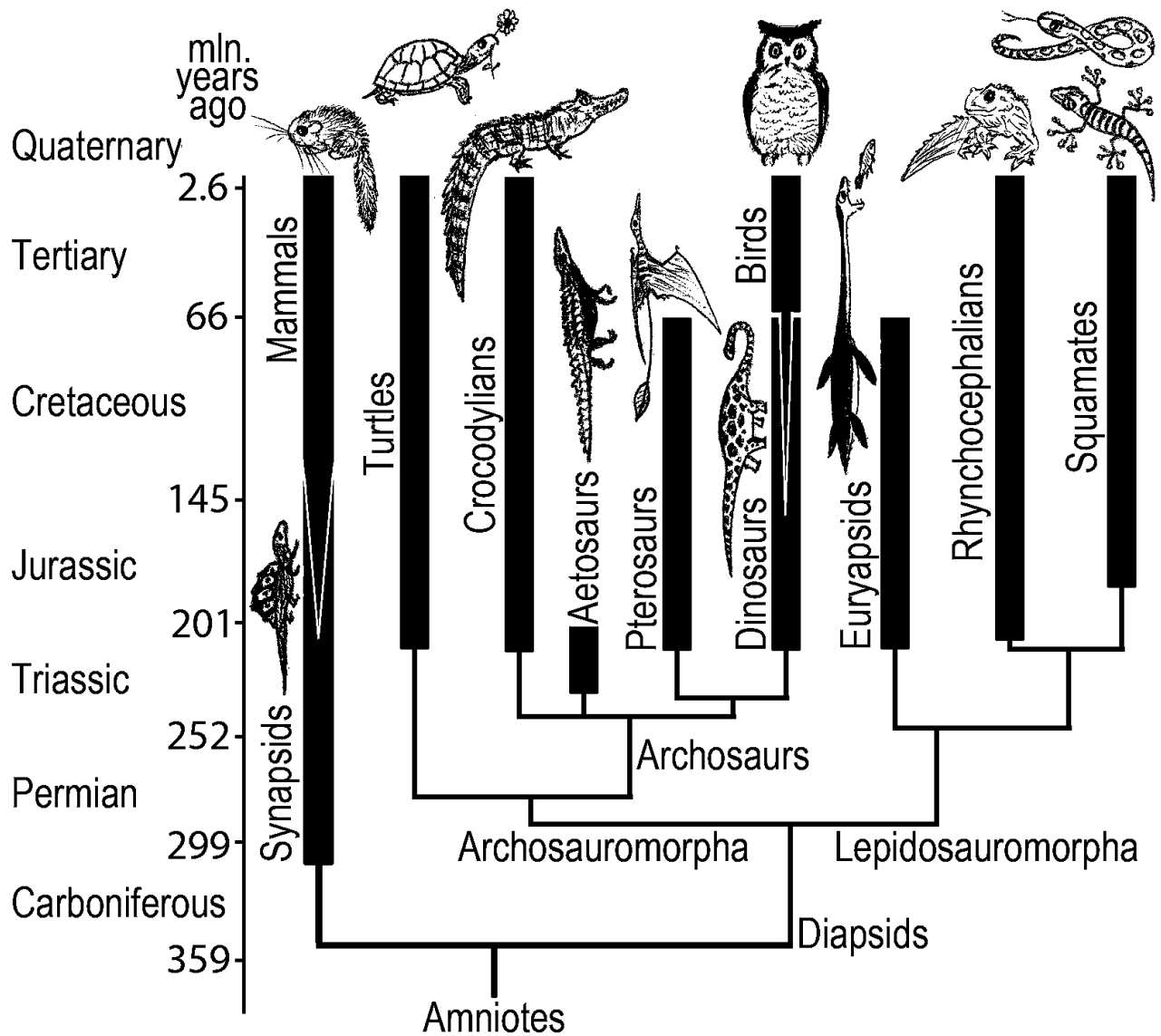
Water plant with very primitive reproductive organs

Terrestrial fauna

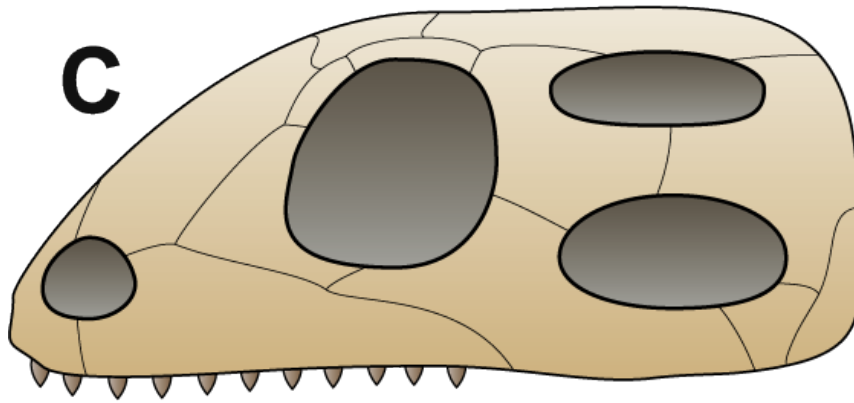
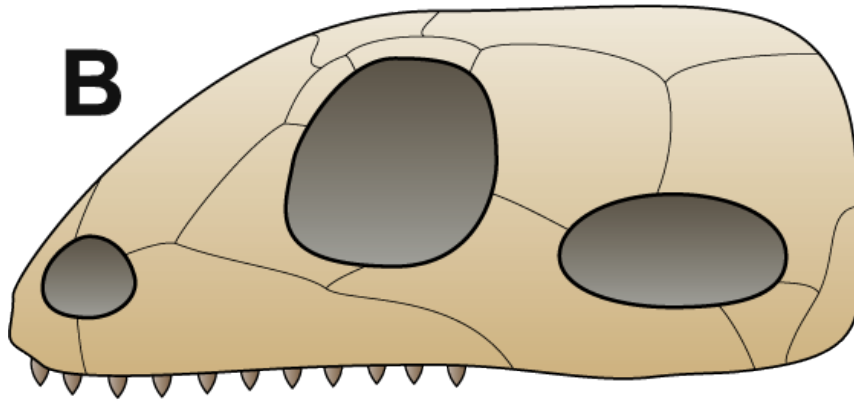
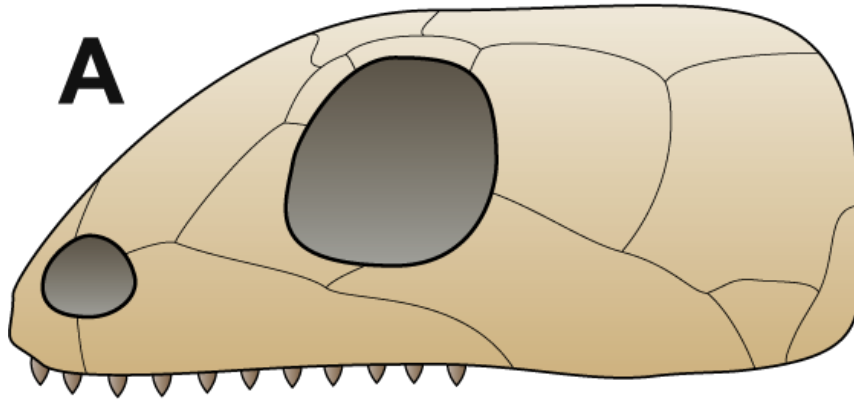
- Amphibia
- Reptilia
 - Synapsida: ancestors of **mammals**, e.g., pelycosaurs
 - Anapsida: **turtles** and many extinct lineages like pareiasaurs from Permian, now frequently united with diapsids
 - Diapsida: the most diverse reptilian group
- Aves (departed from Diapsida)

- Mammalia (in transition from synapsid reptiles to core mammals)

Reptiles, mammals and birds



Subdivisions of reptiles



A Anapsid skull

B Synapsid skull

C Diapsid skull

Tricodont proto-mammal



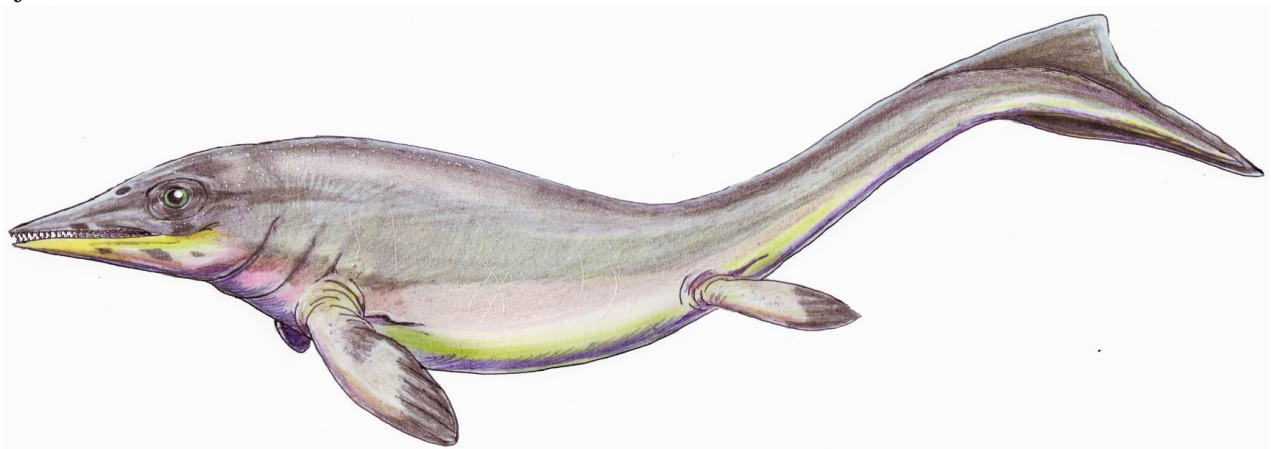
Diapsid reptiles

- Ichthyosauria: marine, dolphin-like reptiles
- Sauropterygia: placodonts and plesiosaurs

These two first groups are called “euryapsids”

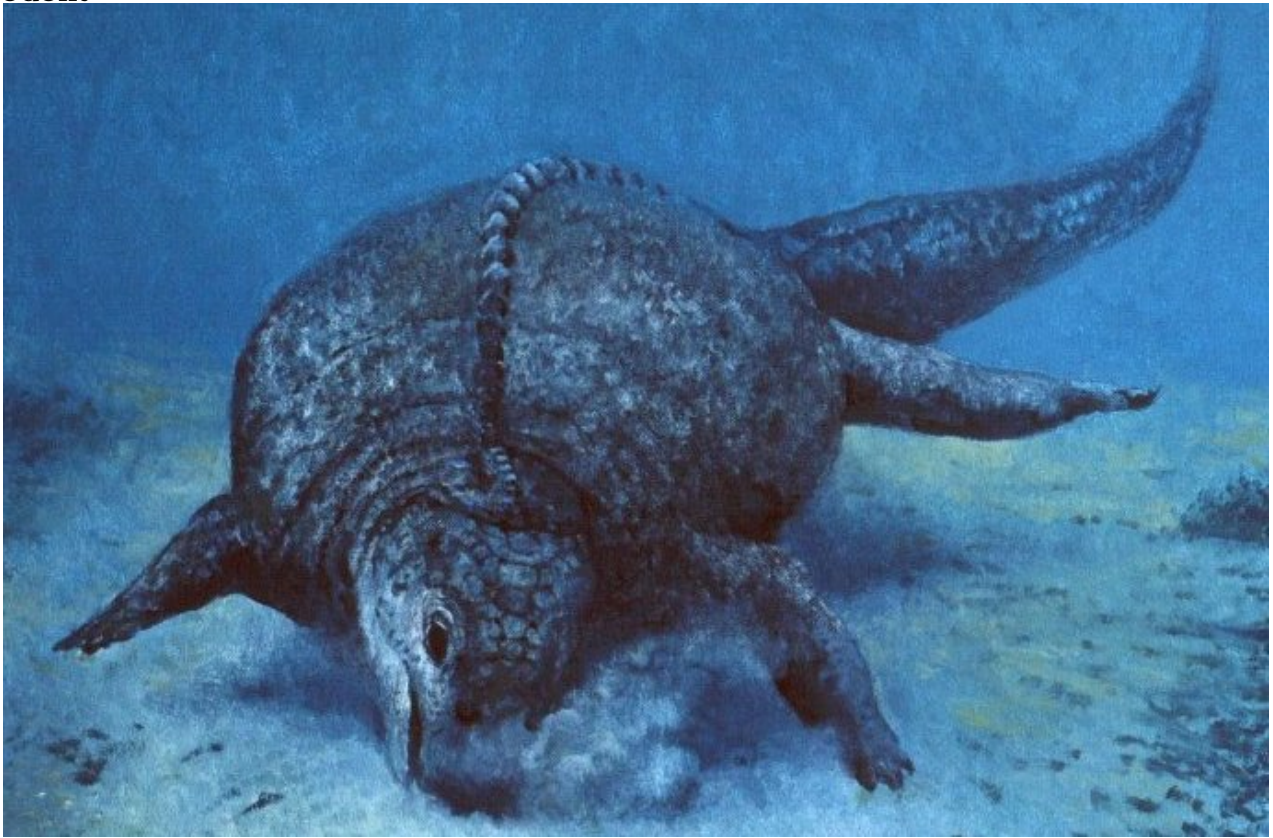
- Lepidosauria: lizards, snakes and extinct mosasaurs
- Archosauromorpha: proterosuchids, aetosaurs, crocodiles, dinosaurs (including ancestors of birds)

Ichthyosaur



Ichthyosaurs were viviparous. Note also the vertical fin.

Placodont



Covered with skin plates, eat mollusks.

Plesiosaurs



Mosasaur



Archosauromorph reptiles

- Proterosuchia, Aetosauria: basal archosauromorphs
- Crocodylomorpha: advanced behavior, four-chambered heart
- Pterosauria: archosaur “bats”, some with fur-like cover. Note that skin membrane is not very effective wing.
- Dinosauria: bipedal archosaurs:
 - Ornithischia: “bird-hipped”, include ankylosaurs and stegosaurs, ornithomimids (like *Iguanodon*), pachycephalosaurs and ceratopsids (but not birds!)
 - Saurischia: “lizard-hipped”:

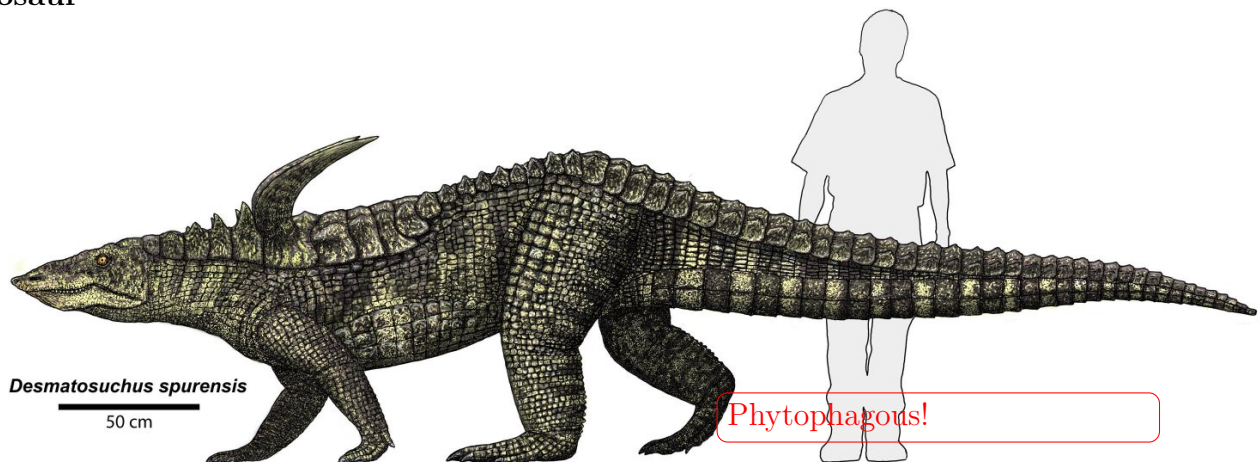
- A. Theropoda: true bipedal, carnivorous or insectivorous, mostly feathered: Ceratosauria (“southern carnivores”), Allosauroidae and relatives, including *T. rex*, Maniraptora and descendants
- B. Sauropodomorpha: secondary quadrupedal, small heads, long necks, long tails; largest dinosaurs

Proterosuchid



Chasmatosaurus from movie

Aetosaur

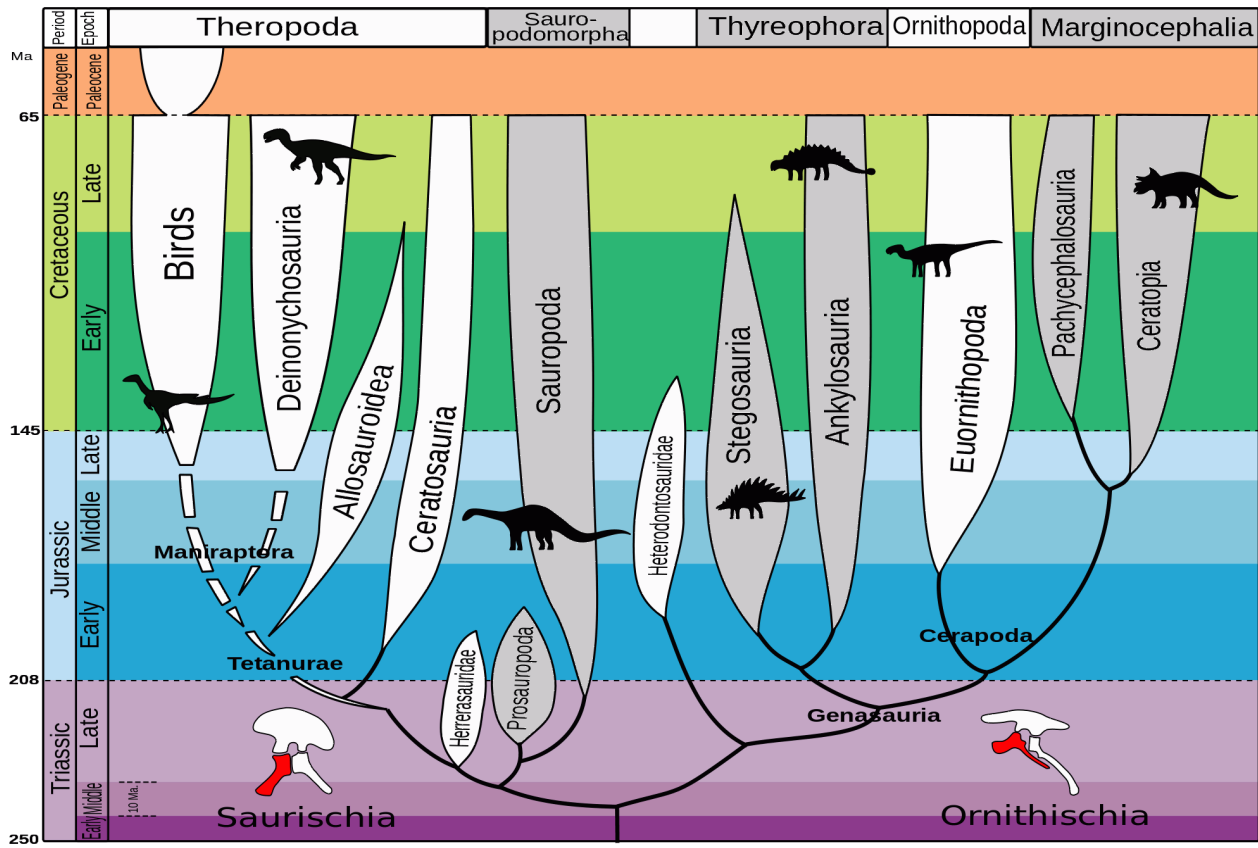


Phytophagous!

Dsungaripterus pterosaur



Dinosaurs in time



Early ornithischian *Tianyulong*



Allosaurioid *Yutyrannus* from China



Feathered, warm-blooded, social

Theropoda: *Tarbosaurus* and *Gallimimus*



Early maniraptor *Gigantoraptor*



Late maniraptor *Microraptor*



For Further Reading

References

- [1] Seed. <http://en.wikipedia.org/wiki/Seed>
- [2] Reptiles. <http://en.wikipedia.org/wiki/Reptile>
- [3] Dinosaurs. <http://en.wikipedia.org/wiki/Dinosaur>

10 Movies

- BBC: Walking with monsters (all episodes)
- BBC: Walking with dinosaurs
 - New blood

- Time of titans
- Cruel sea