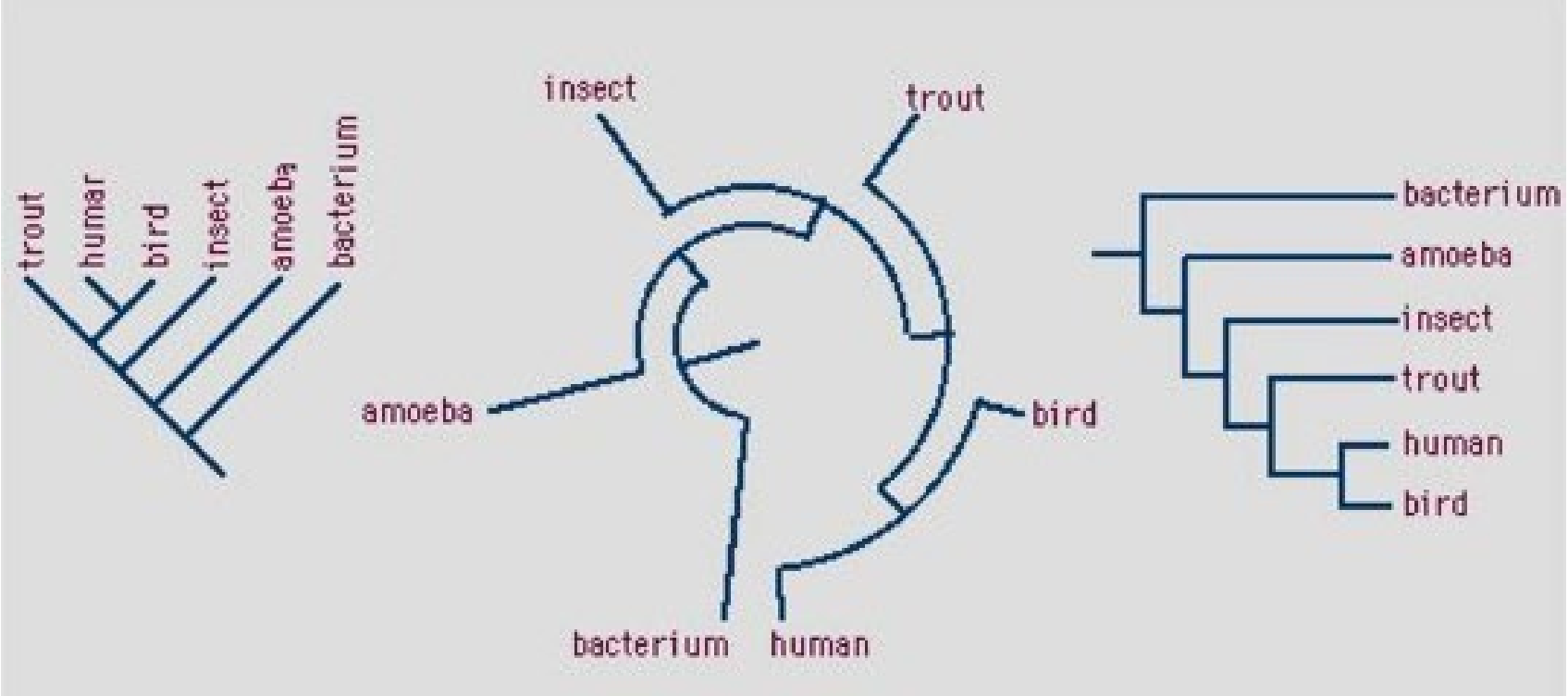
Fossil Evidence for Evolution 3



Relative Dating – Fluorine Dating

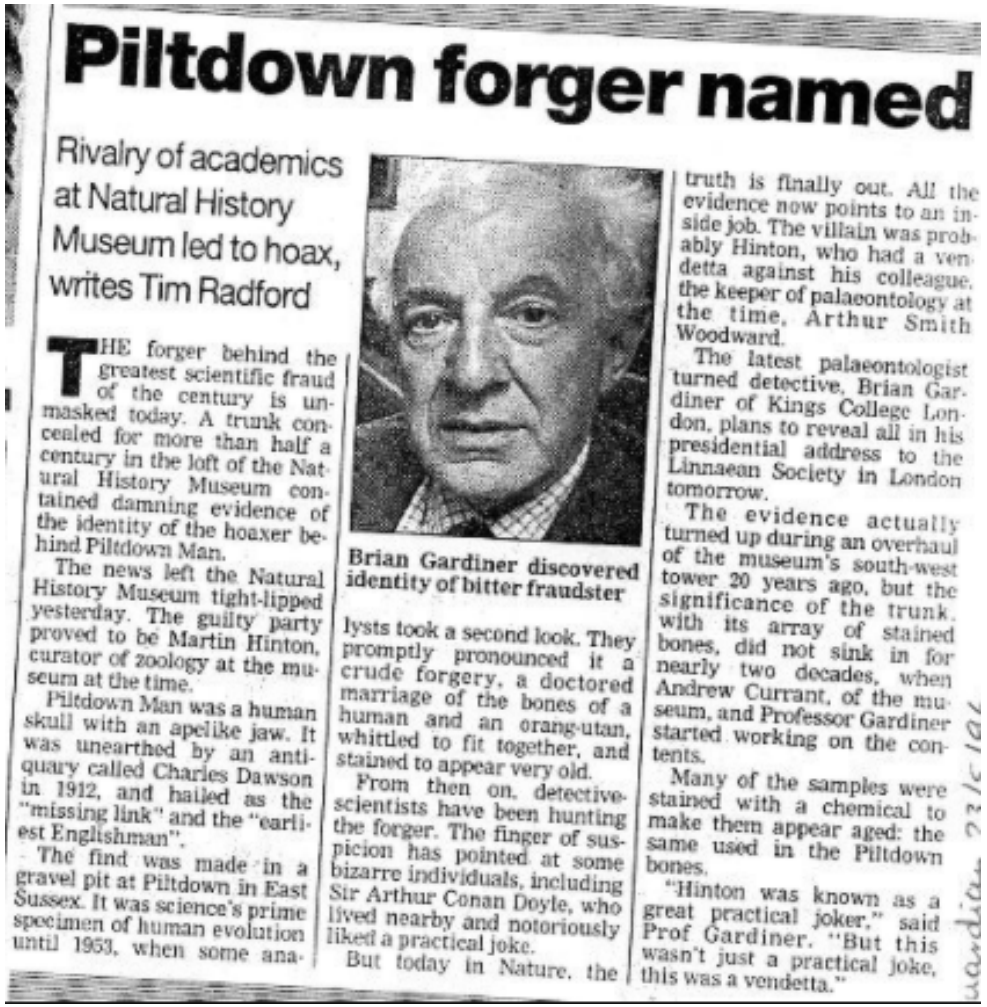
Phylogenetic Trees

Geological Timescale

Date:	Human Biology Year 12 ATAR
Do Now Past Exam Question **Lesson Agenda** 1: Do Now 2: Relative dating Techniques – Fluorine dating 3: Phylogenetic Trees 4: Geological Timescale 5: Lesson summary and windup **Suggested Study** • Read through today's notes and textbook section • Complete review worksheet, then mark and correct using the answer key on Connect (compulsory). **NEXT LESSON** Other evidence for evolution: Comparative Anatomy Comparative Embryology Homologous Structures Vestigial Structures Geographic Distribution	**Learning Aims** • Describe how fluorine dating can be used to provide relative ages of fossils. • Define the term "phylogenetic tree". • Use a variety of phylogenetic trees to identify common ancestry and level of relatedness. • Draw a phylogenetic tree using given data. • Identify that the geological timescale is vast. • Identify that humans are very recently evolved. **Key Vocabulary** Phylogenetic Fluorine Dating

Relative Dating – Fluorine Dating

- Used for relative dating of fossils bones *in the same location.*
- If bone is left in soil, fluoride ions from ground water replace some of the ions in the bone over time.
- All fossil bones in a particular deposit should contain same amount of fluoride
- Can therefore detect fossils that have been displaced
- Older fossils, have more fluorine as have been there longer
- Can't use to absolute date though, as amount of fluoride in water supply fluctuates over time.
- Example: "Piltdown Man" hoax
  - 1953 – fossil claimed to be of "human ancestor"
  - Fluorine dating showed it to be a hoax:
  - Skull old, but jawbone modern – from orang-utan.



Piltdown forger named

Rivalry of academics at Natural History Museum led to hoax, writes Tim Radford

THE forger behind the greatest scientific fraud of the century is unmasked today. A trunk concealed for more than half a century in the loft of the Natural History Museum contained damning evidence of the identity of the hoaxer behind Piltdown Man.

The news left the Natural History Museum tight-lipped yesterday. The guilty party proved to be Martin Hinton, curator of zoology at the museum at the time.

Piltdown Man was a human skull with an apelike jaw. It was unearthed by an antiquary called Charles Dawson in 1912, and hailed as the "missing link" and the "earliest Englishman".

The find was made in a gravel pit at Piltdown in East Sussex. It was science's prime specimen of human evolution until 1953, when some analysts took a second look. They promptly pronounced it a crude forgery, a doctored marriage of the bones of a human and an orang-utan, whittled to fit together, and stained to appear very old.

From then on, detective-scientists have been hunting the forger. The finger of suspicion has pointed at some bizarre individuals, including Sir Arthur Conan Doyle, who lived nearby and notoriously liked a practical joke.

But today in Nature, the truth is finally out. All the evidence now points to an inside job. The villain was probably Hinton, who had a vendetta against his colleague, the keeper of palaeontology at the time, Arthur Smith Woodward.

The latest palaeontologist turned detective, Brian Gardiner of Kings College London, plans to reveal all in his presidential address to the Linnaean Society in London tomorrow.

The evidence actually turned up during an overhaul of the museum's south-west tower 20 years ago, but the significance of the trunk, with its array of stained bones, did not sink in for nearly two decades, when Andrew Currant, of the museum, and Professor Gardiner started working on the contents.

Many of the samples were stained with a chemical to make them appear aged: the same used in the Piltdown bones.

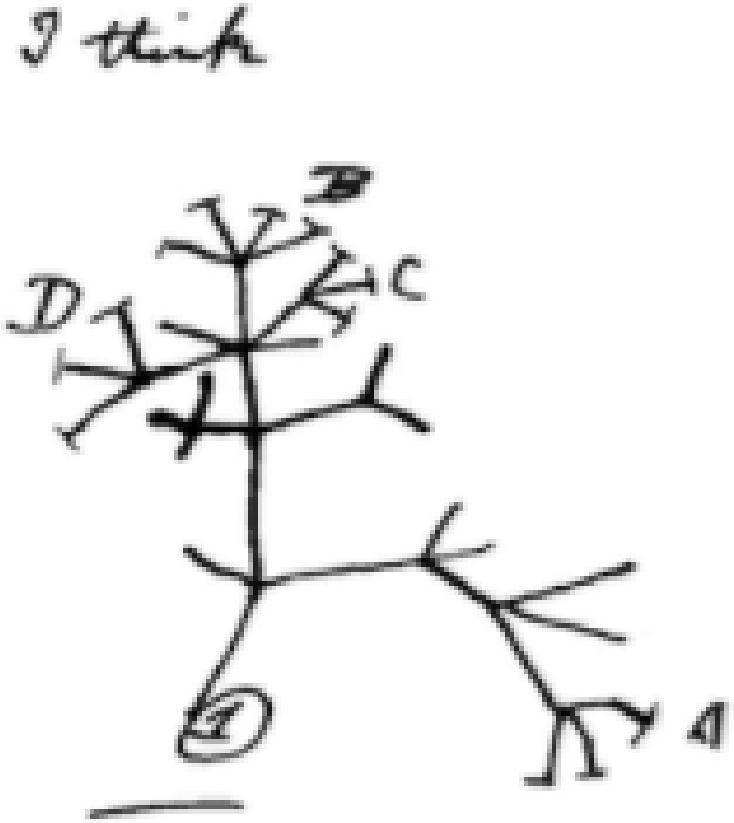
"Hinton was known as a great practical joker," said Prof Gardiner. "But this wasn't just a practical joke, this was a vendetta."

Brian Gardiner discovered identity of bitter fraudster

Learning Aim: Describe how fluorine dating can be used to provide a relative age for fossils.

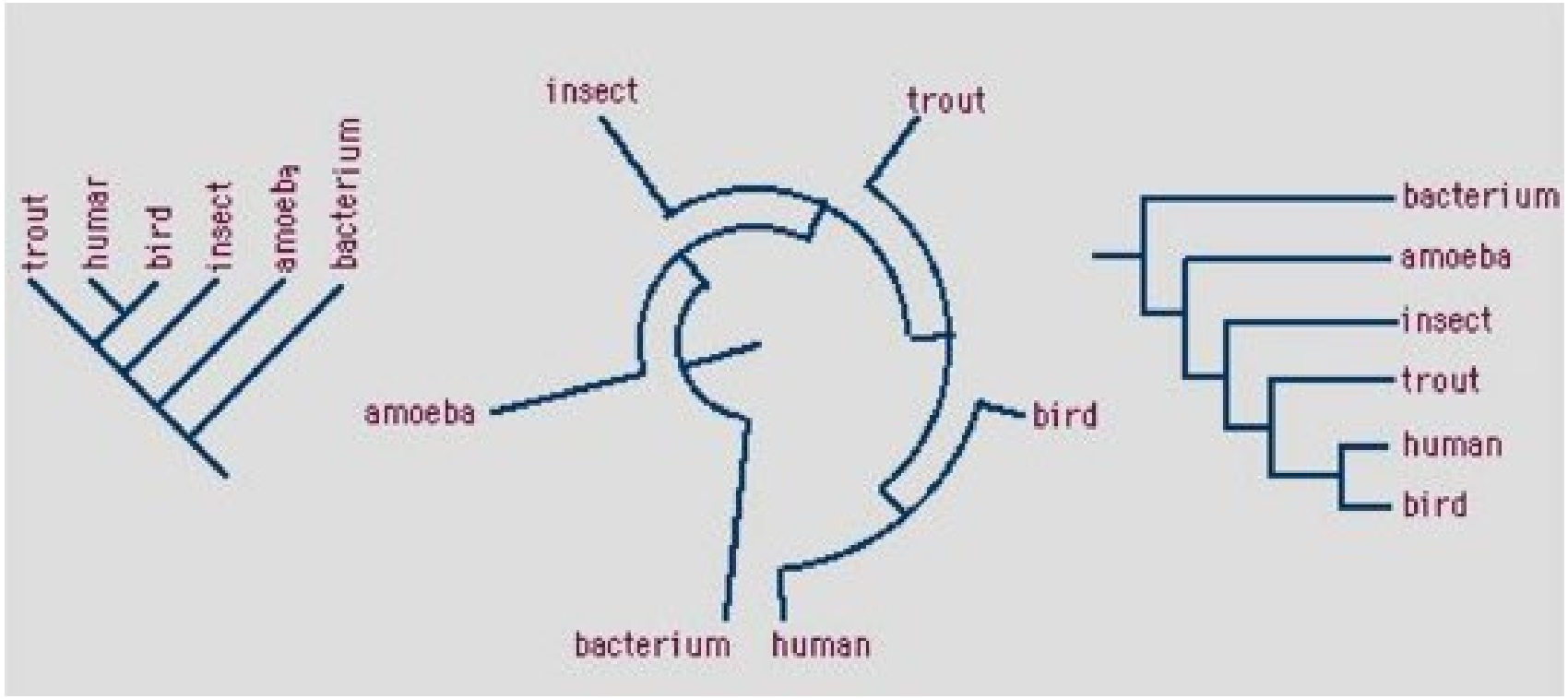
Phylogenetic Trees

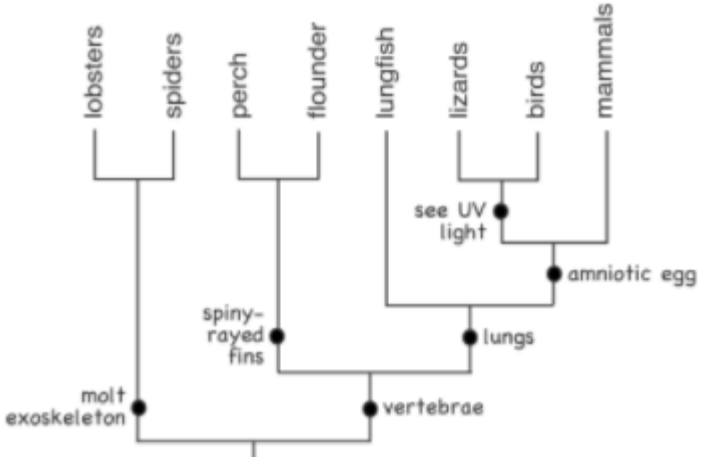
- Using a range of dating, biotech and classification techniques, scientists can work out likely evolutionary relationships
- Probable relationships can be represented as a diagram, called a *phylogenetic tree*.
  - Ancestral organism at the base
  - More recent organisms at end of branches
  - Forks in branches: common ancestors
- Have been used since Darwin's time.

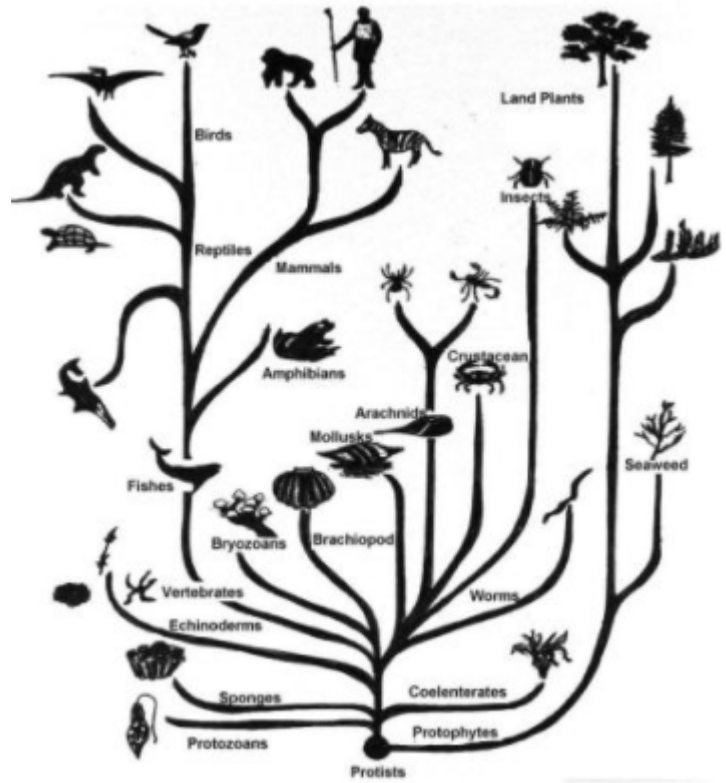


Learning Aim: Define the term "phylogenetic tree"

Phylogenetic Tree examples







Learning Aim: Use a variety of phylogenetic trees to identify common ancestry and relatedness.

Practice: Draw a Phylogenetic Tree Diagram

The following data shows the presence of four enzymes across three species.

Species	Enzyme 1	Enzyme 2	Enzyme 3	Enzyme 4
Opossum	present	present	present	present
Platypus	present	present	present	absent
Chicken	present	absent	absent	absent

Use the characteristics of the organisms listed to make a phylogenetic tree:

Characteristic	Fern	Human	Shark	Bird
Has Spinal Cord	No	Yes	Yes	Yes
Performs Photosynthesis	Yes	No	No	No
Has vertebrae	No	Yes	No	Yes
Has placenta	No	Yes	No	No

Learning Aim: Draw a phylogenetic tree using given data.

The Geological Time Scale

- Enormous time span involved in the evolutionary process
- First life approx 3.5 billion years ago
- Divided into eras, periods, epochs:

Table 16.2 The geological time scale covering the past 600 million years

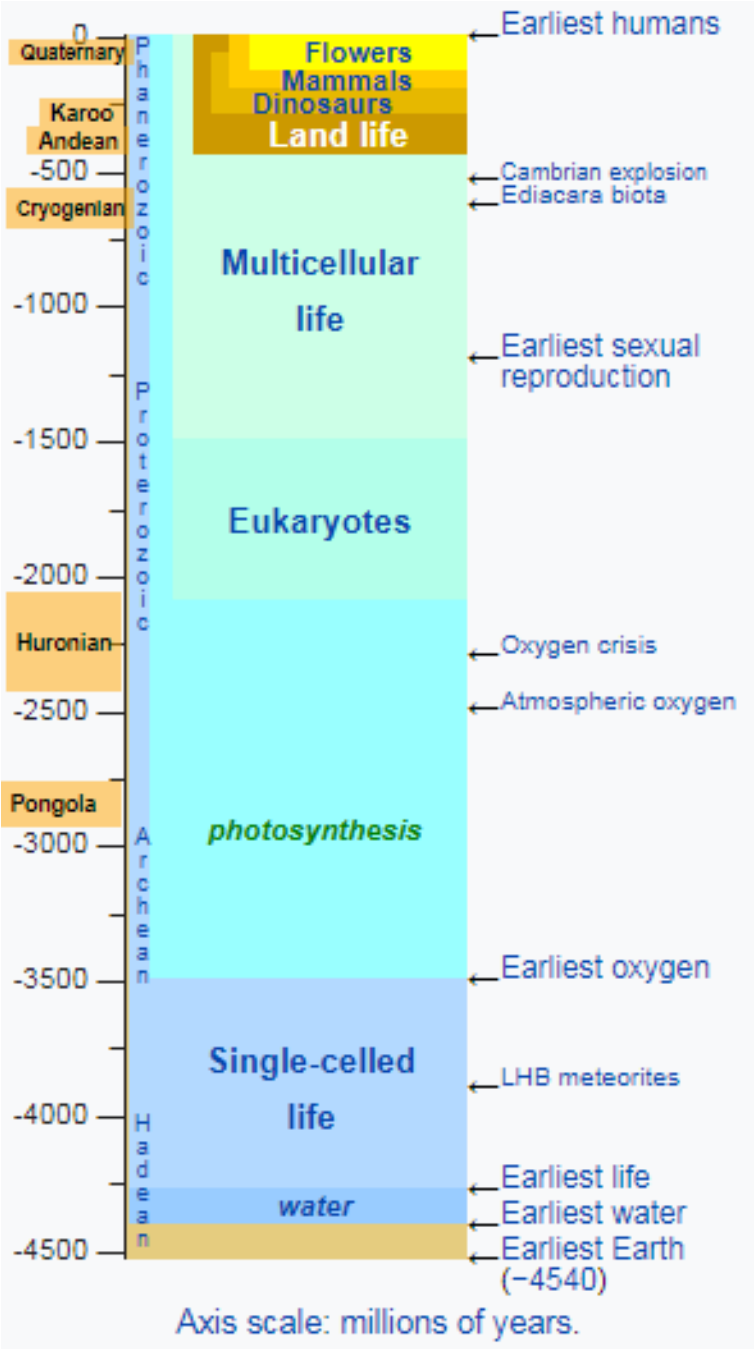
Era	Period	Epoch	Millions of years BP
Cainozoic (Cenozoic)	Quaternary	Holocene (Recent)	0.012 (11 700 years)
		Pleistocene	2.6
	Tertiary	Pliocene	5.3
		Miocene	23
		Oligocene	34
		Eocene	56
		Palaeocene	65
Mesozoic	Cretaceous		145
	Jurassic		200
	Triassic		251
Palaeozoic	Permian		299
	Carboniferous		359
	Devonian		416
	Silurian		444
	Ordovician		488
	Cambrian		542
	Ediacaran		635

Learning Aim: Identify that the geological timescale is vast.

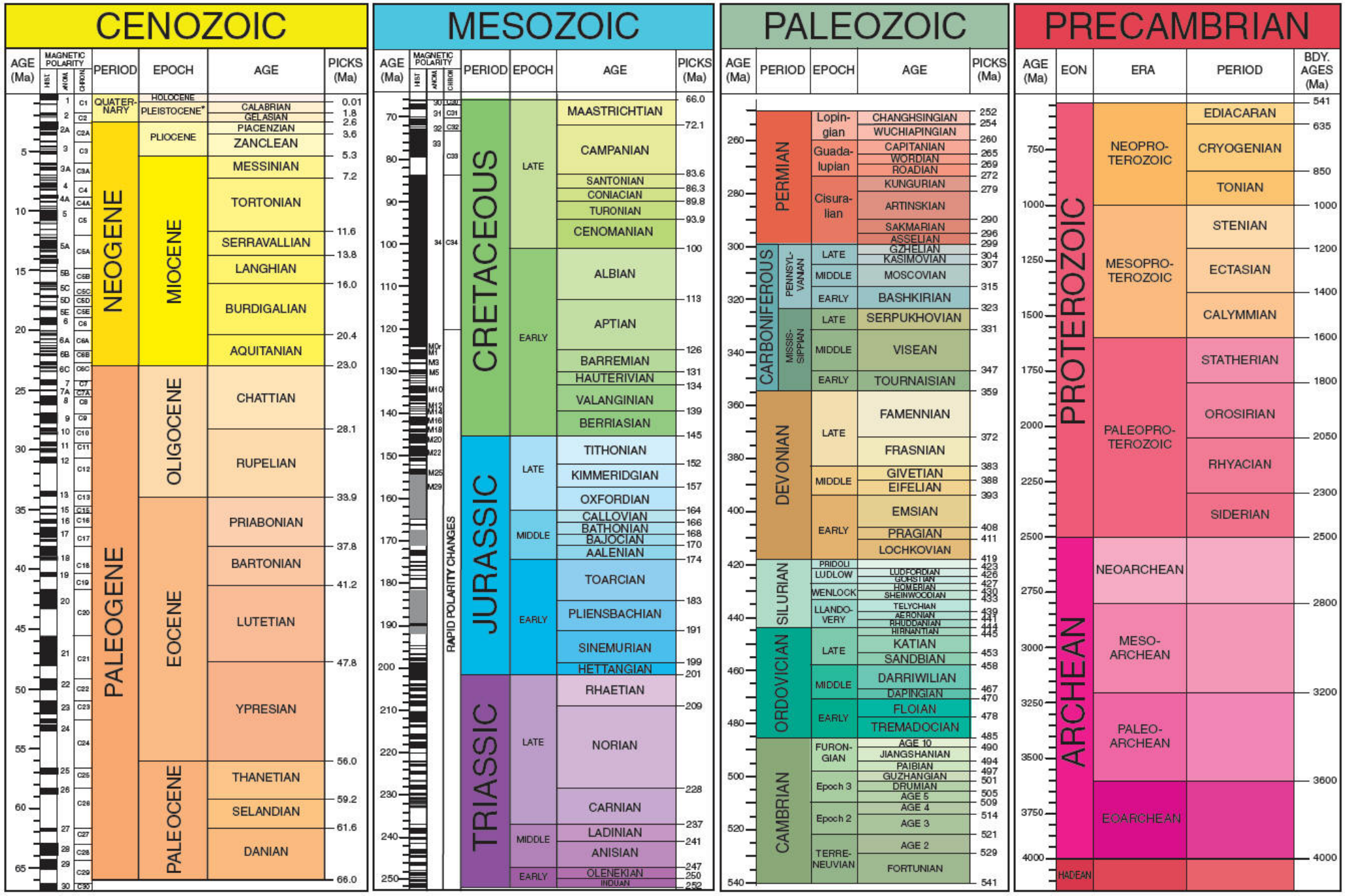
The Geological Time Scale

- Humans and human ancestors are relatively very recent:

- Cenozoic onwards



Learning Aim: Identify that humans are very recently evolved.


CENOZOIC
AGE (Ma)
MAGNETIC POLARITY
HST
ANOM
CHRON
PERIOD
EPOCH
AGE
PICKS (Ma)
QUATER-NARY
NEOGENE
PALEOGENE
HOLOCENE
PLEISTOCENE*
PLIOCENE
MIOCENE
OLIGOCENE
EOCENE
PALEOCENE
CALABRIAN
GELASIAN
PIACENZIAN
ZANCLEAN
MESSINIAN
TORTONIAN
SERRAVALLIAN
LANGHIAN
BURDIGALIAN
AQUITANIAN
CHATTIAN
RUPELIAN
PRIABONIAN
BARTONIAN
LUTETIAN
YPRESIAN
THANETIAN
SELANDIAN
DANIAN
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1.8
2.6
3.6
5.3
7.2
11.6
13.8
16.0
20.4
23.0
28.1
33.9
37.8
41.2
47.8
56.0
59.2
61.6
66.0
MESOZOIC
AGE (Ma)
MAGNETIC POLARITY
HST
ANOM
CHRON
PERIOD
EPOCH
AGE
PICKS (Ma)
CRETACEOUS
JURASSIC
TRIASSIC
LATE
EARLY
MIDDLE
MAASTRICHTIAN
CAMPANIAN
SANTONIAN
CONIACIAN
TURONIAN
CENOMANIAN
ALBIAN
APTIAN
BARREMIAN
HAUTERIVIAN
VALANGINIAN
BERRIASIAN
TITHONIAN
KIMMERIDGIAN
OXFORDIAN
CALLOVIAN
BATHONIAN
BAJOCIAN
AALENIAN
TOARCIAN
PLIENSBACHIAN
SINEMURIAN
HETTANGIAN
RHAETIAN
NORIAN
CARNIAN
LADINIAN
ANISIAN
OLENEKIAN
INDUAN
RAPID POLARITY CHANGES
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89.8
93.9
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PALEOZOIC
AGE (Ma)
PERIOD
EPOCH
AGE
PICKS (Ma)
PERMIAN
CARBONIFEROUS
PENNSYL-VANIAN
MISSIS-SIPPIAN
DEVONIAN
SILURIAN
ORDOVICIAN
CAMBRIAN
Lopin-gian
Guada-lupian
Cisura-lian
LATE
MIDDLE
EARLY
PRIDOLI
LUDLOW
WENLOCK
LLANDO-VERY
FURON-GIAN
Epoch 3
Epoch 2
TERRE-NEUVIAN
CHANGHSINGIAN
WUCHIAPINGIAN
CAPITANIAN
WORDIAN
ROADIAN
KUNGURIAN
ARTINSKIAN
SAKMARIAN
ASSELIAN
GZHELIAN
KASIMOVIAN
MOSCOVIAN
BASHKIRIAN
SERPUKHOVIAN
VISEAN
TOURNAISIAN
FAMENNIAN
FRASNIAN
GIVETIAN
EIFELIAN
EMSIAN
PRAGIAN
LOCHKOVIAN
LUDFORDIAN
GORSTIAN
HOMERIAN
SHEINWOODIAN
TELYCHIAN
AERONIAN
RHUDDANIAN
HIRNANTIAN
KATIAN
SANDBIAN
DARRIWILIAN
DAPINGIAN
FLOIAN
TREMADOCIAN
AGE 10
JIANGSHANIAN
PAIBIAN
GUZHANGIAN
DRUMIAN
AGE 5
AGE 4
AGE 3
AGE 2
FORTUNIAN
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541
PRECAMBRIAN
AGE (Ma)
EON
ERA
PERIOD
BDY. AGES (Ma)
PROTEROZOIC
ARCHEAN
HADEAN
NEOPRO-TEROZOIC
MESOPRO-TEROZOIC
PALEOPRO-TEROZOIC
NEOARCHEAN
MESO-ARCHEAN
PALEO-ARCHEAN
EOARCHEAN
EDIACARAN
CRYOGENIAN
TONIAN
STENIAN
ECTASIAN
CALYMMIAN
STATHERIAN
OROSIRIAN
RHYACIAN
SIDERIAN
541
635
850
1000
1200
1400
1600
1800
2050
2300
2500
2800
3200
3600
4000

Limitations of the fossil record

- Incomplete: few fossils formed as specific conditions required:
  - Quick burial
  - Presence of hard body parts, or imprint
  - Absence of decay organisms
  - Long period of stability
  - Correct environmental conditions eg soil pH
- Only some fossils formed get found
- Dating material can be problematic in some cases
- Fossils often incomplete

Learning Aim: Identify some limitations of the fossil record.