NAUTILOIDS AND AMMONOIDS

CLASSIFICATION

Phylum: Mollusca

Class: Cephalopoda

Order: Nautiloids & Ammonoids

-The class now contains two, **only distantly related, extant subclasses**: **Coleoidea**, which includes o**ctopuses, squid, and cuttlefish**; and **Nautiloidea,** represented by **Nautilus**

Nautiloids and **Ammonoids** are sub-classes (**orders**) of the class Cephalopoda.

Modern cephalopods **are marine dwellers** and tend to be predators such as squid, cuttlefish and the octopus. One living Cephalopod, the Nautilius, has an **external shell**, a survivor from the days when cephalopods were extremely successful in the **late Palaeozoic and Mesozoic seas**. They are **globally distributed** throughout geological history.

The variety/biodiversity shown in cephalopods makes the a useful fossil **zone indicator** for the **Mesozoic**, Nautilius provides valuable information on how fossil cephalopods functioned and their **mode of life**.

Coleoidea (internal shell)

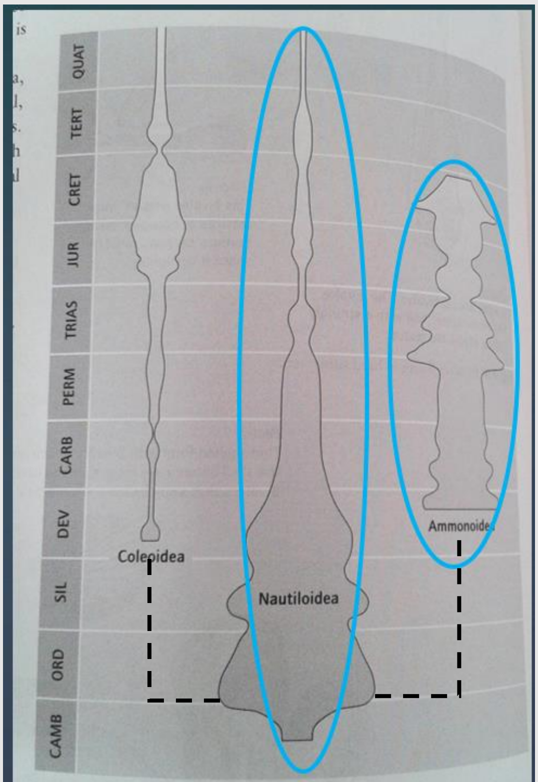


Fig. 9.9 Diversity of cephalopod subclasses through geological time.

Nautiloids (external shell)

<u>Key terms</u>

- **The body chamber** is the cavity where the animal lived.
- **The protoconch** is the initial, embryonic shell in the centre of the coiled animal. New chambers are added onto this as the animal grows.
- **Septal necks** are where the septa are pierced to allow the tube of soft tissue (siphuncle) through. Septal necks extend to support the soft tissue.
- **The septum** is the wall of the chamber. This is the back wall when it is part of the body chamber.
- **A siphuncle** is a continuous delicate tube connecting all the chambers.

- **A suture** is a line along which the septum of the shell fuse.
- **The umbilicus** is the diameter of the depression between the inside margins of the last coil.

TYPES OF COILING

Almost all Ammonoids and Nautiloids are **planispirally coiled**. This means that the shell **coils in a single horizontal plane** (with the **diameter increasing** away from the axis of coiling/centre) opposed to a helical coiling system.

However, there are 2 forms of coiling mode:

Involute coiling The inner coils are almost completely hidden by more recent coils. This type of coiling is demonstrated by Nautilius. Involute coiling results in a narrow umbilicus, and presumably a weaker shell(?).
This type of coiling is shown by the Nautilus.
Evolute coiling Describes a coiling growth opposite to involute, in which the inner coils are easily seen, they are NOT hidden by more recent coils, giving a wider umbilicus.
This type of coiling is common in Ammonoids

NAUTILOIDS

~ Cambrian to recent (with their acme in the early Palaeozoic)

- Extant and fully marine
- Often found in early Palaeozoic rocks (much, much less in recent strata). Some species of Nautiloids had shell ornament with spines and ribs, but most have a smooth shell.
- Their shells are formed from aragonite. The modern Nautilus is shown below.

The modern-day Nautilus lives in a coiled shell, which originates at a **protoconch**.

As the organism grows in the final body chamber, it se**als off older chambers** with a wall called a **septum (plural septa)**. These then are empty chambers joined by a narrow tube called a **siphuncle.** The siphuncle extends all the way back to the original chamber and can be used to alter the **proportions of gas and liquids** in the chambers. This, in turn, helps control the position of the organism in the **water column.**

The shells of fossil Nautiloids may be either straight (i.e. orthoconic as in Orthoceras **NOT BELEMNITES**), curved (as in Cyrtoceras) coiled (as in Cenoceras).

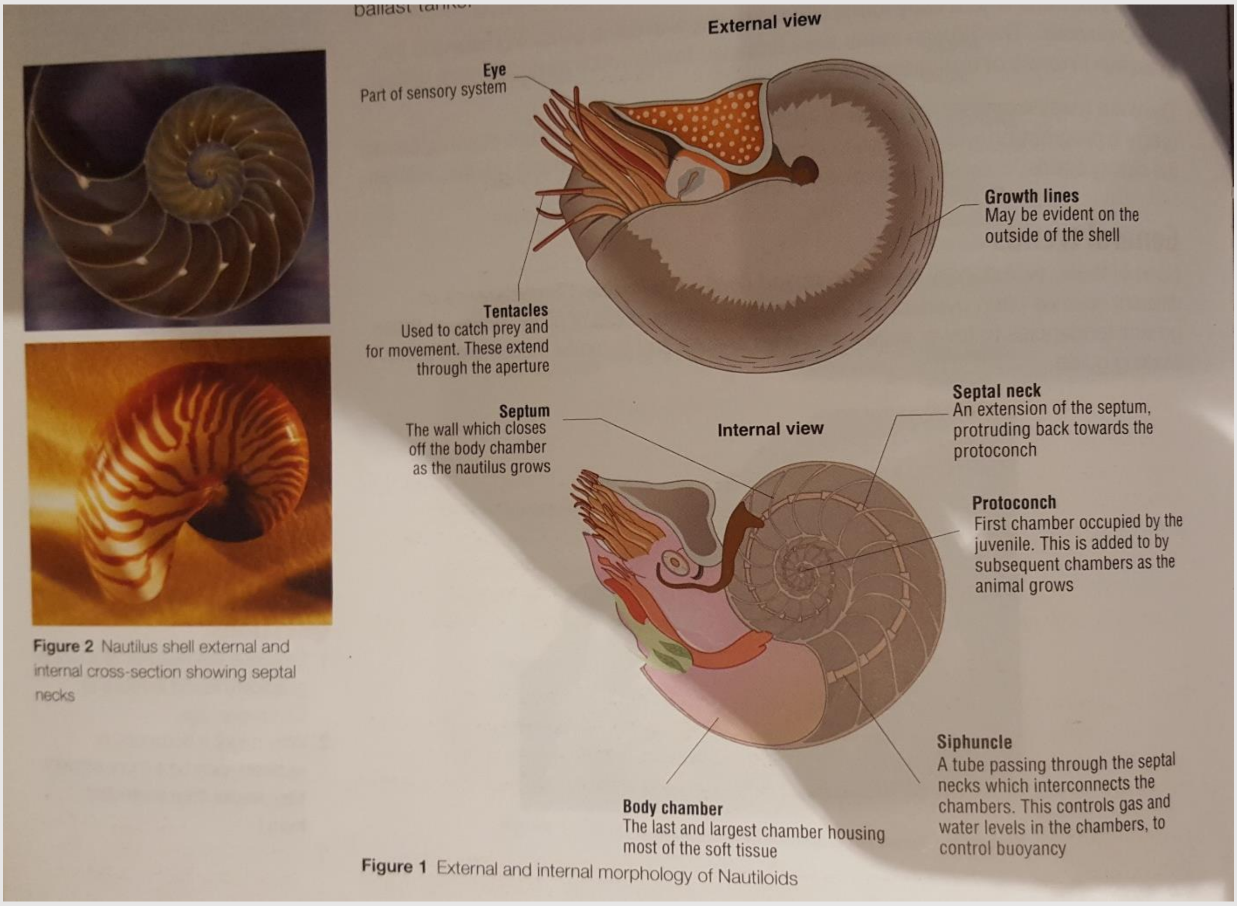


Figure 2 Nautilus shell external and internal cross-section showing septal necks

Figure 1 External and internal morphology of Nautiloids

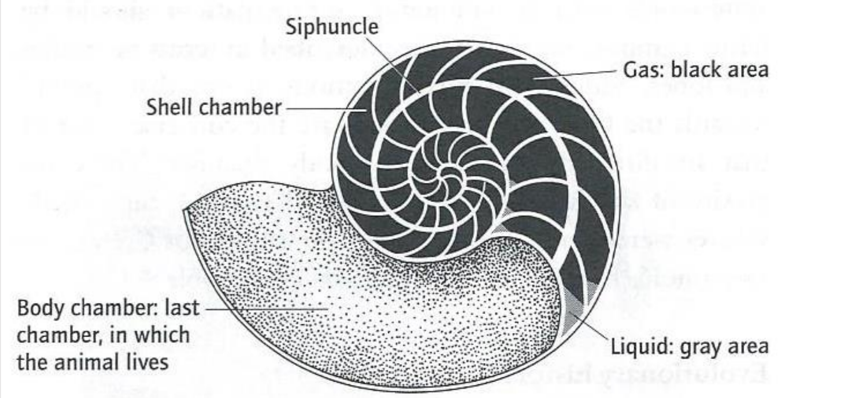
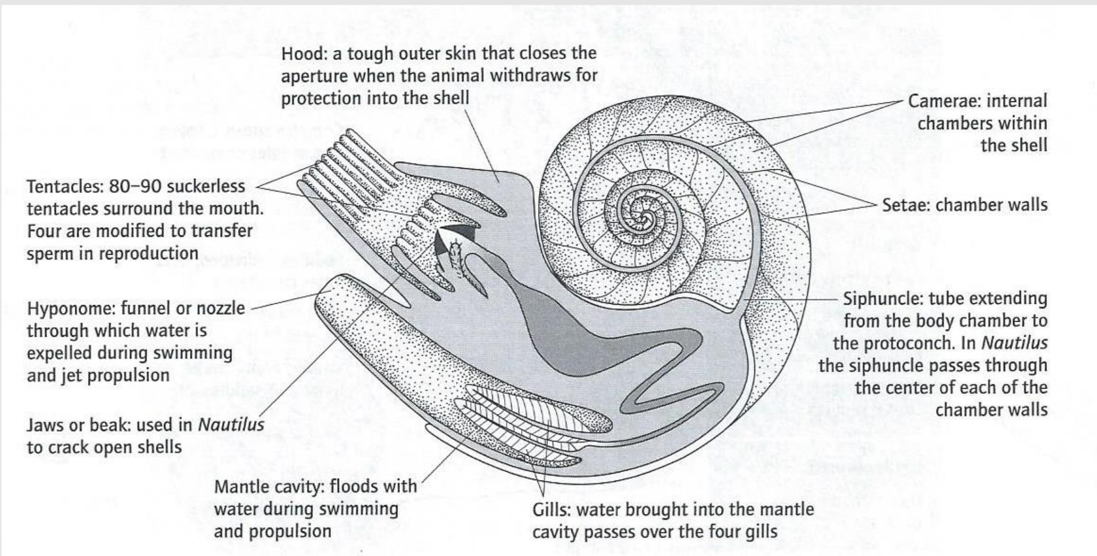
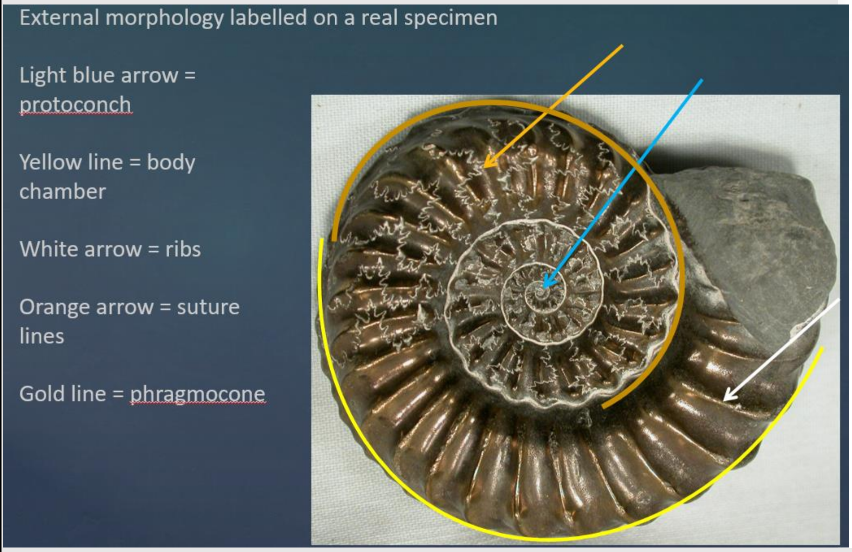


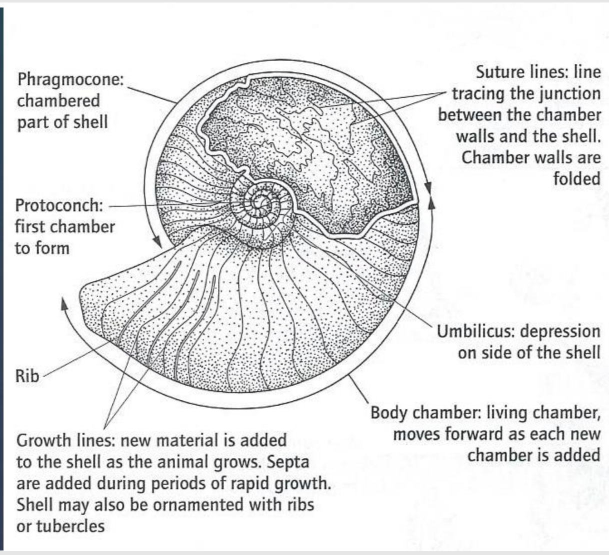
Fig. 9.11 The buoyancy mechanism of *Nautilus*.



AMMONOID MORPHOLOGY

- Ammonoids are an **extinct group** of invertebrates. Counter-intuitively they are more closely related to living Coleoids than they are to shelled Nautiloids. The earliest Ammonoids appeared **during the Devonian**, and the last species died out during the **Cretaceous-Tertiary (K-T) extinction event**.
- Ammonites are excellent index fossils. It is often possible to link the rock layer in which a particular species or genus is found to specific geological time periods, to accuracies of just 100 000 years!
- Their fossil shells usually take the form of **planispirals**, although there were some helically spiralled and non-spiralled forms.
- In contrast to Nautiloids, their coiling is **evolute** and there may be **ornament** such as **ribs** on the exterior of the shell.
- Some also have **a keel**, which stuck out from the **outer margin** and probably **provided stability** when the cephalopod **was in motion**.
- Some forms have a slot in **the outer** (**ventral) margin** called a **sulcus**, which presumably had the same effect.





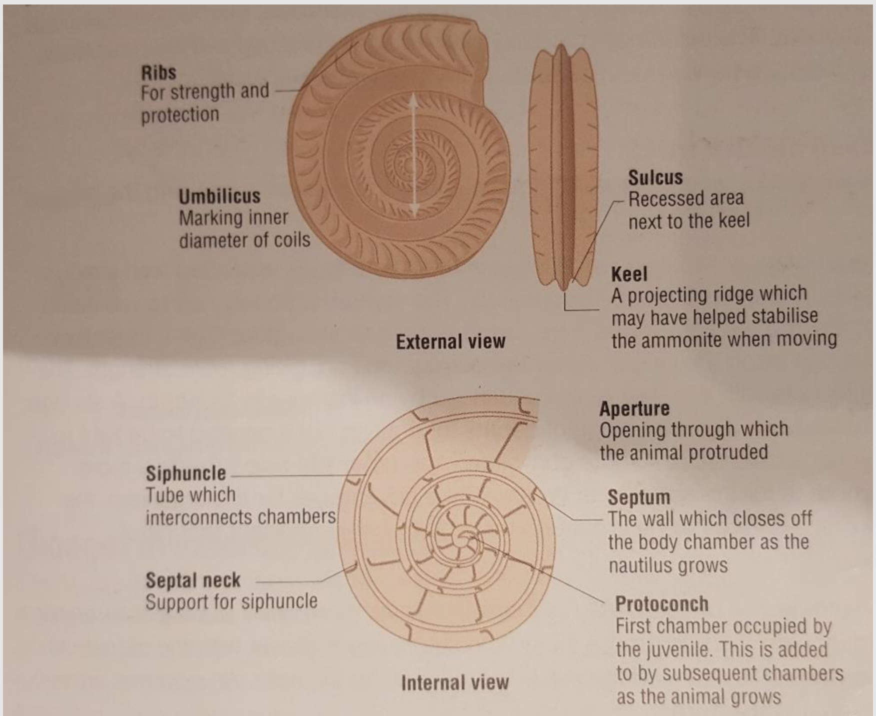
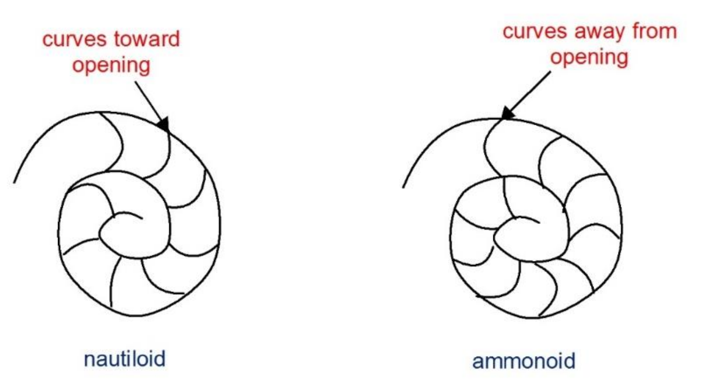


Figure 3 External and internal morphology of ammonoids

A GOOD METHOD FOR DETERMINING THE DIFFERENCE BETWEEN AMMONOIDS AND NAUTILOIDS.

1. If the internal shell/fossil can be observed then this method is useful. The shape of the septa curvature differs between Nautiloids and Ammonoids (not to be confused with ribs which are external).



2. A Nautiloid shell will usually be smooth on the exterior with no ornament or ribbing. In contrast, an Ammonoids shell can have ornament and ribbing on its exterior. Some also have a keel and sulcus that stuck out from its outer (ventral) margin.

3. Another big difference is that Nautiloids will tend to be involute producing a narrow umbilicus. Ammonoids, however, are commonly evolute with a wider umbilicus in relation to its size.
   Remember, this is much harder to tell is a fossil specimen has been sliced in half to see earlier coils.

4. The Siphuncle of a Nautiloid will always connect the body chamber to the original chamber through the CENTRE of all previous chambers. In Ammonoids, the siphuncle also interconnects previous chambers but it has the tendency to run closer to the outer (ventral) margin rather than the centre.
5. The sutures of Nautiloids tend to be more regular and simple (straight like orthocone Nautiloid cephalopods) or gently curved. Modern Nautilus only shows the curvature of septa. Ammonoids, however, tend to have complex sutures with crenulations. Ammonites show such frilly and complex sutures on both lobes and saddles that they are termed ammonitic sutures.

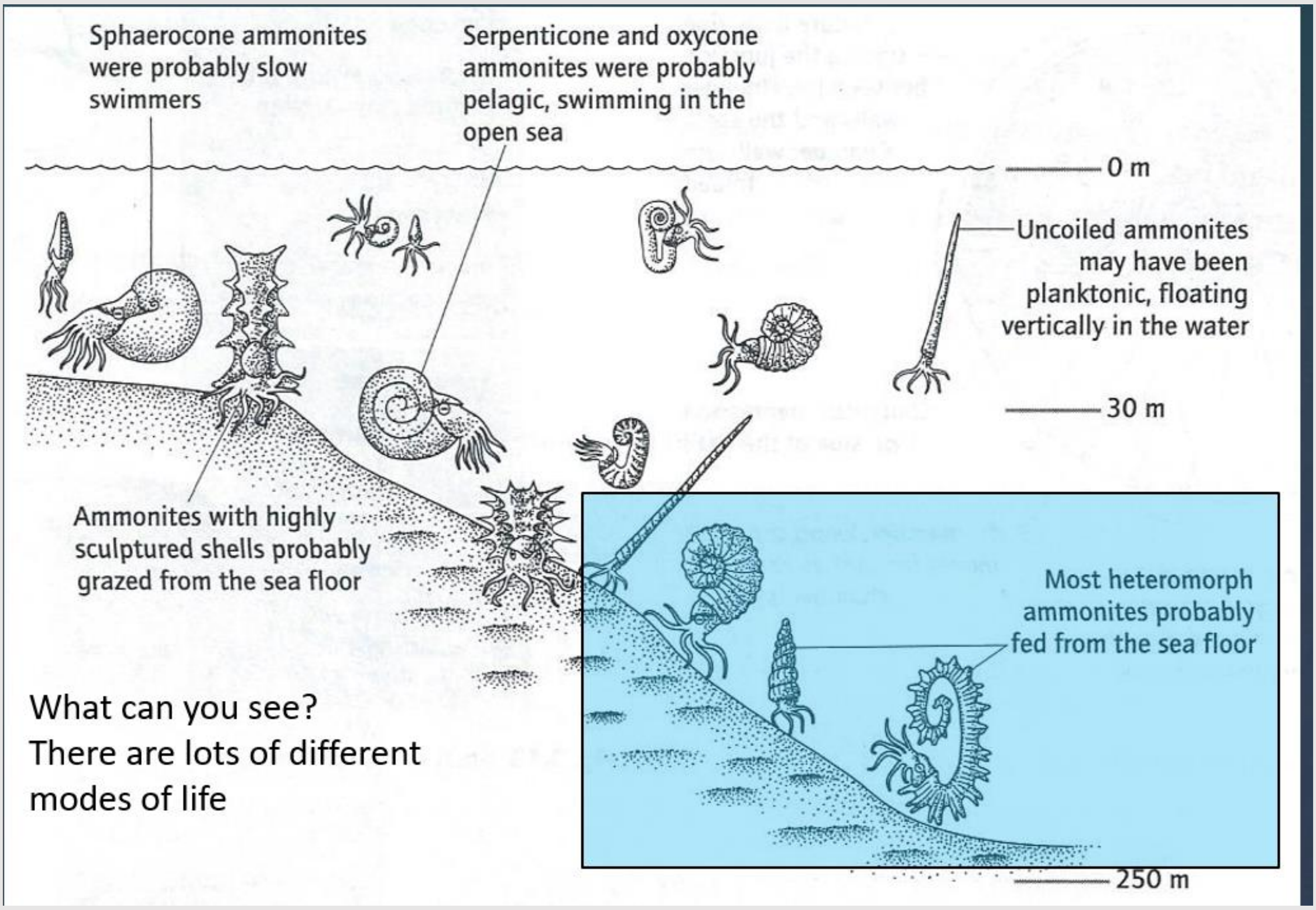
AMMONOID MODES OF LIFE

All Ammonoids were pelagic and nektonic but they occupied different parts of the water column and fed of different prey/food types. Their locomotive mechanisms varied.

Nektonic – lateral movement	**Tentacles** are used to provide a **gentle swimming motion** in some living species; those same tentacles could have been used to pull the creature along the seafloor. They may also have used a **jet propulsion** method to propel l the cephalopod **backwards.** In a time of danger in the water, which is **circulated through the mantle for respiration**, water can be forcibly expelled through a **tube beneath the tentacles** called the **funnel**. The funnel can be pointed to provide some choice of direction but always backwards.

Nektonic – vertical movement	The empty chambers all possess a **mixture of gas and liquid**. The gas is **nitrogen-rich**. The relative volumes of liquid and gas can be adjusted **using the siphuncle**; where more gas increases the buoyancy causing the cephalopod to rise in the **water column** but more liquid causes it to sink. Nautilus moves up from **400m depth to 70m depth** (a d**ecrease in nearly 40 atmospheres**) at night **to feed**.
Hunter killer	Evidence suggests that cephalopods were **predatory creatures,** hunting their prey. This does not necessarily mean that they were fast moving, the **jet propulsion** could just be **for emergency** usage to escape.

It is predicted that Ammonoids were hunter **predators, seafloor grazers** on continental shelves and also **opportunistic predators** since their jet propulsion system is not for hunting but instead emergency escape. They did not have to move fast unless they were being predated.



A modern day Nautilus could move vertically and horizontally in the water column. Explain how this movement is brought about (4 marks)

This lateral movement *is brought about my a jet propulsion nozzle beneath the tentacles which expels water which had been inhaled into the mantle cavity (for respiration). The jet is positioned so the Nautilius can choose* ***which direction*** *it wants to move back towards.*

The ***vertical movement*** *is caused by* ***varying proportions of gas to liquid*** *inside the chambers of the animal. This ratio determines the position of the animal in the water column, increasing the amount of liquid causes sinking and increasing the gas stored will cause levitation.*

Ammonoids are all pelagic and nektonic but could have lived in:

- ***Neritic*** *(shallow waters)*
- ***Pelagic*** *(deeper water)*
- *The* ***abyssal plain (****incredibly deep 3-5km)*

MORE ON CEPHALOPOD EVOLUTION

Nautiloids were the earliest of Cephalopods (evolving in the early Palaeozoic - more precisely the **upper Cambrian**). Many early Nautiloid shells were not curled but instead rather straight. They were known as **orthocone Nautiloids**. They were **prolific** (**=plentiful**) in the Palaeozoic but only the coiled forms survived through to the Mesozoic.

By **the upper Devonian**, Ammonoids evolved and were clearly distinct from the Nautiloids. They remained relatively unchanged until the Triassic when they began to diversify.

Some of these were extinct by the end of the Permian in a major extinction event. One surviving family went on to **populate the Jurassic seas with rapid evolution.** After the Jurassic, they declined through the Cretaceous while also producing some unusual forms as they did (see the **heteromorphs**) and were finally wiped out in the **K-T event (Cretaceous-Tertiary).**

Surprisingly, the Nautiloids managed to live through to this present day albeit with dwindled numbers. The belemnites probably evolved from the **straight-shelled (orthoconic) Nautiloids** during the upper Carboniferous - their closest living relatives are squid.

CHANGES IN SUTURE LINES

The Suture lines mark where the wall of the chamber, the septum, fuses with the inside of the shell. It is most well-believed that the changes in suture lines are linked with strength and the ability to exploit different environments.

The septum were exposed to high pressures and the **early forms were simply domes to strengthen** them. Later forms had **crenulations** along them, rather like **corrugated** iron, giving it more strength.

The **strength of the join** to the shell is also enhanced by the **increase in length**.
A stronger shell is advantageous in that it allows for a **wider range of depths** to be reached for **hunting**. However, it must **remain light** to allow for better acceleration in water. A more **convoluted** (intricately twisted/folded) **septum** might also provide a more **secure anchorage for soft tissue.**

No matter the advantages, complexity found in sutures is enough to classify important groups of cephalopods.

<u>When describing the degree of complexity of the suture lines:</u>

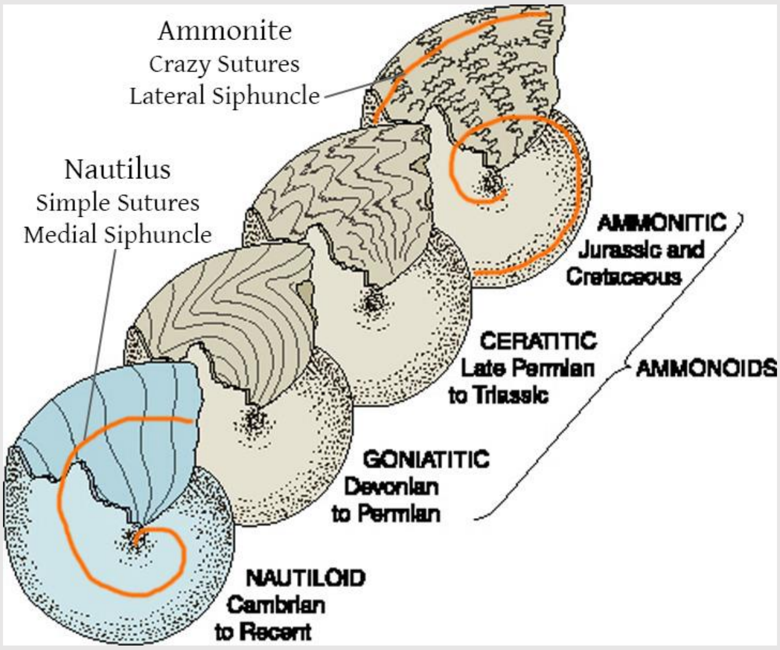
- The suture lines are drawn with the outside of the shell (**the venter**) **on the left**
- The inside of the shell (the **umbilicus**) **on the right**.
- An **upwards arrow** points towards the **aperture.**

The earliest Cephalopods had the simplest of sutures.

Nautiloids range **from straight** to a few **gentle curved** sutures. These are named after a group of **lower Palaeozoic** straight-shelled Nautiloids, **Orthoceras.** The term **orthoceratitic** means that the sutures are very simple. **Modern-**day **Nautilus** only shows **gentle curving sutures**.

The Ammonoids sutures on the other hand, are very complex. The Palaeozoic forms are called **goniatites** after the angular shape of their suture lines. Both saddles and lobes are smooth. Most goniatites perished in the Permo-Triassic extinction and those who survived were outnumbered by a group with more complex sutures, the **ceratites.**
Ceratites developed frilly, more complex lobes, whilst their **saddles remained quite simple**. Their numbers dwindled into the **Permian and lower-Triassic**. **The sutures** are approximately described as **ceratitic.**

In the **Upper Triassic,** the 'true' **ammonites became dominant**. They have frilly or complex folds on both lobes and saddles. The sutures are very complex and so are described as **ammonitic sutures.**


Ammonite
Crazy Sutures
Lateral Siphuncle
Nautilus
Simple Sutures
Medial Siphuncle
AMMONITIC
Jurassic and
Cretaceous
CERATITIC
Late Permian
to Triassic
AMMONOIDS
GONIATITIC
Devonian
to Permian
NAUTILOID
Cambrian
to Recent