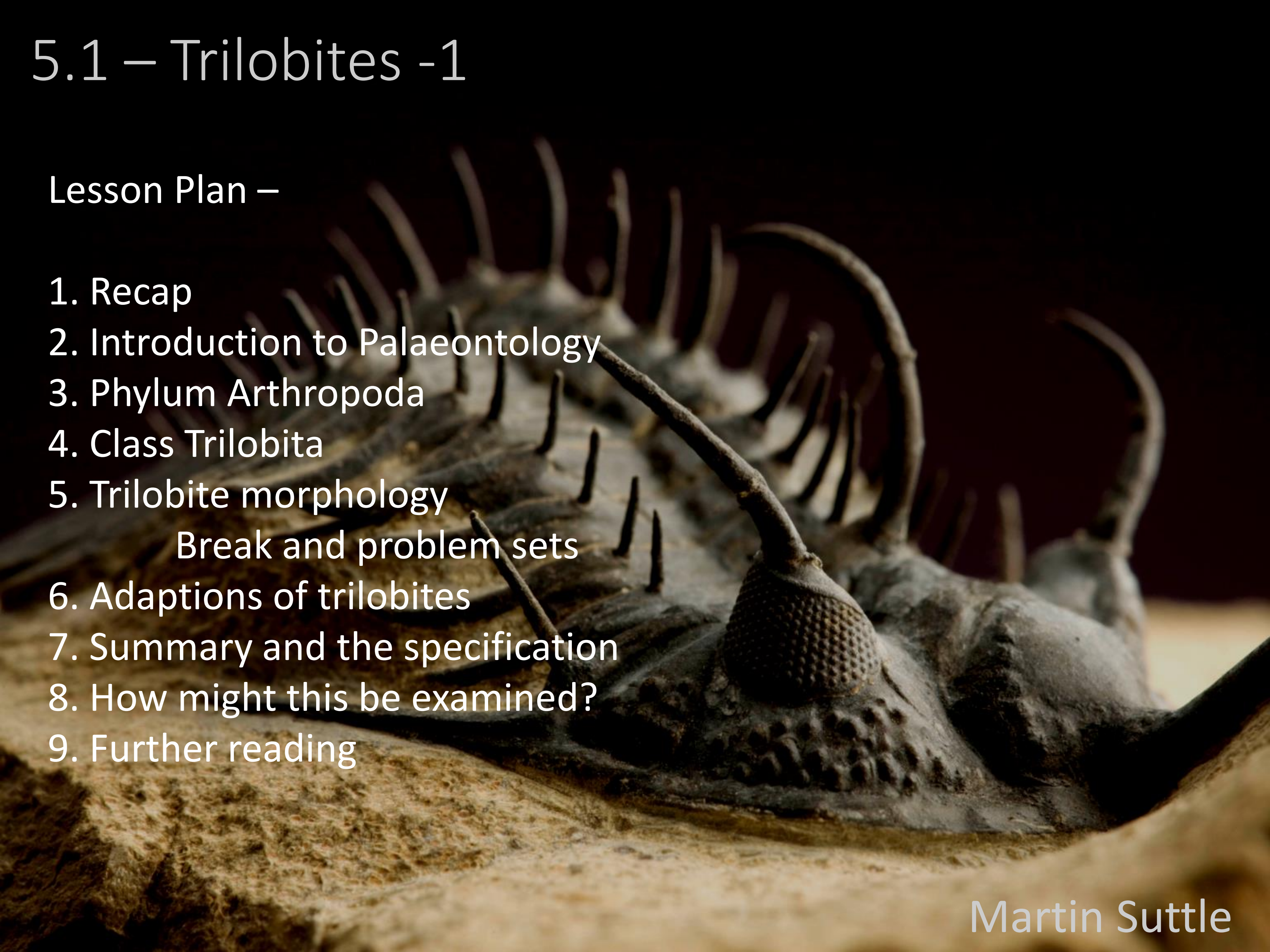
5.1 – Trilobites -1

Lesson Plan –

1. Recap
2. Introduction to Palaeontology
3. Phylum Arthropoda
4. Class Trilobita
5. Trilobite morphology

    Break and problem sets

6. Adaptions of trilobites
7. Summary and the specification
8. How might this be examined?
9. Further reading



Martin Suttle

5.1 – Recap

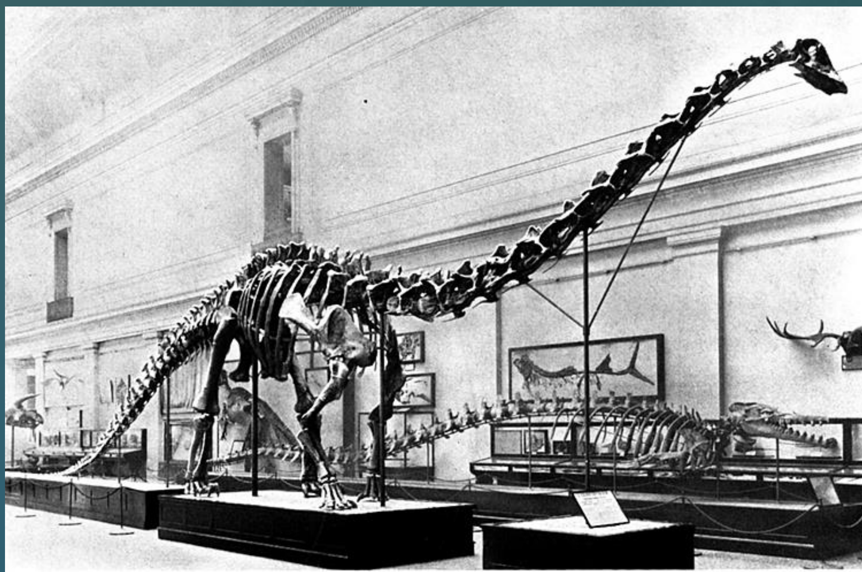
- Draw schematic diagrams for the trace fossils:

1. Thallasinoides
2. Diplocraterion

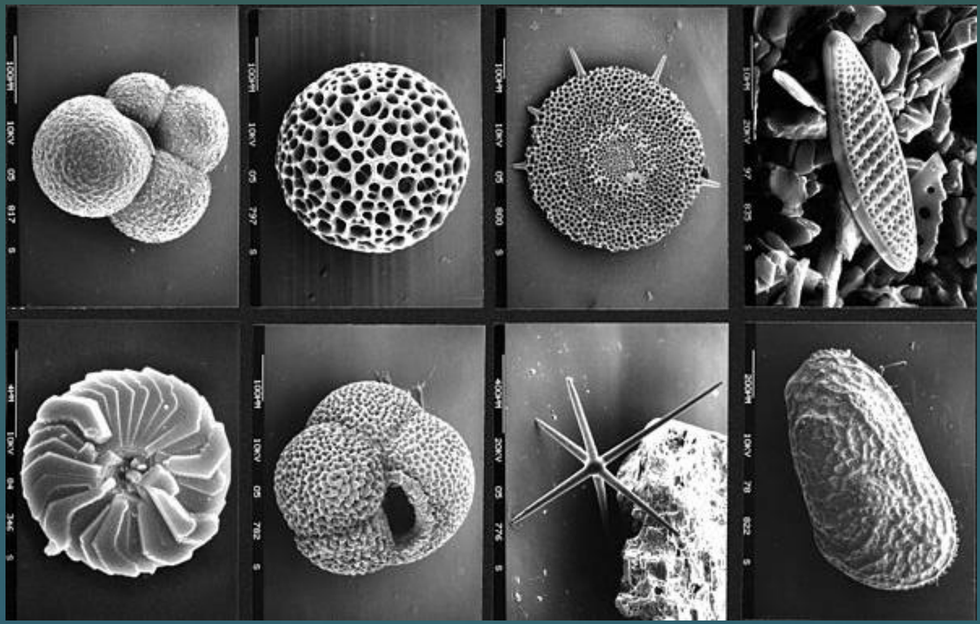
- Write a bullet point explanation for replacement

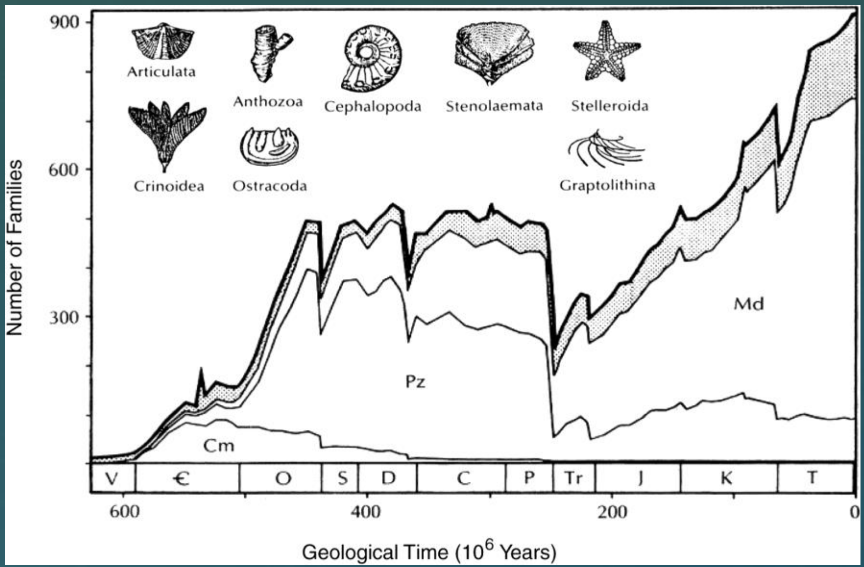
- What is the correct trace fossil name for excrement?

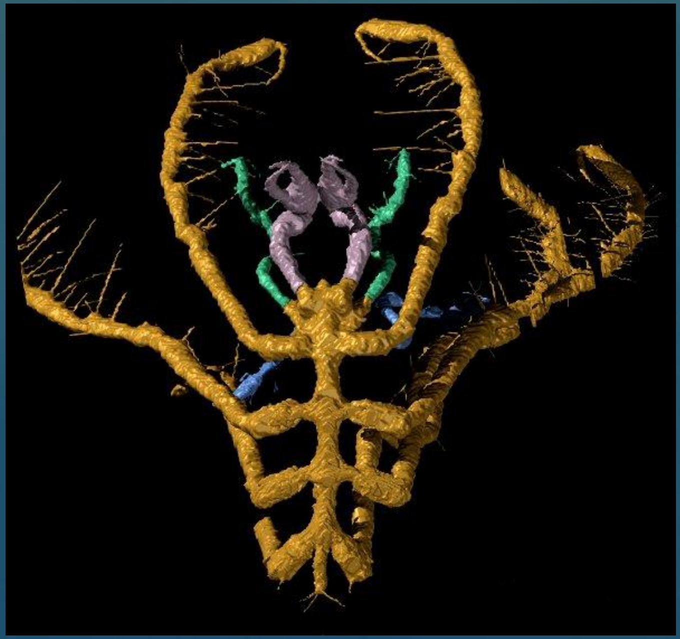
5.1 – Classical paleontology

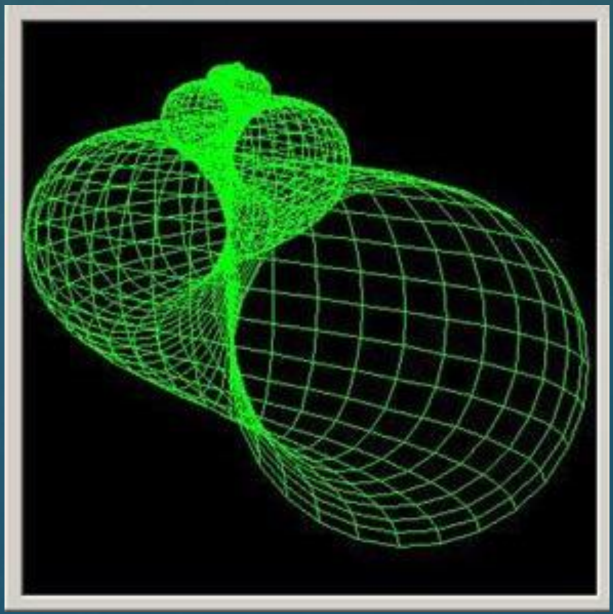


5.1 – Modern paleontology









5.1 – Modern paleontology

"The present is the key to the past" – Uniformitariansim

In palaeontology?

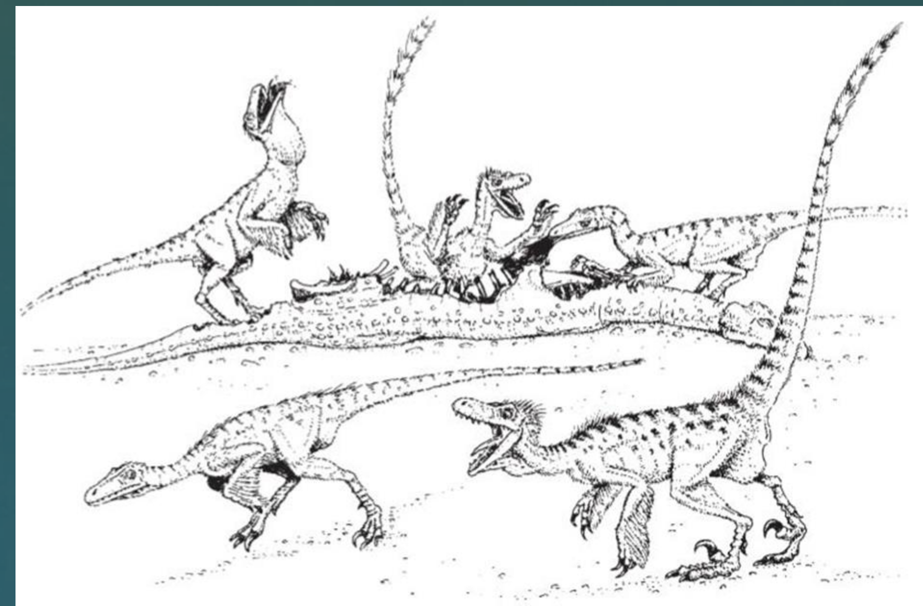
Often we use closely related modern day (extant) **organisms as analogues, to infer how past extinct forms lived**.

Modern counterparts therefore give us hints about palaeo morphology and behaviour.

For example: "*Were Deinonychus (sub set of Theropod dinosaurs) pack hunters?*"
Evidence from:
-Morphology
-Predator-prey relations in the fossil record
-Trace fossils (trackways)
-**Behaviour of extant diapsids** (primitive archosaurs and aves)

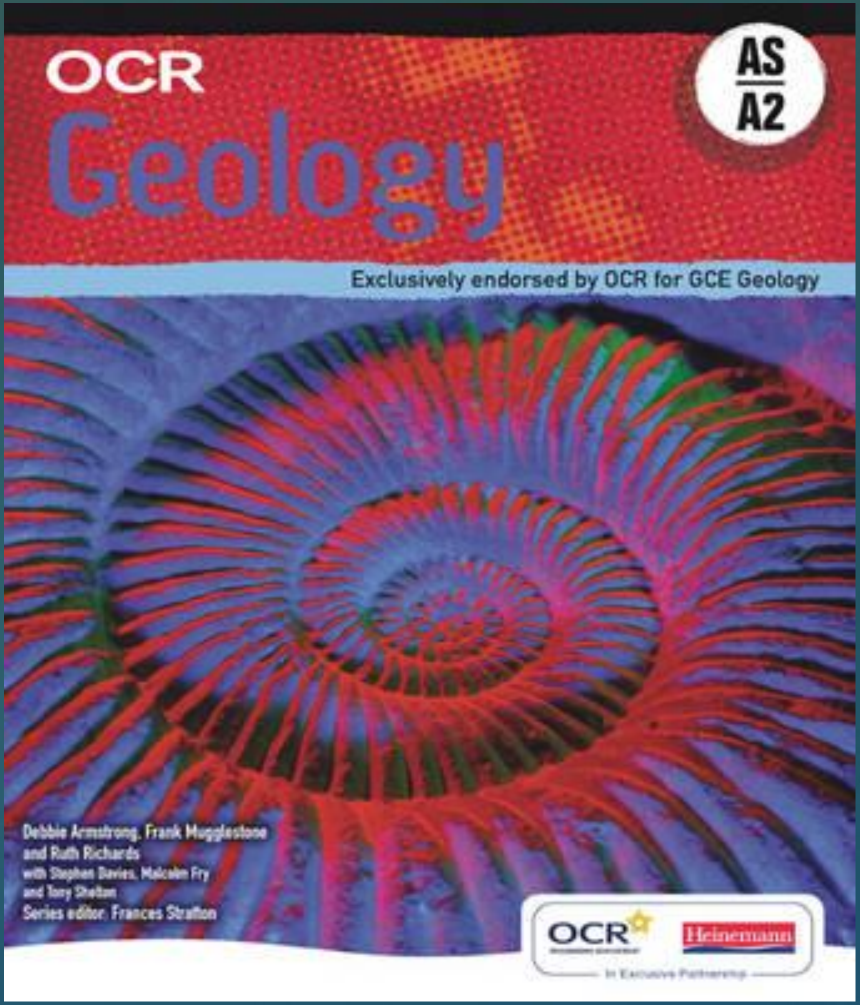
5.1 – Modern paleontology

"Were Deinonychus pack hunters?"



5.1 – Paleontology in the A2

-Fossilisation ✓
-Trace fossils ✓
-Trilobites
-Corals
-Brachiopods
-Echinoids
-Bivalves
-Gastropods
-Belemnites
-Graptolites
-Microfossils
-Cephalopods
-Evolution
-Amphibians
-Dinosaurs



So why are we studying all this?
What are some real life applications?
Always feel free to ask.

5.1 – Phylum Arthropoda

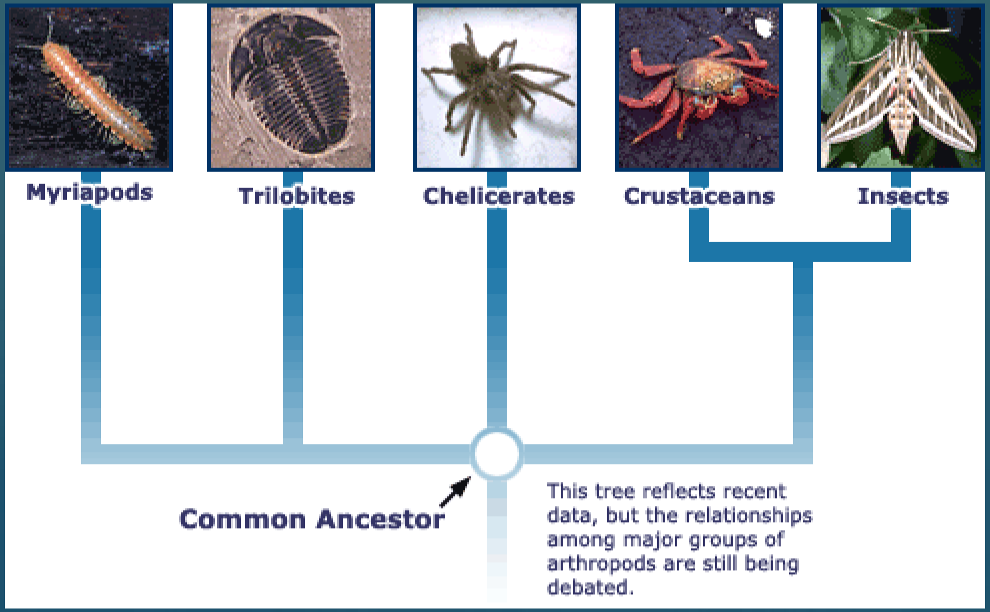
..But today, we are looking at Trilobites

5.1 – Phylum Arthropoda

..An invertebrate animal having:

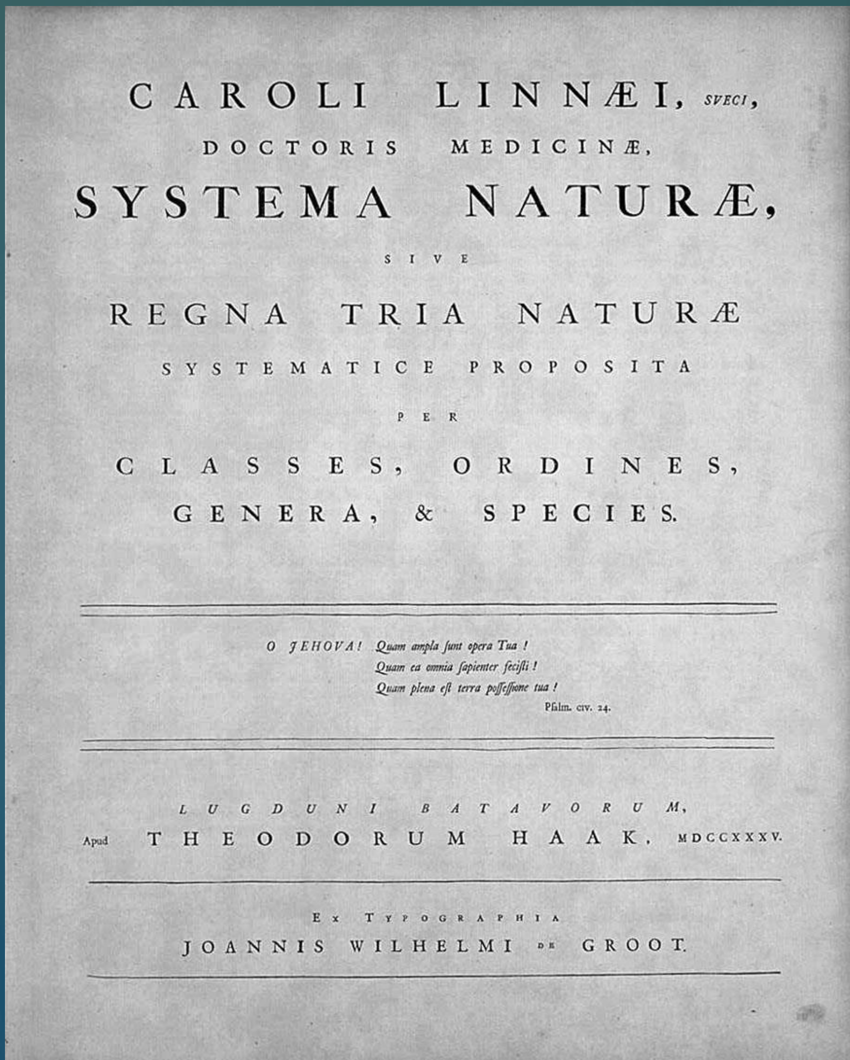
- An exoskeleton (external skeleton)
- A segmented body, and
- Jointed appendages (limbs)

Evolutionarily related, a single common ancestor:



5.1 – Phylum Arthropoda

-What is a Phylum?



CAROLI LINNÆI, SVECI,

DOCTORIS MEDICINÆ,

SYSTEMA NATURÆ,

SIVE

REGNA TRIA NATURÆ

SYSTEMATICE PROPOSITA

PER

CLASSES, ORDINES,

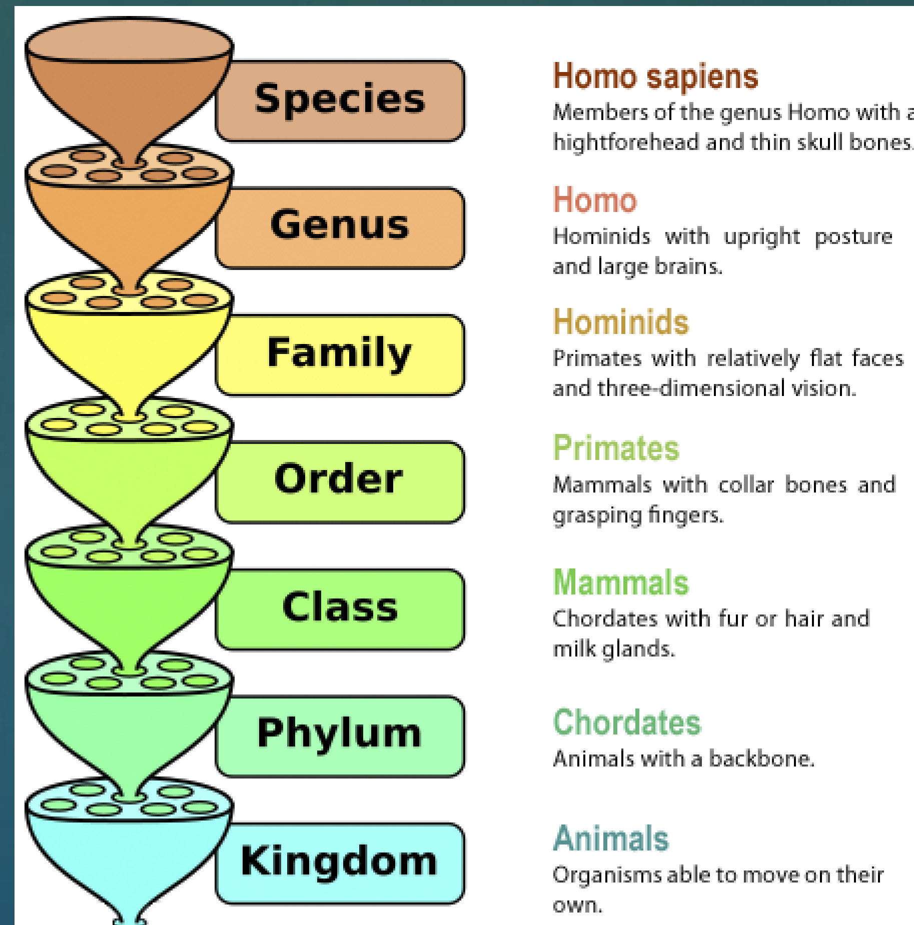
GENERA, & SPECIES.

O JEHOVA! Quam ampla ſunt opera Tua!
Quam ea omnia ſapienter feciſti!
Quam plena eſt terra poſſeſſione tua!
Pſalm. civ. 24.

LUGDUNI BATAVORUM,

Apud THEODORUM HAAK, MDCCXXXV.

Ex Typographia
JOANNIS WILHELMI DE GROOT.



5.1 – Phylum Arthropoda

-Highly successful/diverse group of invertebrate animals.

There are an estimated 30 million species of arthropods, mostly insects. This is **three-quarters of all currently known living and fossil species**

An inordinate fondness for beetles:

"The Creator would appear as endowed ***with a passion for stars, on the one hand, and for beetles on the other****, for the simple reason that there are nearly 300,000 species of beetle known, and perhaps more, as compared with somewhat less than 9,000 species of birds and a little over 10,000 species of mammals. Beetles are actually more numerous than the species of any other insect order.* ***That kind of thing is characteristic of nature****."*

- Haldane 1949

5.1 – Phylum Arthropoda

The most distinctive features:

1.

2.

3.

4.

5.

6.

5.1 – Phylum Arthropoda

The most distinctive features:

1. **Exoskeleton**

2. ...constructed of **chitin**

3. **Bilateral symmetry**

4. Segmented bodies

5. Many jointed **biramous appendages**

6. **Ecdysis** (moulting) and periodic growth

5.1 – Phylum Arthropoda

1. **Exoskeleton** and 2. constructed of **chitin (**and sometimes other materials)

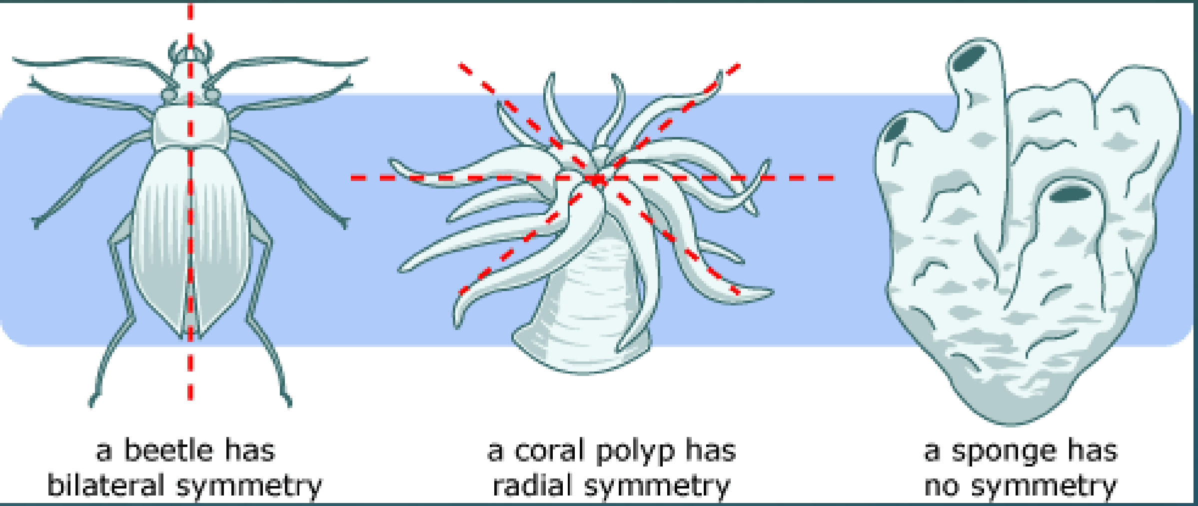
Provide roles in:

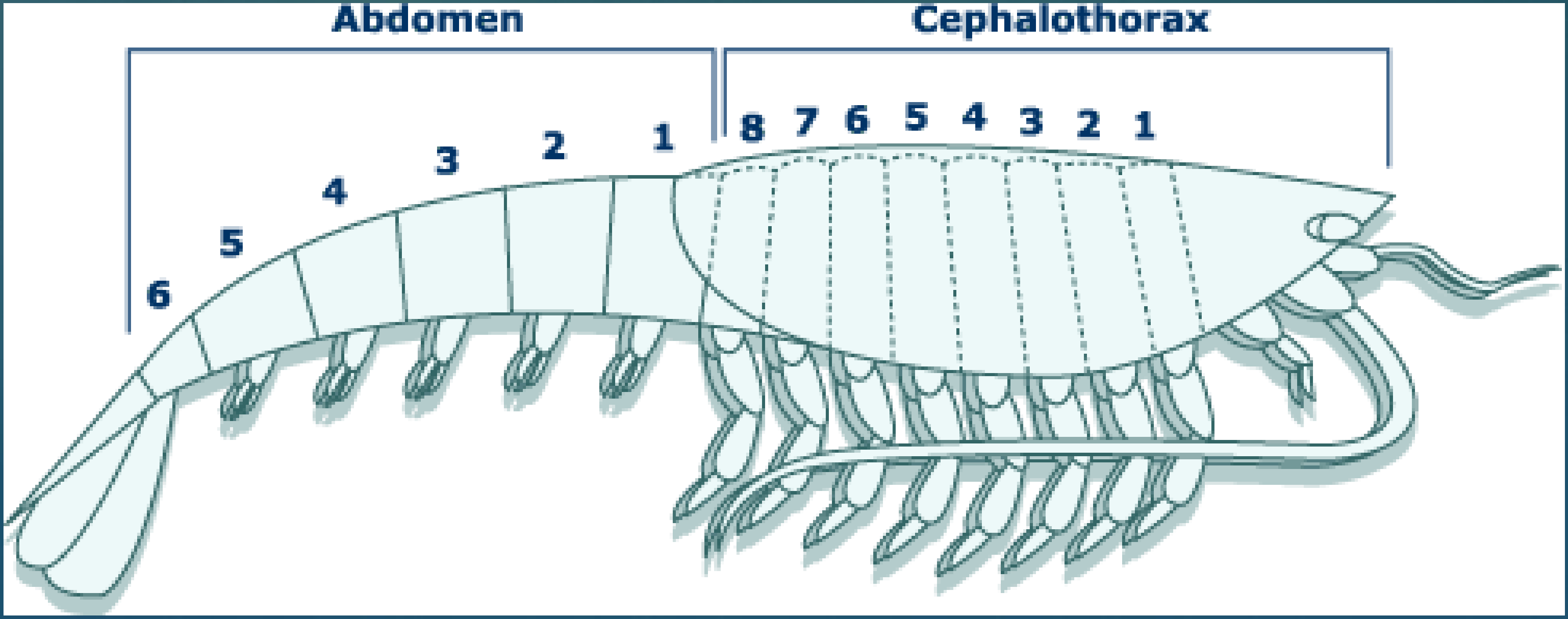
1. **Protection**
2. **Attachment** framework **for musculature**
3. A **barrier against desiccation** in terrestrial organisms.
4. Sensing

Chitin may be described as a modified form of cellulose.
The exoskeleton is constructed of three layers: waxy outer layer, chitin, inner layer proteins. **This is also sometimes impregnated with small calcite crystals as in Trilobites.**

5.1 – Phylum Arthropoda

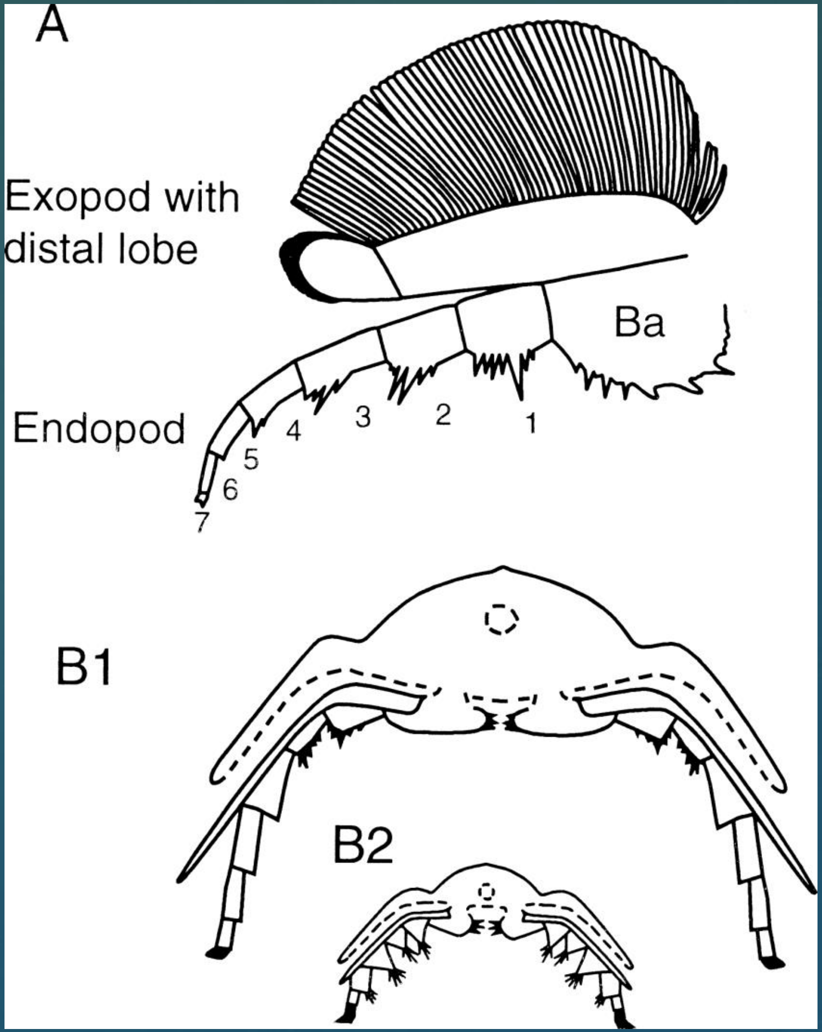
3. **Bilateral symmetry**
And
4. **Segmented bodies**





5.1 – Phylum Arthropoda

5. Many jointed **biramous appendages**



5.1 – Phylum Arthropoda

6. **Ecdysis** (moulting) and periodic growth

1. The animal stops feeding and its epidermis releases enzymes that digests the endocuticle.

2. The animal makes its body swell by taking in a large quantity of water or air, and this makes **the old cuticle split along predefined weaknesses**. **Known as Sutures**

3. It commonly takes several minutes for the animal to struggle out of the old cuticle. At this point the new one is wrinkled and so soft that the animal cannot support itself and finds it very difficult to move, and the new endocuticle has not yet formed.

4. The animal continues to pump itself up to stretch the new cuticle as much as possible, this then hardens the new exocuticle and eliminates the excess air or water.

5.1 – Class trilobita

Are a well-known fossil group of extinct marine arthropods that form the class Trilobita. Trilobites form one of the earliest known groups of arthropods.

Because trilobites had **wide diversity** and an **easily fossilized exoskeleton** an extensive fossil record was left behind!

Some 17,000 known species span the Palaeozoic.

This clade therefore has a lot to say about:
biostratigraphy,
palaeontology,
evolutionary biology
and **plate tectonics**

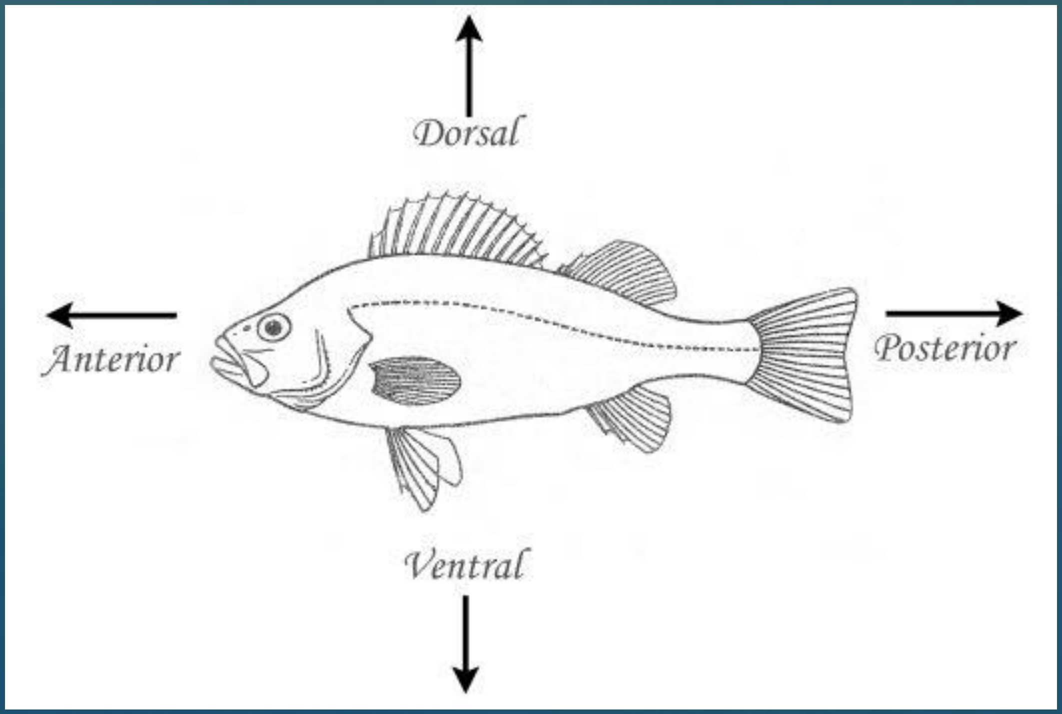
5.1 – Morphology

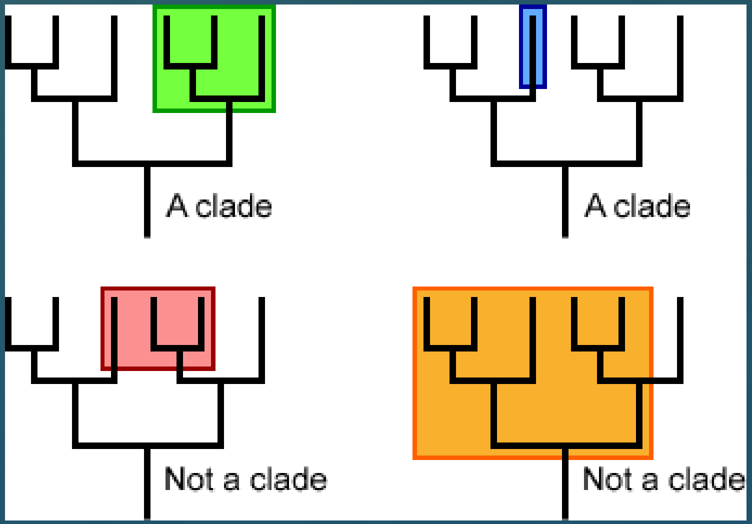
For the next few weeks, we're going to need to use a few general terms frequently:

- **Anterior** (front)
- **Posterior** (back)
- **Dorsal** (top)
- **Ventral** (bottom)

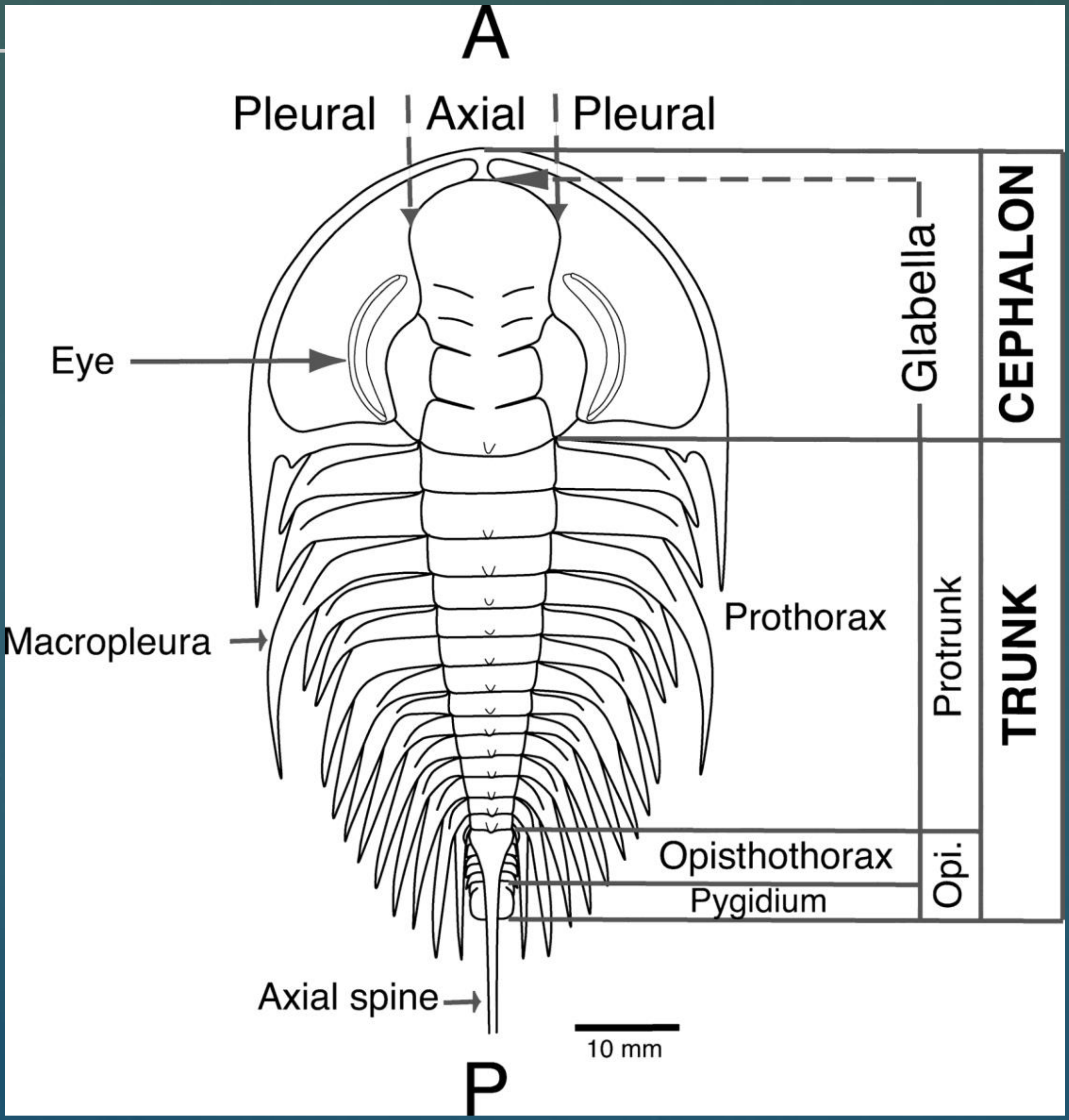
- Clade
- Evolutionary lineage
- **Extinct**
- **Extant**

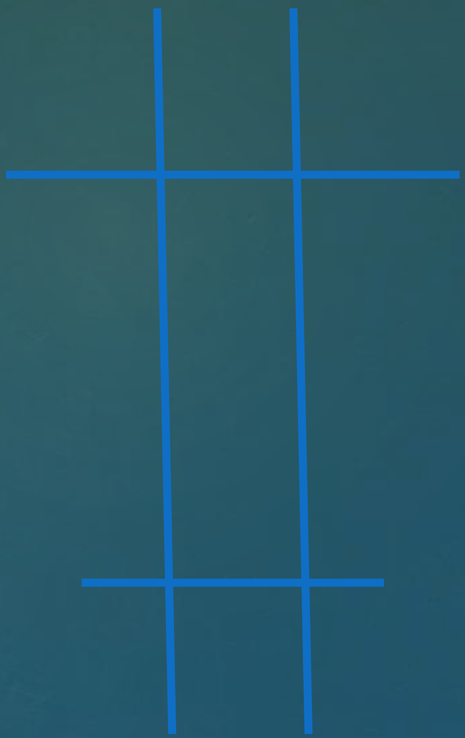
- **Morphology**
- Adaptive radiation
- Taxonomy
- and Many more





5.1 – Trilobite morphology

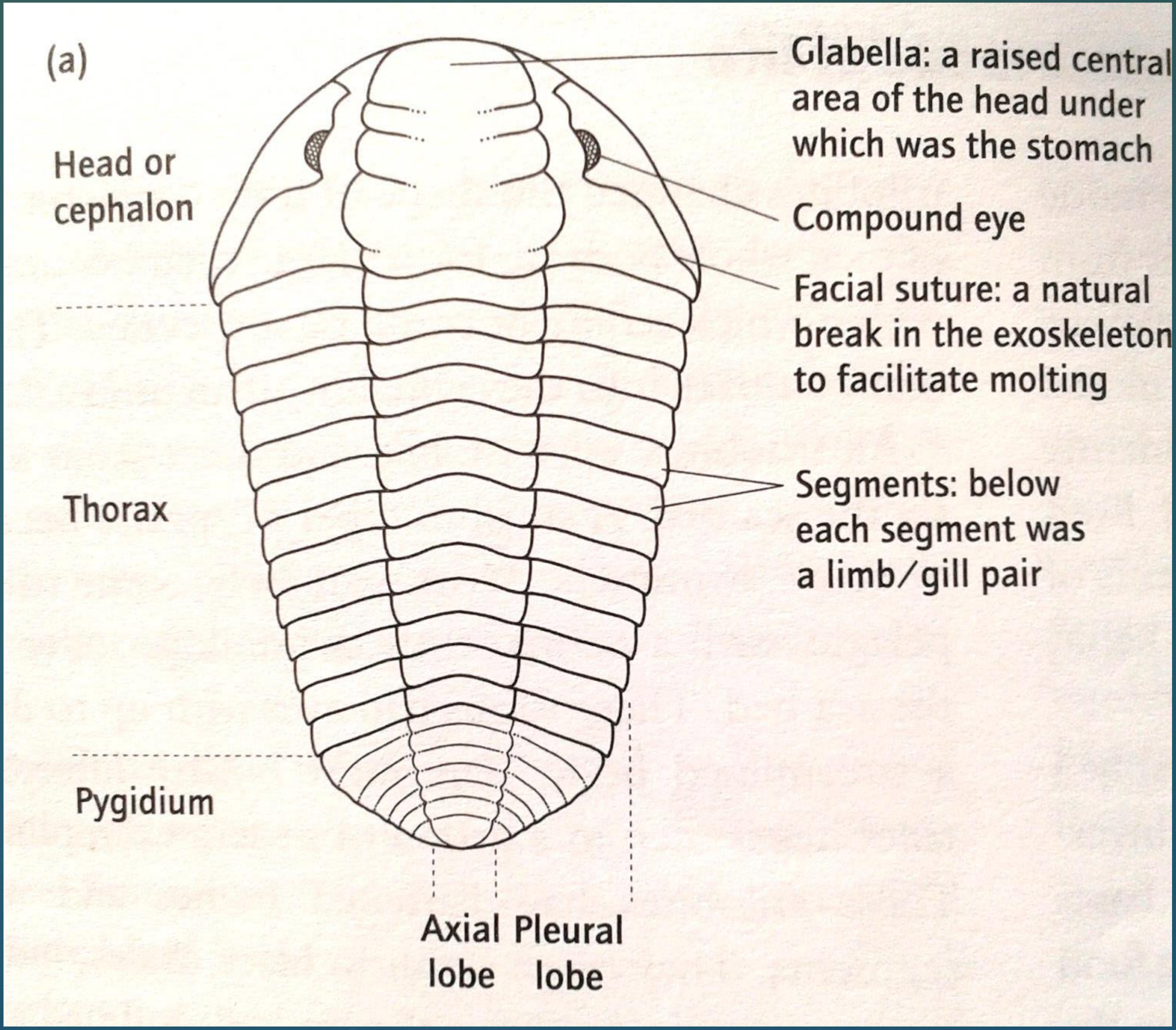




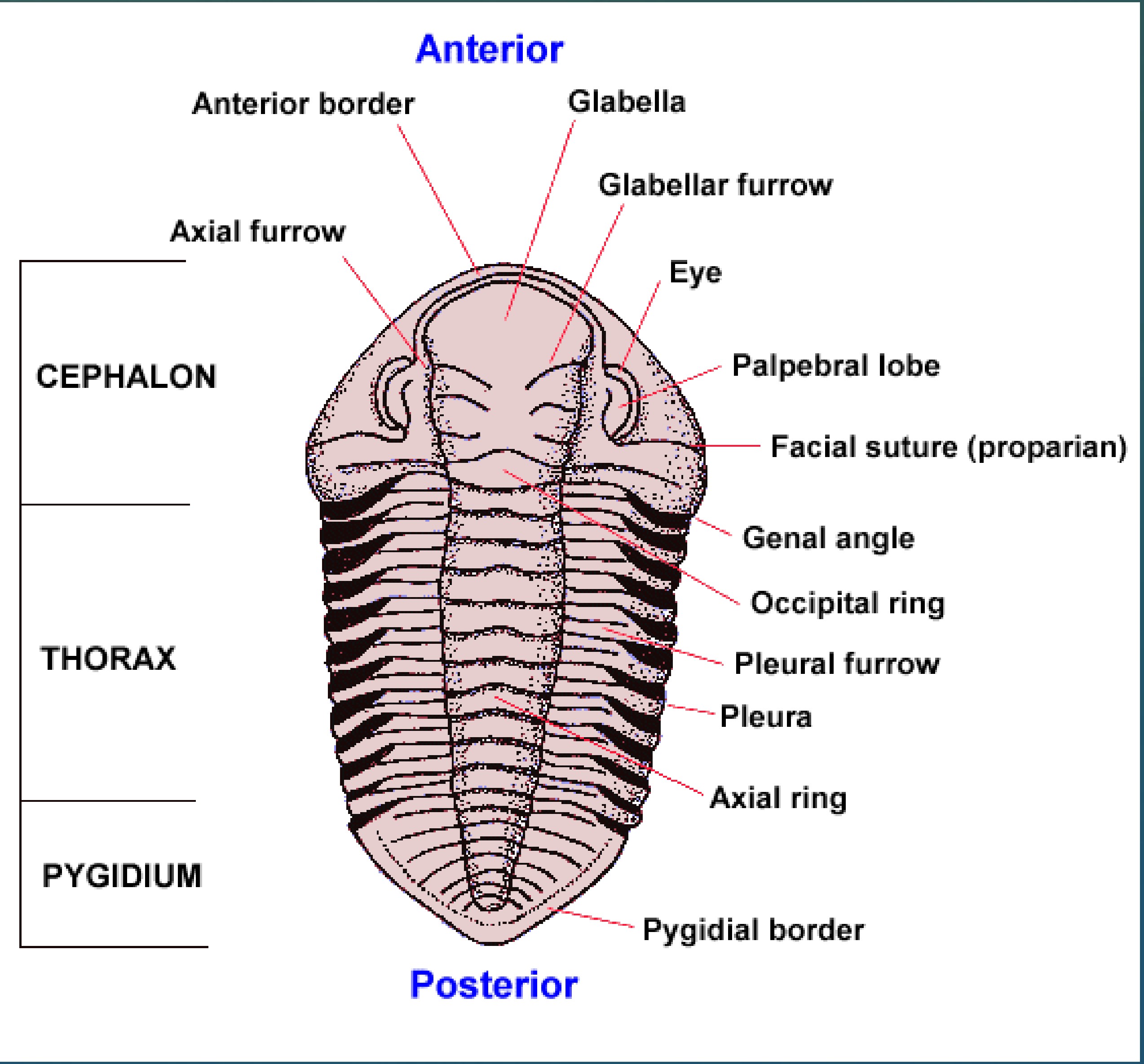
Trilobite

Tri is the prefix used for three, the trilobite body can be broken into three parts, both parallel and orthogonal to their axis.

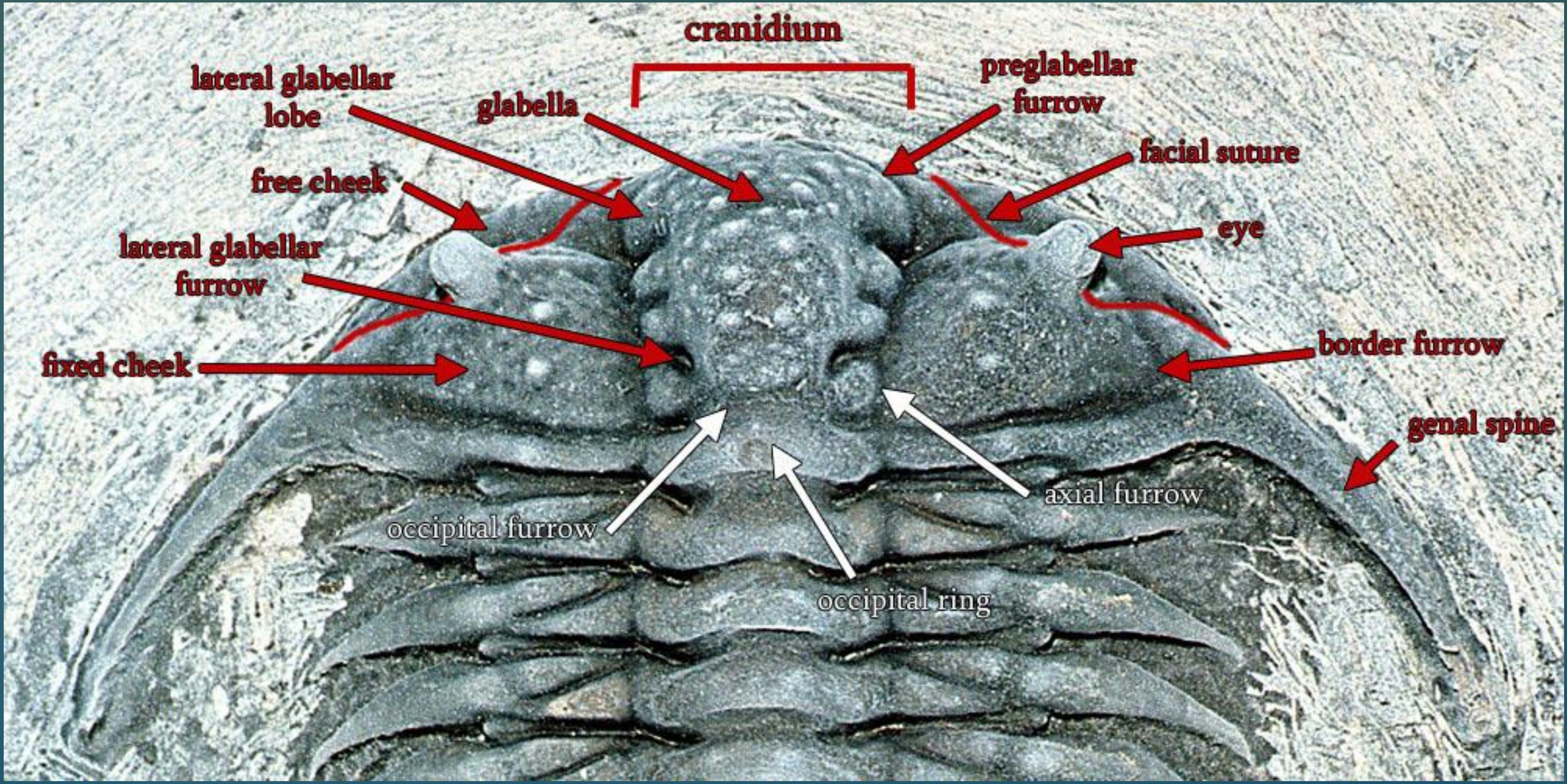
5.1 – Trilobite morphology



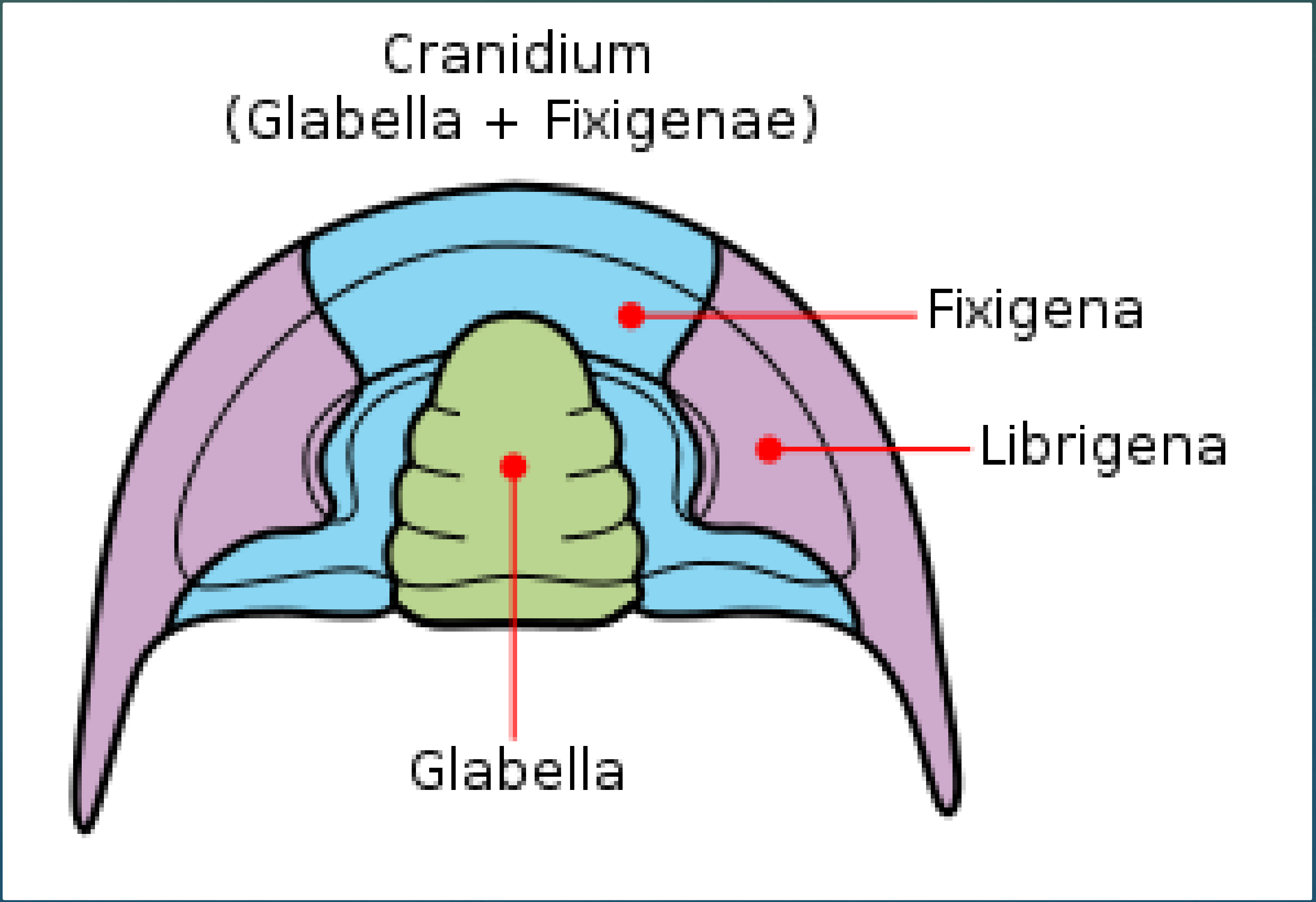
5.1 – Trilobite morphology



5.1 – Trilobite morphology



5.1 – Trilobite morphology



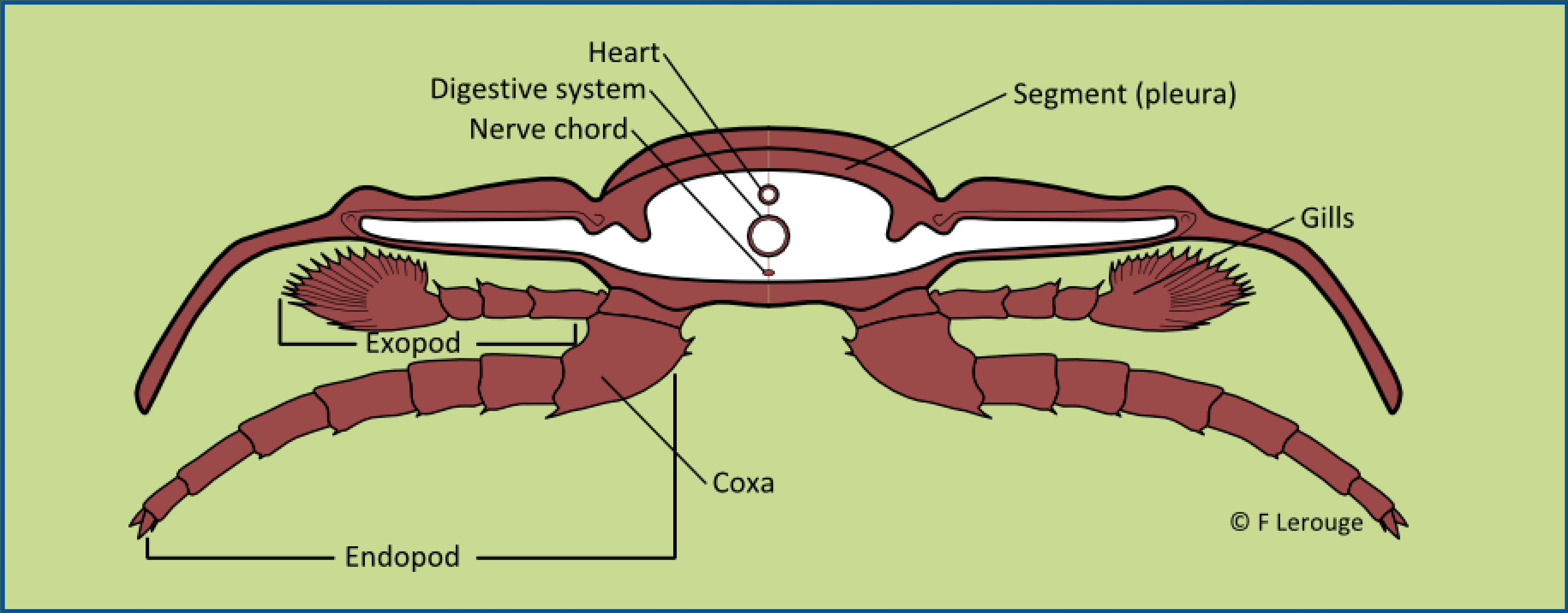
5.1 – Trilobite morphology

-**Glabella** – raised, central region that houses the stomach. The size of the glabella correlates to the size of the stomach, with large glabella being an indication of predatory diets. Alternatively this may be filled with gas for buoyancy.

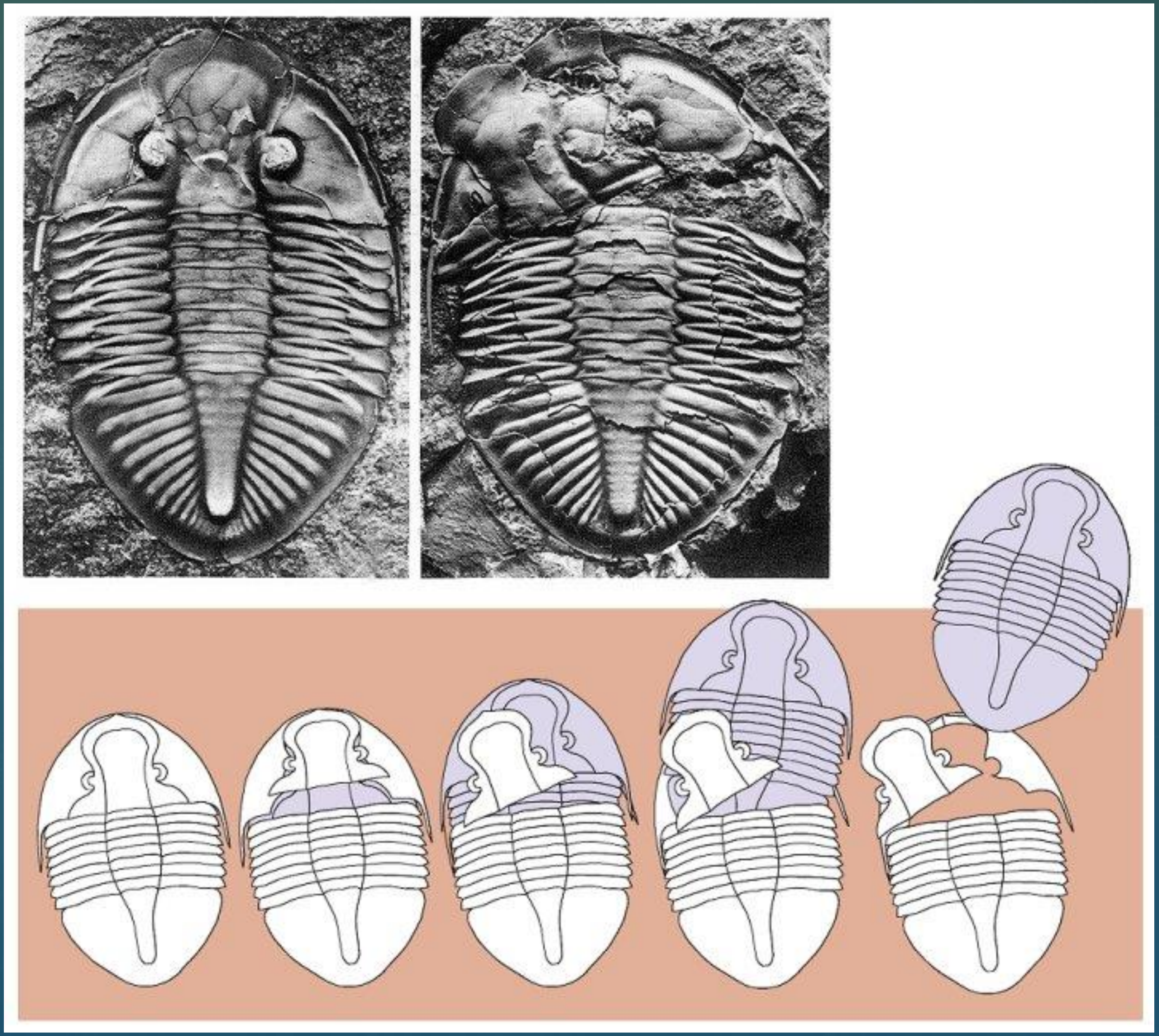
-**Hypostome** - the hard mouthpart in trilobites found on the ventral side of the cephalon. The hypostome can be classified into three types based on whether they are permanently attached to the rostrum or not and whether they are aligned to the anterior dorsal tip of the glabella.

-**Facial sutures** - the natural fracture lines in the cephalon of trilobites. Their function was to assist the trilobite in shedding its old exoskeleton during ecdysis .

5.1 – Trilobite morphology

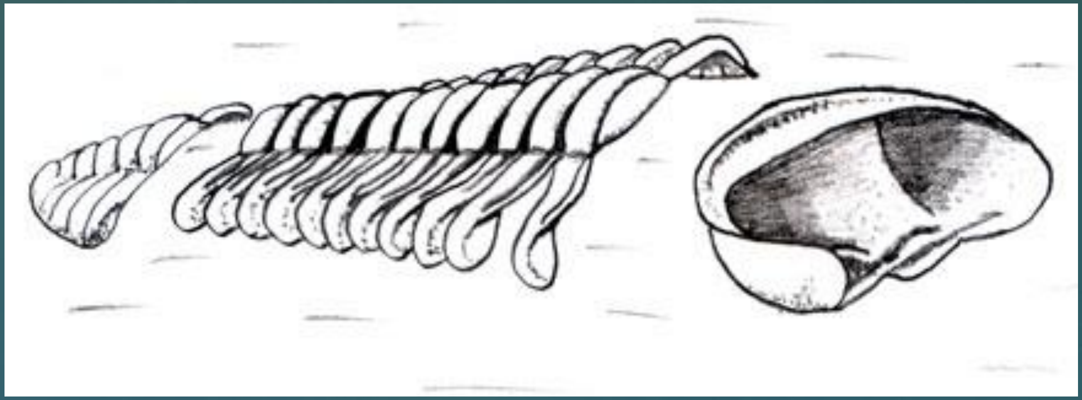


5.1 – Ecdysis in Trilobites



5.1 – Ecdysis in Trilobites

What does this phenomena mean for the fossil record?



In trilobites **moulting starts by fractures along facial sutures, separating the fixed cheek from the free cheek.**

The animal then wriggles free, forwards through this break.

5.1 – Break and problem sets

Q1. What role does the exoskeleton perform?

Q2. Below are some images of **enrolled** trilobites, what adaptive advantages might enrolling confer?

Q3. What are the most distinctive features of Arthropods? (we looked at 6)

Q4. Give two examples of extant arthropods

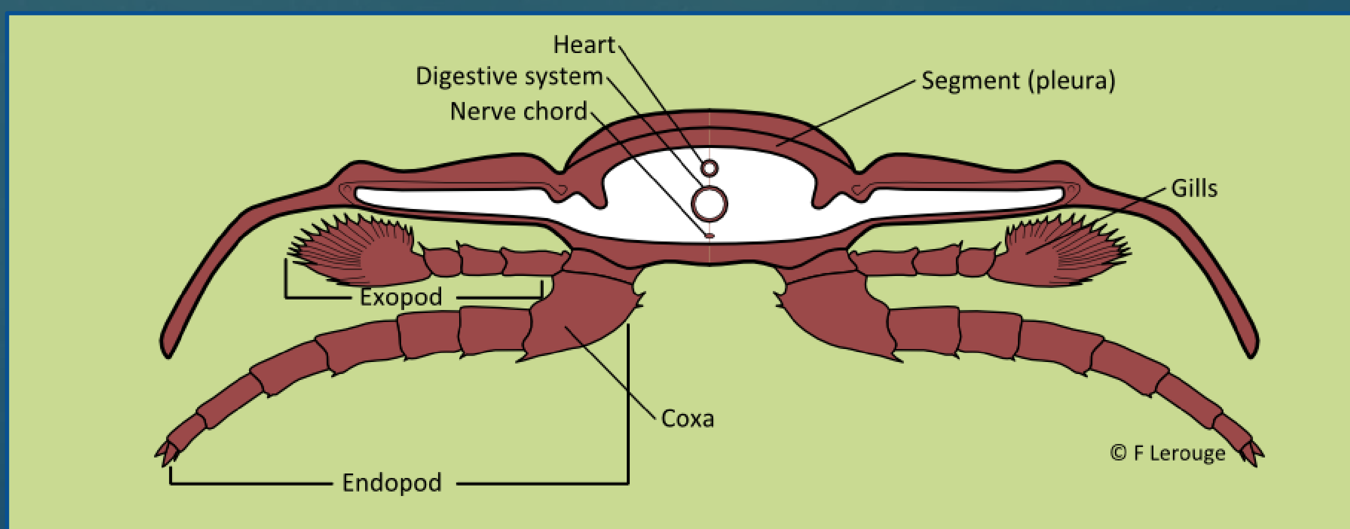
Q5. What impact might ecdysis have upon the fossil record?

5.1 – Answers

Q1. The exoskeleton has many functions; primarily these are: **protection**, **attachment for muscles**, a **barrier against desiccation** and sensory roles (hairs poke through the exoskeleton)

Q2. Enrolling is believed to be **a behavioural defensive response** to both **predation** and **high energy environments**. Trilobites have been found preserved on shallow sea floors, enrolled as a temporary shielding against high seas.

Q3. A X-section similar to the one drawn below, would be ideal:



5.1 – Answers

Q4. Arthropods have many distinctive features which might appear 'alien' to us: e**xoskeleton,** ...constructed of **chitin**, **bilateral symmetry**, **segmented bodies**, jointed **biramous appendages** and **ecdysis**.

Q5. Any of the 1,170,000 described living species (accounting for ~80% of all known animals).

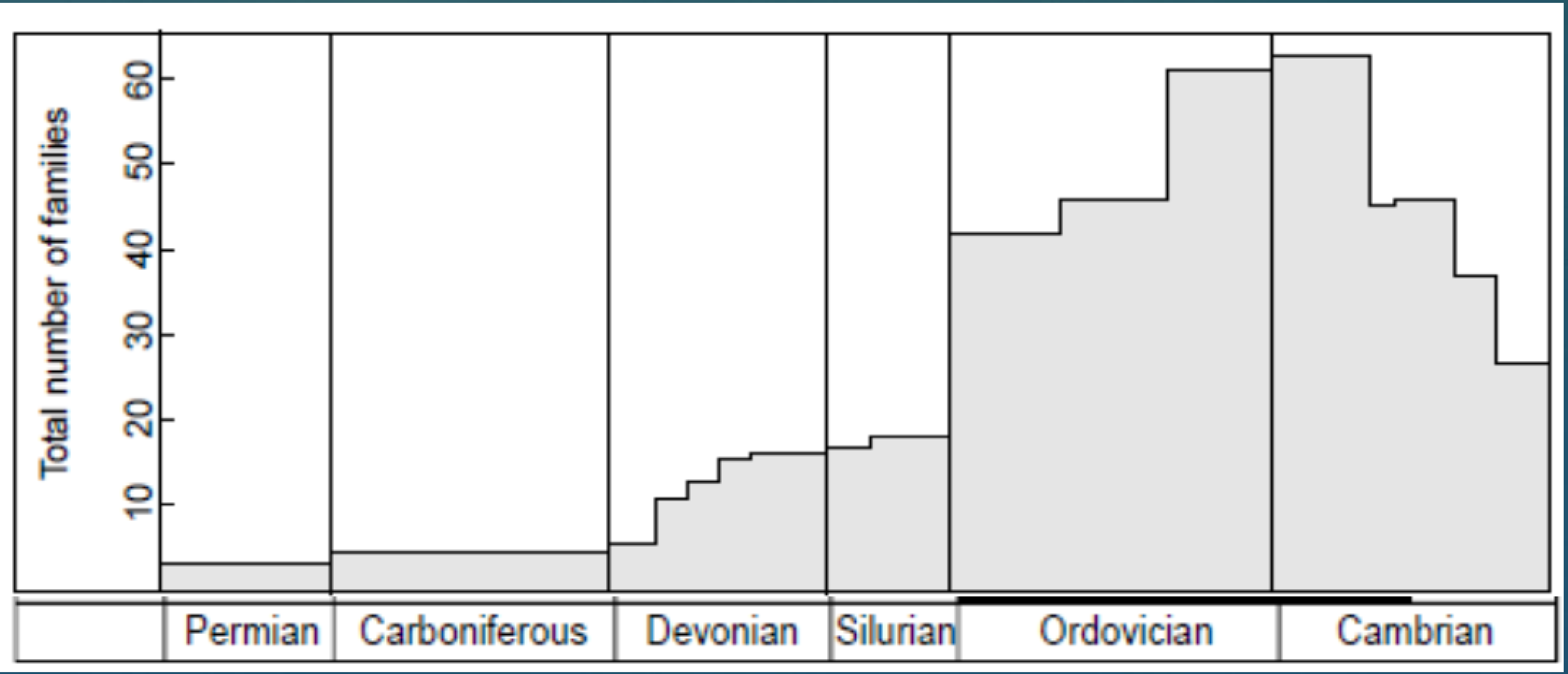
Q6. Ecdysis means arthropods will produce **multiple hard part exoskeletons** through it's life, these have a **relatively high fossilisation potential** leading to many 'copies' of themselves being produced throughout their life time.

Such activity increases the probability of fossilisation and biases the fossil record towards organisms with this trait.

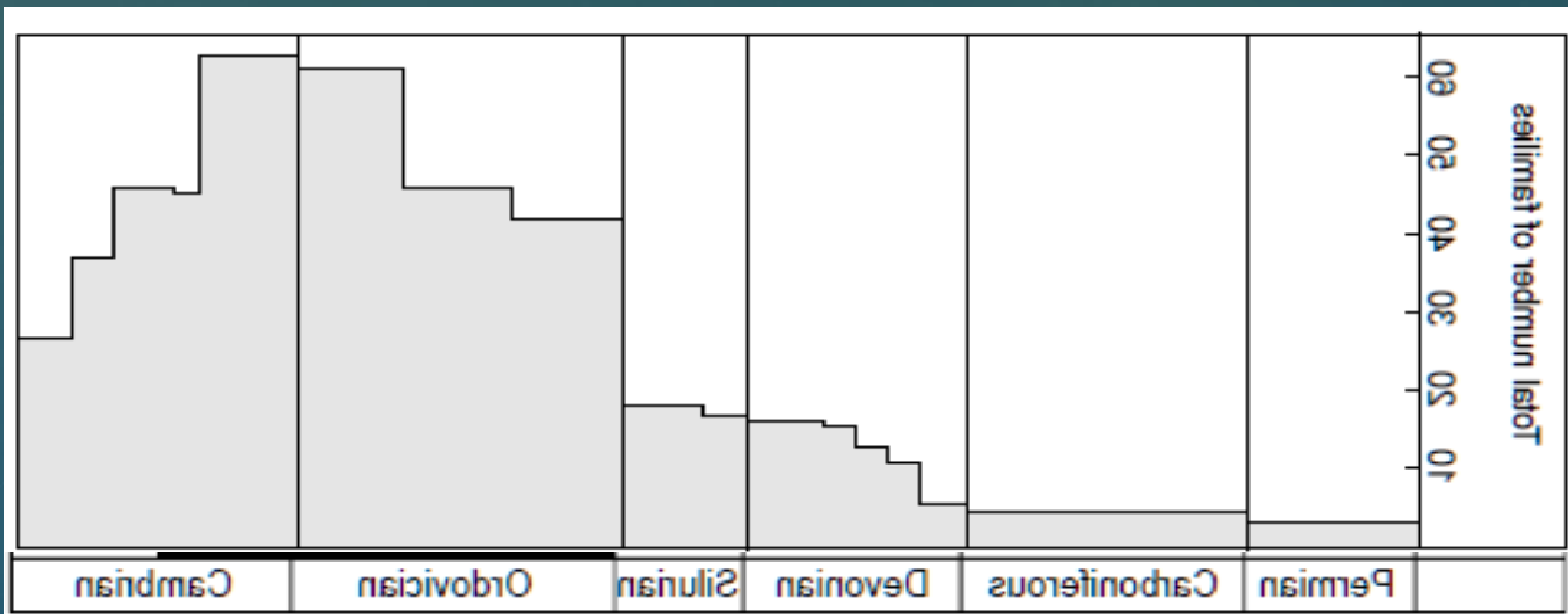
5.1 – Adaptions of trilobites

-Principal evolutionary trends from primitive morphologies include:

- The origin of new types of eyes
- Improvements in enrollment and articulation mechanisms
- Increased size of pygidium (micropygy to isopygy)
- Development of extreme spinosity
- Narrowing of the thorax and increasing or decreasing numbers of thoracic segments



5.1 – Adaptions of trilobites



5.1 – Adaptions of trilobites

... extracting food from it. These ... Most of these lifestyles are shown in Fig. 8.2.

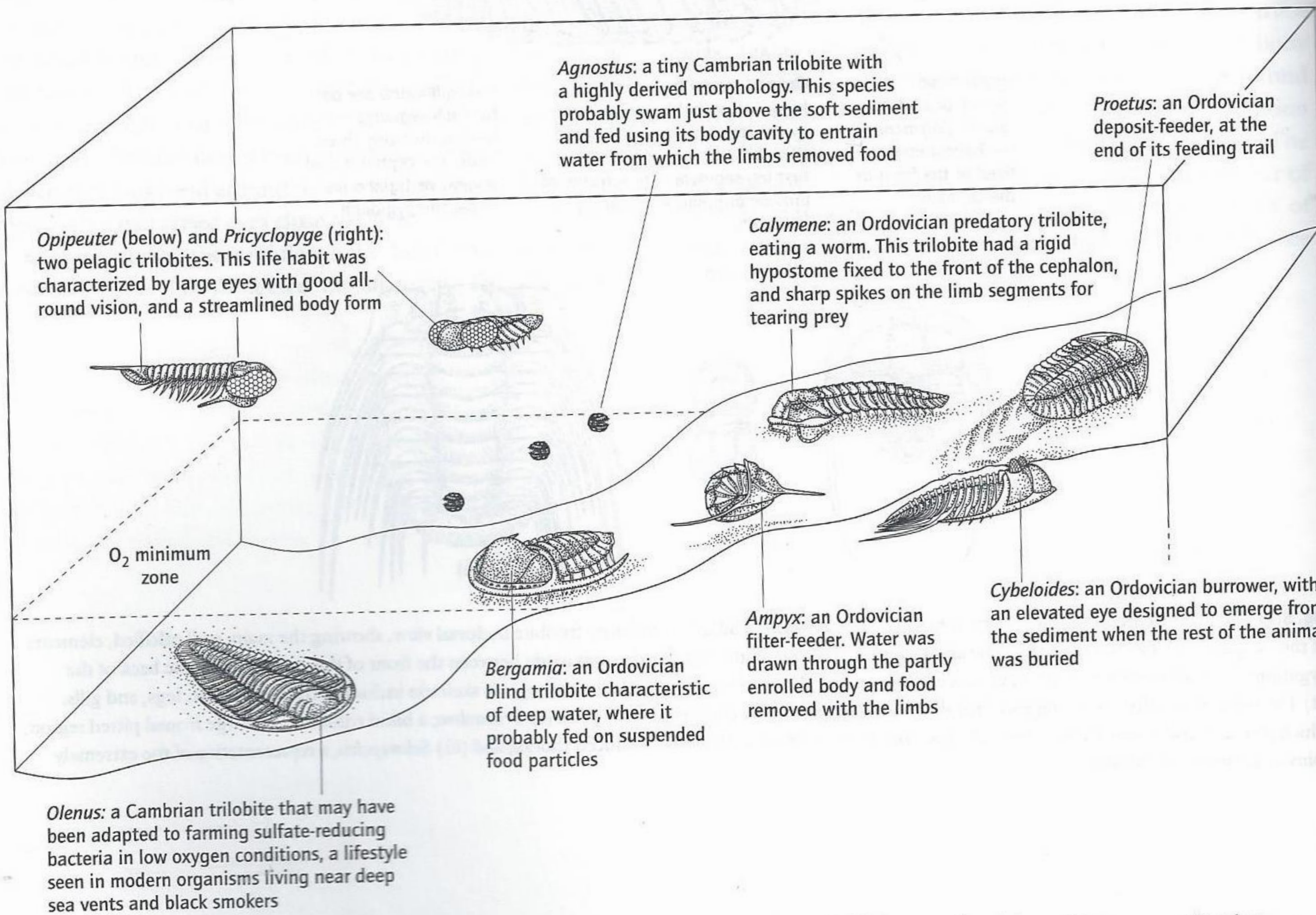


Fig. 8.2 A reconstruction of a range of late Cambrian to Silurian trilobites showing their probable life habits and positions. The reconstruction deepens from right to left, and there is an oxygen minimum zone above the sea bed in the extreme left of the image. All trilobites were marine.

5.1 – Adaptions of trilobites

Exoskeletal architecture, hypostomal morphology and mode of life of Silurian and Lower Devonian dalmanitid trilobites – Geosciences 2007

The overall exoskeletal architecture and hypostomal morphology of Silurian Dalmanites and Lower Devonian Odontochile, Reussiana and Zlichovaspis are compared and discussed. All four genera were benthic. However, a gradual shift from predator-scavenger to a scavenging feeding habit is inferred from the evolution of these dalmanitids in the Upper Silurian and Lower Devonian. In the more conservative, probable predator-scavenger Dalmanites, the posterior hypostomal doublure has a group of robust denticles: these would have been effective shredding structures, enabling milling or cutting of food into smaller particles, and allowing Dalmanites to deal with mechanically relatively robust prey. Lower Devonian dalmanitids from the Prague Basin possess a comparable denticulate structure on the posterior hypostomal doublure. However, although overall exoskeletal dimensions are larger, the denticles are significantly finer and denser. The whole exoskeleton of these younger dalmanitids, with a large multi-segmented pygidium, is considered well adapted for close approximation to the sediment surface. Shallow burrowing in a soft substrate, and scavenging with opportunistic predation, is therefore considered to be their main feeding habit. Odontochile, Reussiana and Zlichovaspis characteristically occur in micritic limestone facies, where the sediment surface is likely to have been soft. The shift from a more predatory to a dominantly scavenging mode of life may have occurred independently in several unrelated dalmanitid groups.

5.1 – Adaptions of trilobites

Abstract:

However, a gradual shift from predator-scavenger to a scavenging feeding habit is inferred from the evolution of these dalmanitids in the Upper Silurian and Lower Devonian. In the more conservative, probable predator-scavenger Dalmanites, the

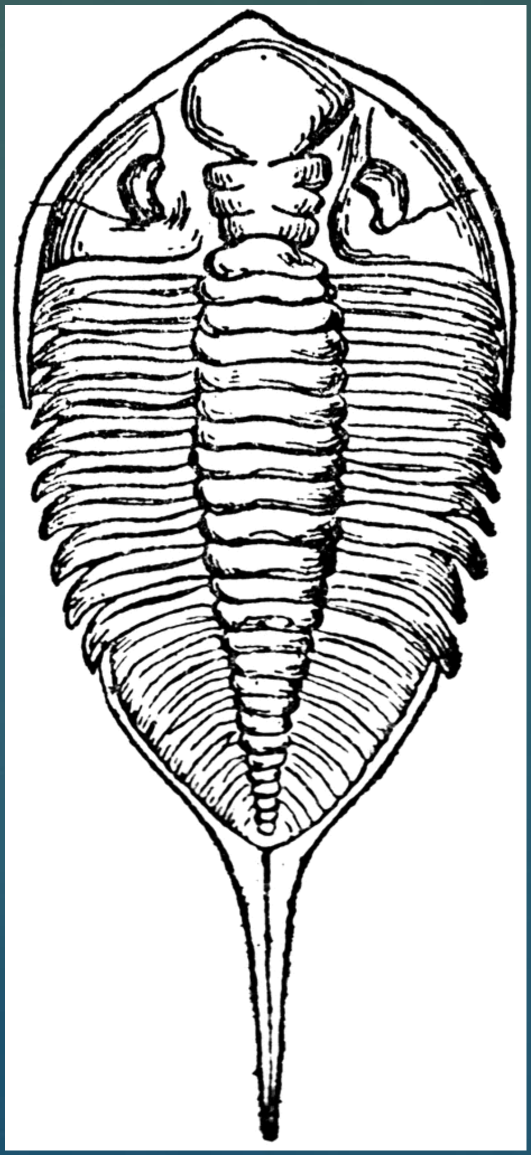
-"Posterior hypostomal doublure has a group of robust denticles"

Inferred for : "effective shredding structures, enabling milling or cutting of food into smaller particles, and allowing Dalmanites to deal with mechanically relatively robust prey."

Another group: "The posterior hypostomal doublure. significantly finer and denser." and "a large multi-segmented pygidium"

Inferred for " well adapted for close approximation to the sediment surface. Shallow burrowing in a soft substrate, and scavenging with opportunistic predation, is therefore considered to be their main feeding habit."

5.1 – Adaptions of trilobites



5.1 – Summary and the specification

This lesson introduced Trilobites, the first of the fossil species we are going to study, we covered the morphology of trilobites and the process of ecdysis.
The specification requires you to:

"Know the morphology of trilobites…"

(a) Describe the trilobite exoskeleton: **cephalon, thorax, pygidium, glabella, compound eyes, facial suture, free cheek, fixed cheek, spines, pleura,** nature and position of the legs and gills, and explain the inferred functions of these features.

So make sure you know where all these pieces belong on the trilobite body and what they do.

Next week we'll be looking at specific trilobite genera and their modes of life.

5.1 – How might this be examined?

Composite short answer questions…

"Fossil G shows a dorsal and ventral view of a benthonic trilobite. Label the following morphological features on the appropriate diagram:

genal angle
glabella
mouth
pleuron

4 marks

The diagram below shows a cross section through the thoracic segment shaded on fossil G.

Draw and label the position of the gills and legs on the above diagram.

2 marks

Give two pieces of evidence to support the hypothesis that fossil G is an arthropod

2 marks

This was from Jun 2006.

5.1 – Further Reading

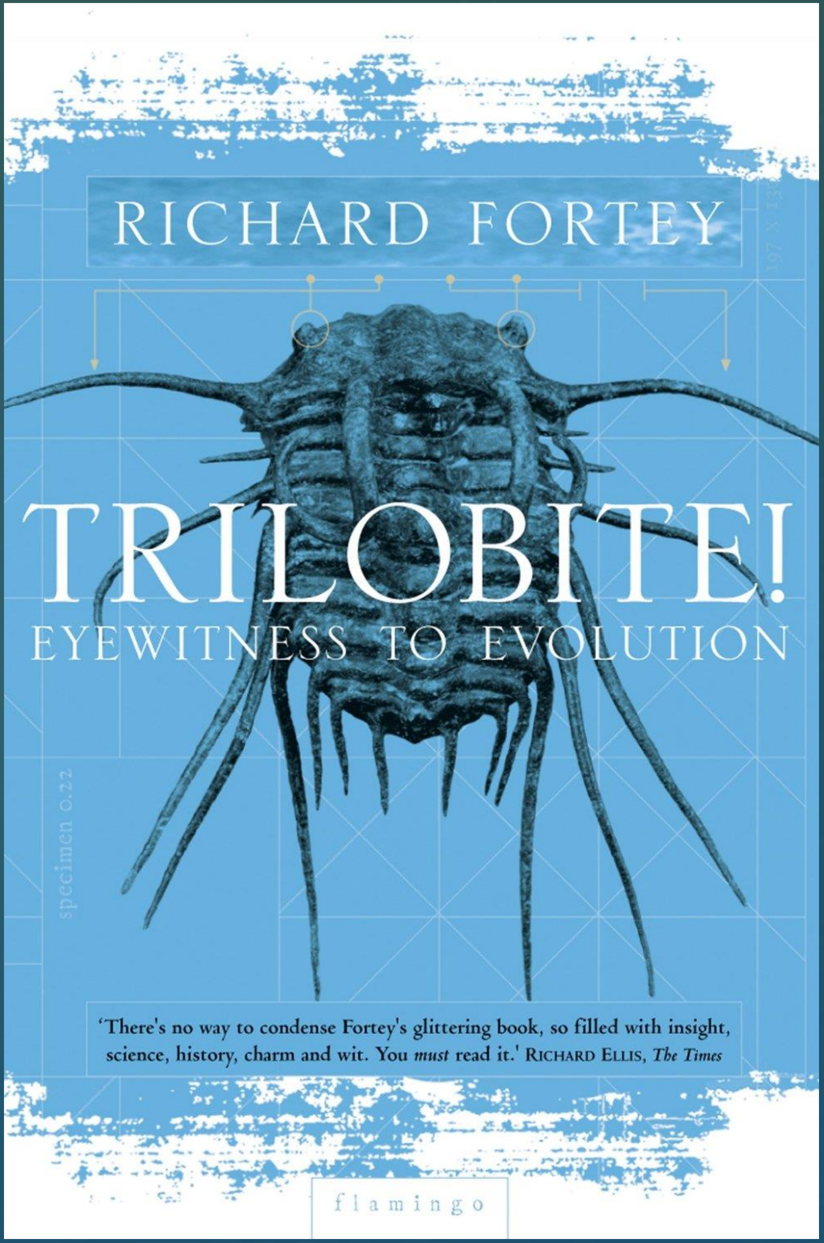
Fossils at a Glance
By Clare Milsom and Sue Rigby
Chapter 8 – Pg. 53-60

What are Trilobites? (Online resource)
http://www.trilobites.info/trilobite.htm

This online resource is amazing, it can tell you everything there is to know (pretty much) about trilobites.

First life (BBC Documentary)
By David Attenborogh

Trilobite!
Eyewitness the Evolution
By Richard Forety



5.1 – Extra time?

Attenborough on Trilobites:

http://www.youtube.com/watch?v=Epw-uKBYQVI

Apologies for the suboptimal quality.

5.1 – Morphology

In this course you will have to learn the morphology of each fossil species we study.

The OCR course focuses intently on the morphology of species, and how this relates to their **mode of life**, **evolutionary history** and **adaptions to the environments in which they live**.

You can therefore see why it is important that we covered evolutionary theory at the beginning of this course, and why I have included so many morphlogicaly/anatomical images of the fossil animals we are going to study.

The easiest way to learn the morphology of each species is to introduce them in the class slides, discuss their peculiarities and then…

For you to draw schematic sketches of the animals and label the most important parts. This will help you remember, understand and recall them for the exams!