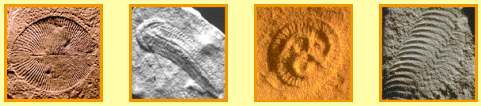
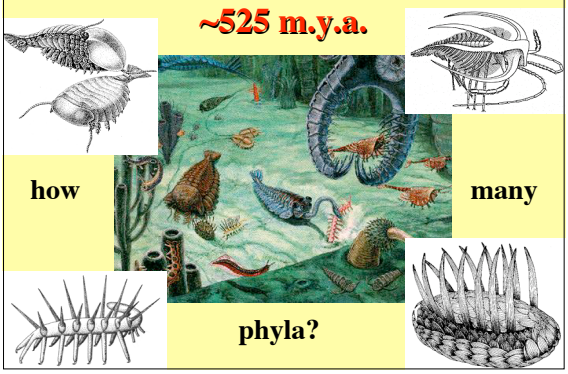
earliest clear Metazoan fossils
from ~600 m.y.a. - Ediacara fauna



[but animals possibly originated ~10^9 m.y.a.]

then a sudden burst of diversification
in Cambrian; most phyla arise ~550m.y.a.

the famous Burgess Shale fauna
~525 m.y.a.



how many phyla?

Animal features:

- multicellular; heterotrophic; aerobic;
  ingest food - phago- or pino-cytosis
- anisogamous gametes
- diploid zygote usually -> blastula
- highly-differentiated tissues
- diverse organ systems
  [skin, blood, nerves, gut, muscle etc]

Animal features:

- enormous size range:
  ~0.1mm to ~30m - 5 powers of 10
- metabolism -> not restricted to
  well-lit environments
- active motility & behaviour;
  unique nervous system; brains
- invaded virtually all habitats, incl. air
- enormous diversity of form

Animal features:

most phyla are shallow aquatic;
>50% restricted to oceans

most species are terrestrial (insects)

true land-dwellers only in 4 groups:
Chelicerata, Insecta, Myriapoda, Chordata

CONTRASTS WITH PLANTS

virtually all plants are sessile, in light only

animals are sessile, planktonic, can crawl, walk, run, swim, burrow, sail, glide and fly on land, sea or air

most are *actively mobile, anywhere*

this associated with:

- **bilateral symmetry**
- **distinct head and leading end**
- **concentration of sensory/feeding apparatus**

ANIMAL DIVERSITY

animals are the most morphologically varied kingdom

highly diverse body plans

traditionally the classification of animals is based in body-plans & embryology

recently revolutionized by DNA

two main branches remain as before:

Parazoa & Eumetazoa

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Parazoa

Sponges **- no distinct tissues or symmetry**

Eumetazoa

Radiata **- 2 cell-layers, radial symmetry**

sea anemones, jellyfish, comb jellies

Bilateria **- 3 cell layers, bilateral symmetry**

basically worm-like, at least as larvae

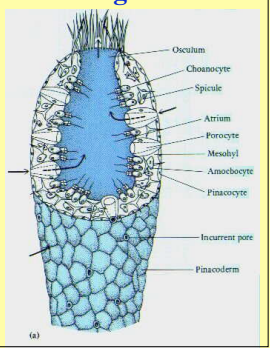
09 : 10 9

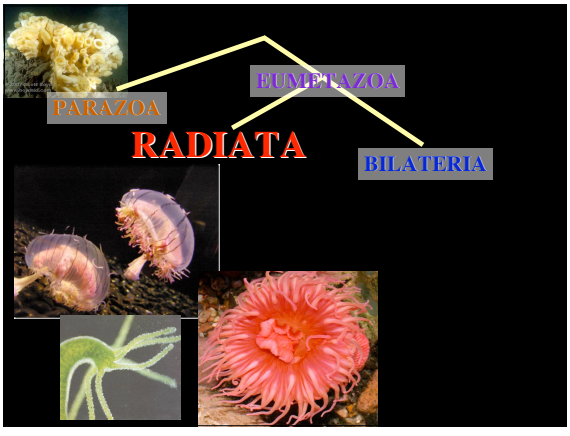
Parazoa - Sponges

no mouth, gut or other organs

sessile filter-feeders

ciliated cells make currents





Eumetazoa : *Radiata*

single body cavity & opening
radial symmetry, no head
simple muscles and nerve net
limited active movement

comb jellies

nematocysts

corals, jellyfish, sea-anemones

Sponges & Radiata

are +/- wholly marine

largely unchanged from first appearance

both feed on items which *come to them*
no active pursuit
need no major body axis

∴ asymmetry or radial symmetry make adaptive sense - no head or advanced sense organs required

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all others, the 3-layer *Bilateria,* show left-right symmetry, mostly with distinct head

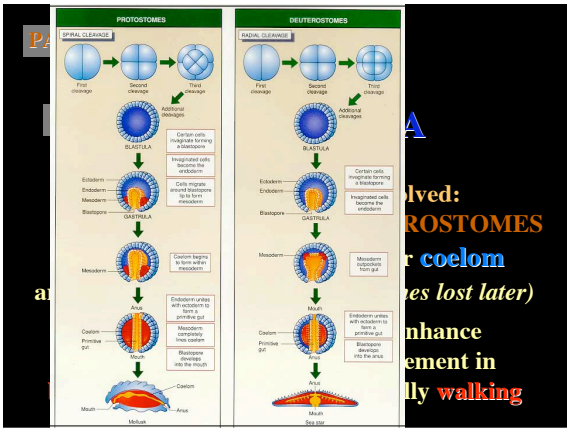
encephalization

directed movement to find and catch food;
sensory apparatus & mouth at front

selection for greater efficiency ->
straight through gut - mouth + anus
better muscles & control -> better movement

get resources -> burrowing into deposits
free swimming - transport & escape

09 15



what is a coelom?

a fluid-filled body cavity
between gut and body wall

fluid is incompressible,
so transmits forces instantaneously

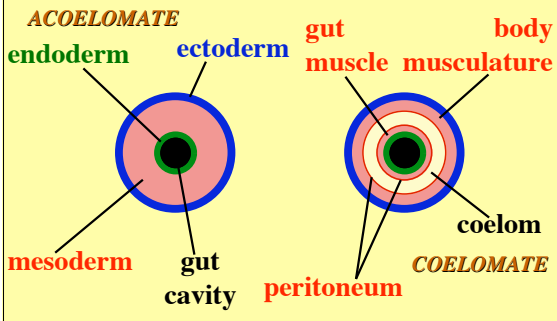
hydrostatic skeleton

also can carry dissolved gases around
- used in respiration - CO_2 & O_2 transport

coelom evolved several times - convergent

09 : 10 17

COELOM CONDITIONS



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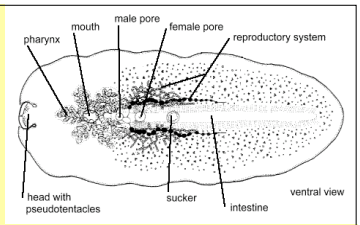
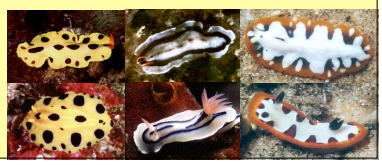
Eumetazoa :
Bilateria

Flatworms

ciliary creeping musculature is weak & poorly coordinated



for swift, strong movement….



…. you need a coelom

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Bilateria

Nematoda - roundworms

0.1mm - 9m!

perhaps a million spp.

free or parasitic

open coelom; longitudinal but *no circular muscles* so can only flip or thrash, *cannot extend*

20

Animals 2

hydrostatic skeleton greatly improved by
SEGMENTATION

segment walls act like valves

in regulating fluid flow, segments permit shape changes that are not only rapid, strong & coordinated, but localized

this precise control over body shape is a prerequisite for efficient
BURROWING
by large organisms

09 : 10

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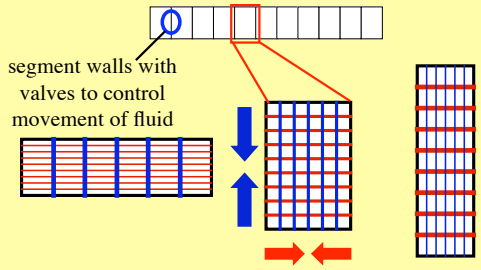
how segmented worms burrow



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all remaining animals have a coelom & at least a trace of such segmentation

some groups display it prominently, e.g. annelid worms, arthropods, chordates

life-style of segmentation's functional origins well-displayed by segmented worms- life's quintessential burrowers

09 :

ANNELIDA : segmented worms





the *coelom & segmentation* triggered an explosive evolutionary radiation of animals into all aquatic environments

but burrowing-style locomotion is useless in water column -> *serpentine movement*

forward motion aided by *external paddles*

this motion enhanced by *rigid skeleton*

all *active swimmers* have skeleton & "limbs" -at least for steering

steering paddles may be used as levers against solid substrate as against water

swimming -> crawling, scrambling

all the basic features of "higher animals" coelom, segments, skeleton, limbs, respiratory system evolved very early in marine habitats

driven by movement to get food resources & safe refuges, in sediments or water column

these basic structures became enormously elaborated & diversified

though these derived forms do not much resemble worms, most zoologists trace them back to that origin

animal structure interpreted as **adaptations to movement in diverse media**

protostomes *deuterostomes*

molluscs arthropods echinoderms chordates



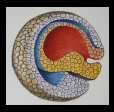


PARAZOA

EUMETAZOA

RADIATA

BILATERIA



protostomes

deuterostomes

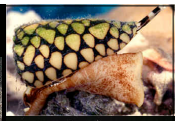
flatworms


annelid worms

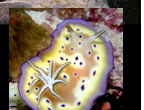

molluscs

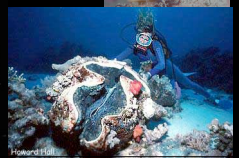
MOLLUSCA

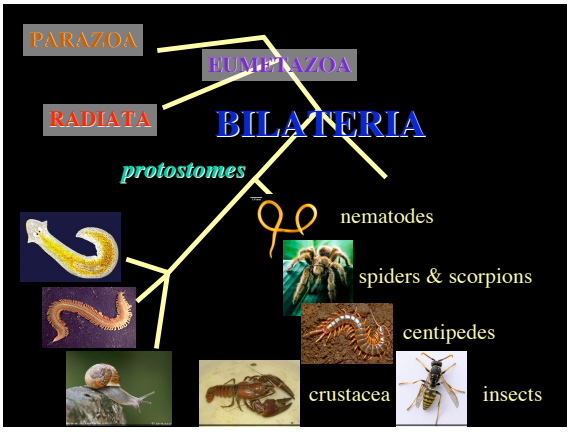


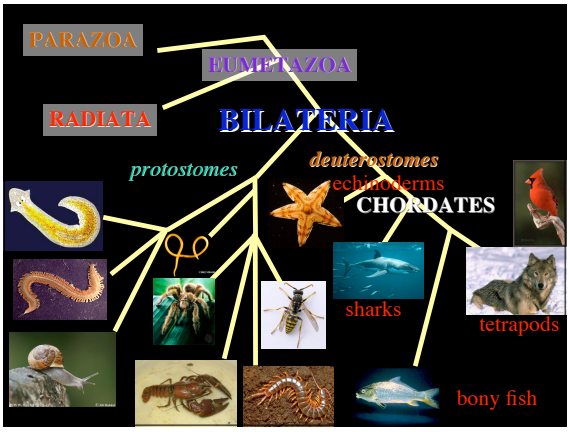


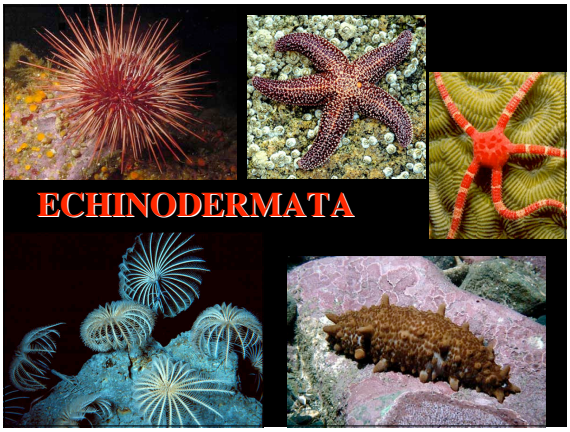


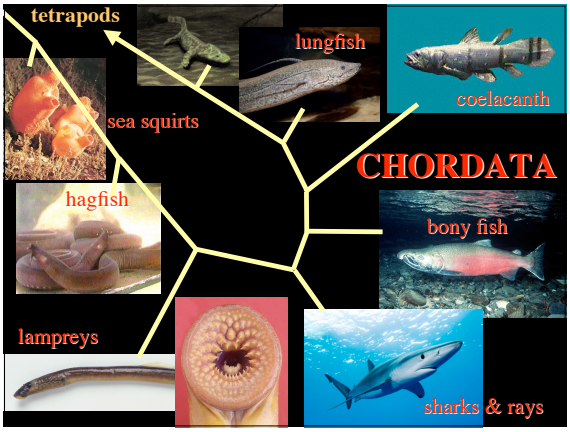





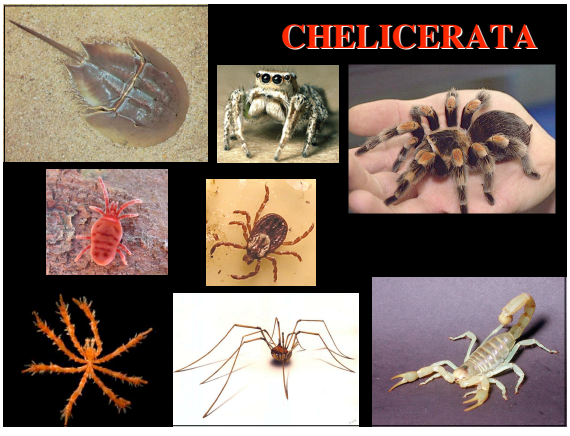



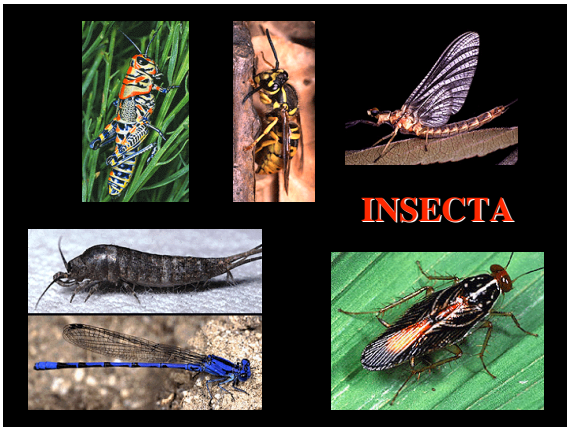






though nearly all basic animal body plans were developed by 500 m.y.a. in ocean,
greatest proliferation of species followed
colonization of land ~3-400 m.y.a.
there animals faced same challenges as plants - air is non-supporting, dry, open to U.V.
strengthen skeleton
impervious skin -> internal lungs
high activity -> active ventilation
09 : 10 water-independent reproduction 35





all fully-terrestrial animals are internally-fertilizing

fully terrestrial *vertebrates* evolved the

amniotic egg

amnion encloses embryo in +/- sea-water; yolk-sac, gas-exchange membranes

most lay eggs, but some retain them inside and nourish them there - viviparity

even greater activity & independence by homeothermy in birds & mammals

vertebrates are found in nearly all habitats

however terrestrial habitats are dominated by the insects

~one million spp. named
probably 10x or 100x more

at any moment, ~10^{18} insects alive
= ~10^{12} kg. living matter - more than us

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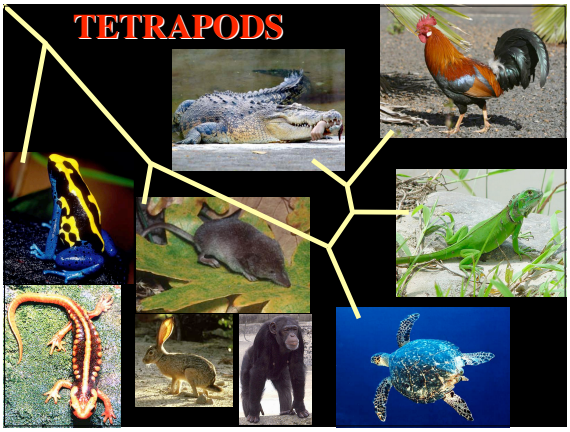

NEXT CLASS

Diversity Inventory: how many of what sort are there?

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many thanks to The Tree of Life site @
http://phylogeny.arizona.edu/tree/life.html
and The Smithsonian Institute @
http://www.nmnh.si.edu/paleo/shale/index.html

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