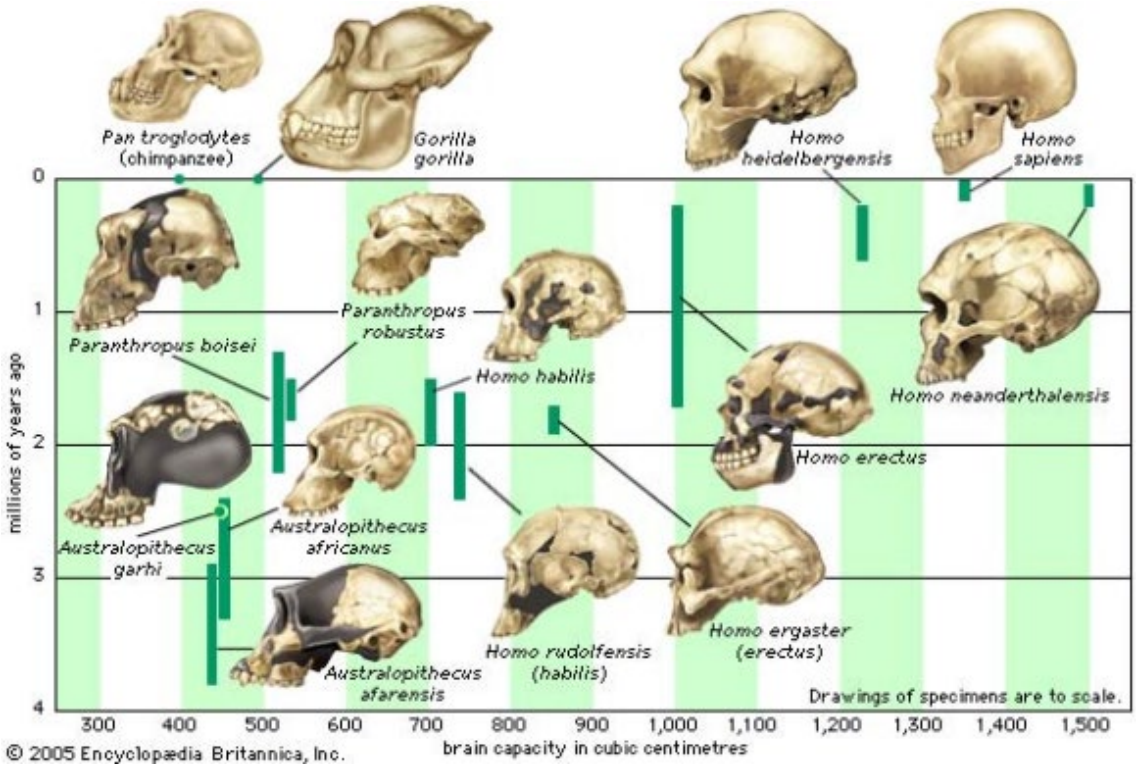
Primate Evolutionary Trends



Date:	Human Biology Year 12 ATAR

Do Now
 	
Past Exam Question
 	
Lesson Agenda
1: Do Now
2: Primate Classification and Evolutionary Trends
3: 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
 	
Tues: Practical Activity – amino acid sequencing
Thurs: Task 11: Science Inquiry – Biotechnological Techniques
Fri: NAIDOC Assembly
	Learning Aims
	• Discuss the primate order
	• Describe how primates are classified
	• Summarize the main characteristics of primates
	• Discuss evolutionary trends in primates
	  • Digits
	  • Dentition
	  • Vision
	  • Cerebral Cortex Size
	  • Gestation and Parental Care
	
	Key Vocabulary
	Primate
	Classification
	Digits
	Dentition
	Gestation

What are Primates?

- The Order of animals that includes Humans
- Also includes:
  - Great Apes
  - Gibbons
  - Monkeys
  - Lemurs
  - Lorises
  - Tarsiers

- Non-human primates are our closest living relatives, so can compare to see how human characteristics may have evolved. This can help us understand the trends in evolution seen in extinct human ancestors as well.
  - Comparative anatomy
  - Comparative biochemistry
  - Behaviour of living primates
  - Fossils of primates

- We can also see trends in evolution in modern primates –the more closely related they are to humans, the more features they share in common, illustrating the evolutionary pathway.

Learning Aim: Discuss the Primate Order

Primate Classification

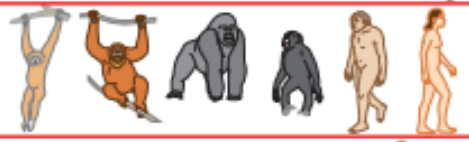
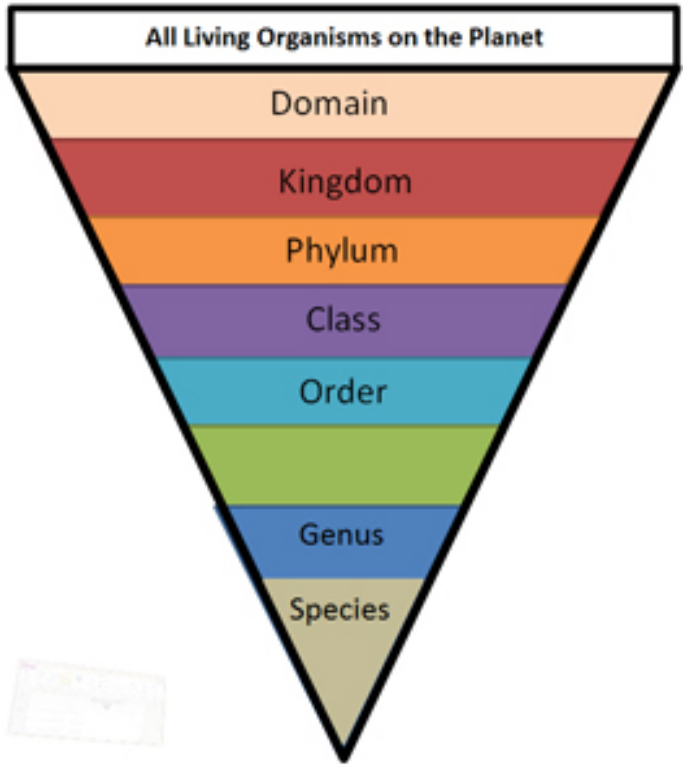
Classification group		Examples
Order Primates		Humans, apes, monkeys, tarsiers, lorises and lemurs
Suborder Haplorrhini		Humans, apes, monkeys and tarsiers
Infraorder Simiiformes		Humans, apes and monkeys
Superfamily Hominoidea		Humans and all apes (great apes and gibbons)
Family Hominidae		Humans and great apes
Subfamily Homininae		Modern and extinct chimpanzees and humans
Genus *Homo*		Modern and extinct humans
Species *sapiens*		Modern humans

Figure 17.2 A diagrammatic representation of the hierarchy within the primate order



Learning Aim: Describe how primates are classified.

Primate Classification

Table 17.1 The classification of humans within the primate order

Level of classification	Name	Examples
Order	Primates	Primates include tarsiers, lemurs, lorises, monkeys, apes and humans
Suborder	Haplorrhini	Haplorrhini include tarsiers, monkeys, apes and humans
Infraorder	Simiiformes	Simiiformes include monkeys, apes and humans
Parvorder	Catarrhini	Catarrhines include Old World monkeys, apes and humans
Superfamily	Hominoidea	Hominoids include apes and humans
Family	Hominidae	Hominids include all modern and extinct orang-utans, gorillas, chimpanzees and humans
Subfamily	Homininae	Hominines include all modern and extinct chimpanzees and humans
Tribe*	Hominini	Hominins include extinct ancestors of humans and modern humans
Genus	*Homo*	*Homo* includes some extinct ancestors of humans and modern humans
Species	*sapiens*	*Homo sapiens* are modern humans

**Note*: Tribe is a classification group within a subfamily. The meaning of tribe here is different from the use of tribe to describe an ethnic group of people.

Learning Aim: Describe how primates are classified.

Primate Classification

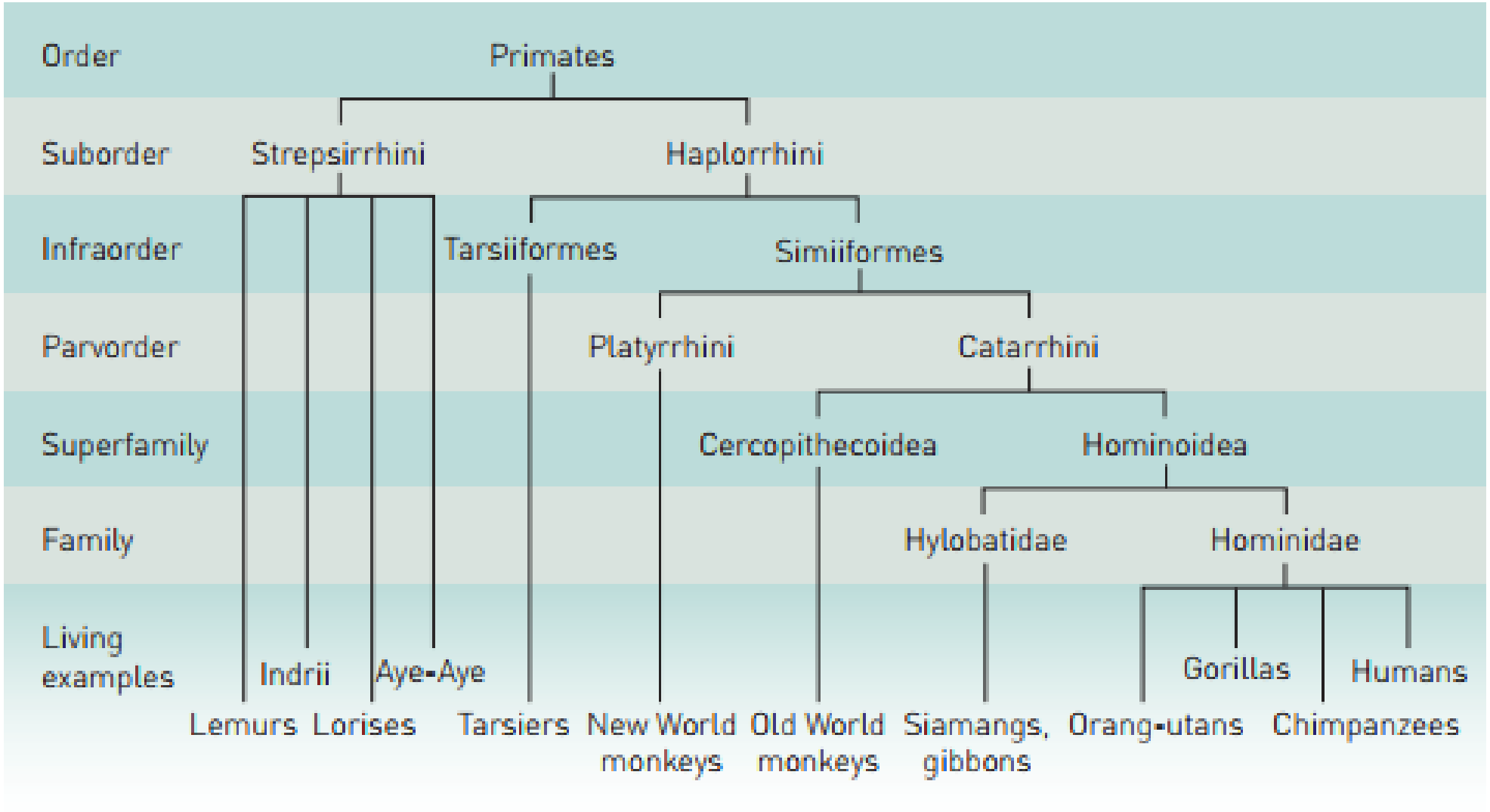


Figure 17.3 A simplified classification of the primates

Learning Aim: Describe how primates are classified.

Primate Classification

- Classification is a dynamic process: as new information comes to light, classification of an organism may change.
- Eg:
  - Earlier classification divided primates into two groups:
    - Simians (humans and human-like primates)
    - Prosimians (primitive primates)
    - Tarsiers were included with prosimians, based on physical characteristics
  - Based on studies of protein sequences and DNA:
    - Most scientists now classify Tarsiers as more closely related to monkeys, apes and humans
  - Humans: classified in same family as great apes – we have very similar DNA and many shared characteristics.

Learning Aim: Describe how primates are classified.

Primate Characteristics

Main features distinctive to primates

- combination of grasping fingers and toes
- overlapping binocular vision

Table 17.2 A summary of the characteristics of members of the order Primates

Feature	Primate characteristics
Body	Not specialised for a particular environment
Limbs	Generally unspecialised
Hands/feet	Pentadactyl – five fingers or toes Nails instead of claws Grasping fingers and toes with friction ridges for gripping First digit opposable
Eyes	Forward facing for three-dimensional (stereoscopic) vision Most are able to distinguish colour
Sense of smell	Very poor
Teeth	Four incisors in both the upper and lower jaw
Brain	Large and complex Cerebrum size increases as primates become more highly evolved
Reproduction	Not restricted to a breeding season Rhythmical sexual cycle Usually only one offspring at a time Long period of parental care for offspring

Learning Aim: Describe how primates are classified.

Primate Evolutionary Trends

- Primate species share a series of features, and have these in common with humans, indicating relatively recent common ancestry.

- This can be seen in:
  - Digits
  - Dentition
  - Vision
  - Cerebral Cortex size
  - Gestation and Parental Care.

Learning Aim: Discuss evolutionary trends in primates.

Trends in digits of primate species

- Primate limbs are unspecialised in structure
  - Allows diversity in use
- 5 digits on each limb (pentadactyl)
  - Highly mobile
  - Prehensile
    - can curl around things to grip
  - Opposable thumbs (and big toes for some)
    - Thumb can cross palm to touch other fingers
- Degree of Opposability
  - Varies between species
  - Depends on relative length of first digit
  - Most primates also have opposable big toe
    - Humans are an exception
    - Feature a disadvantage when bipedal
      - uneven weight distribution
      - poor stability
- Humans have the longest thumb
  - Allows manipulation of materials.

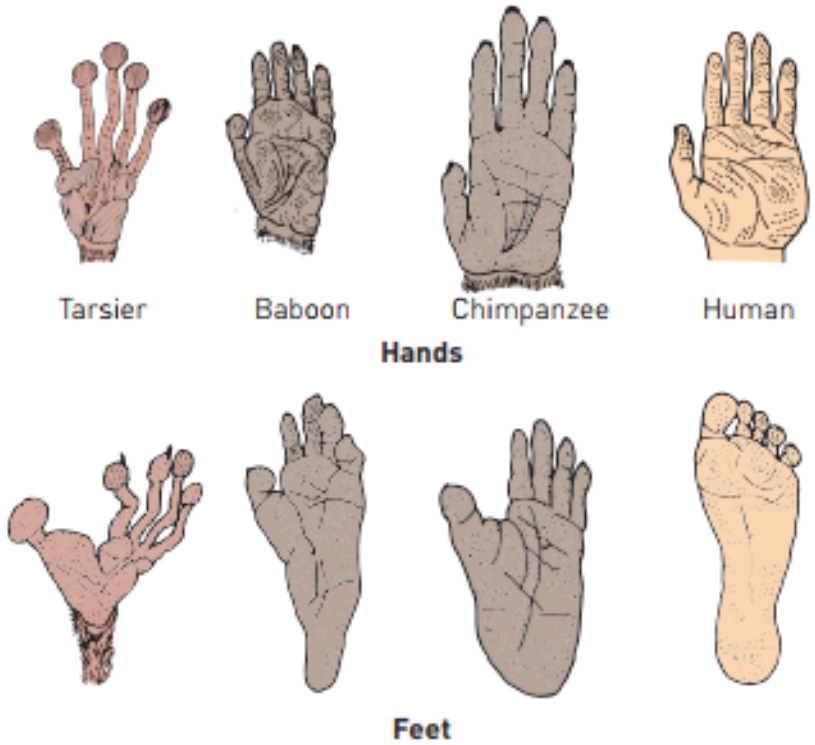


Figure 17.4 Hands and feet of four primates. Unlike other primates, humans do not have an opposable big toe.

Learning Aim: Discuss evolutionary trends in primates.

Digits – nails vs claws

- Tips of digits modified for better grip in trees
  - Nails instead of claws
  - Nails allow better grasping
  - Evolved from claws that became flattened
- Some primates still have claws – Aye-Ayes and Lemurs
  - Lemurs: “toilet claw” for grooming/scratching
  - Aye Ayes – extremely long claw for hooking larvae out of trees.
- Digits also have more sense receptors for feedback when gripping and manipulating
- Friction ridges “fingerprints” increase grip

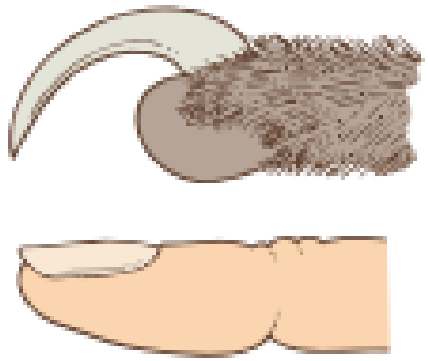


Figure 17.6 Differences between claws and nails

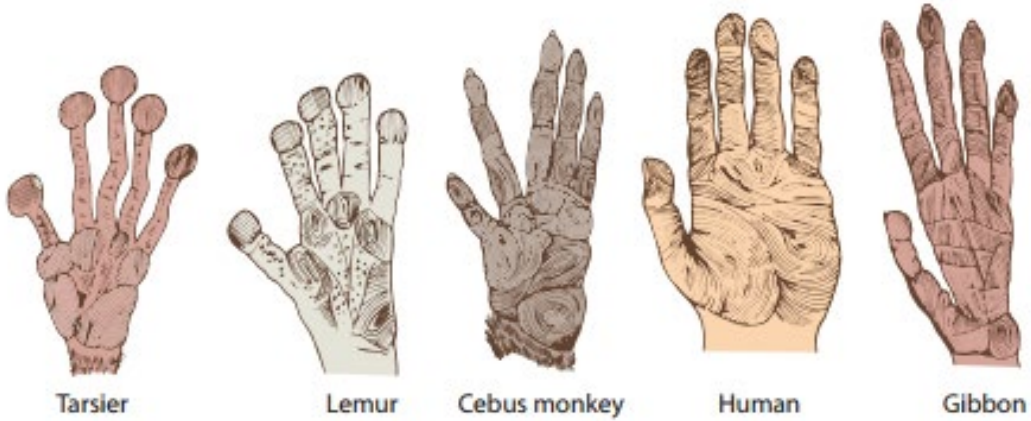


Figure 17.8 The fingerprint patterns of a variety of primates

Learning Aim: Discuss evolutionary trends in primates.

Figure 17.7 The toilet claw of a lemur

Learning Aim: Discuss evolutionary trends in primates.

Digits – mobility

- Humans – very mobile digits
  - Short broad hand, short straight fingers, long strong thumb
  - Allows precision grip
    - Writing
    - Sewing
    - Construction
- True opposable thumb
  - Only in Old World monkeys eg baboons, mandrills, macaques; apes; humans

Learning Aim: Discuss evolutionary trends in primates.

Dentition (Teeth)

- Evolutionary changes can be seen to teeth
- Can look at Dental Formula
  - Gives number of each type of tooth on each jaw quarter
  - Primitive mammals: 3:1:4:3 (incisors:canines:premolars:molars)
- Decrease in number of teeth in primates compared with early mammals.
  - Probably related to gradual reduction in face and jaw size
  - Lemurs and lorises: 36 teeth 2:1:3:3
  - Tarsiers: have lost 2 incisors from lower jaw: 2:1:3:3/1:1:3:3
  - New World Monkeys – evolutionary trend for missing third molar
  - Old World Monkeys, Apes and Humans: 32 teeth 2:1:2:3

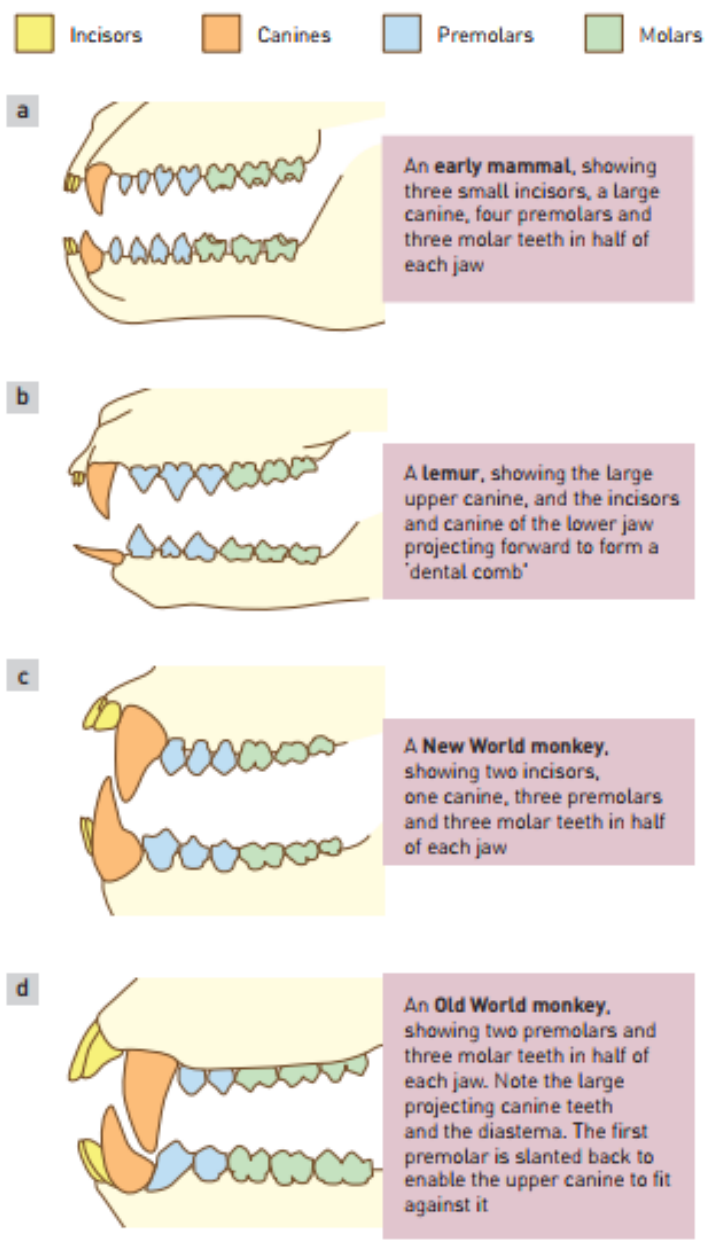


Figure 17.10 The dentition of **a** an early mammal, **b** a lemur, **c** a New World monkey and **d** an Old World monkey

Learning Aim: Discuss evolutionary trends in primates.

Dentition (Teeth)

- Molar teeth show little change from early mammals
  - Generalised diet, generalised teeth
  - Three cusp molar in early mammals
  - Four cusp molar in Old World monkeys
  - Apes and humans: 5 cusp molar
- Fossil teeth often found due to hard enamel preserving the
- Can be used to indicate diet but caution as some adaptations are not due to diet:
  - Dental combs eg lemurs and lorises
  - Large canines in Old World Monkeys – defence and social disply

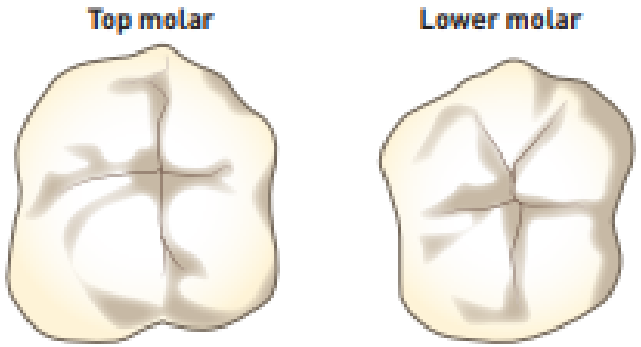


Figure 17.12 The difference in structure between a four-cusp and a five-cusp tooth. The 'valleys' between the four cusps of the top tooth form a '+' pattern, while the 'valleys' between the five cusps of the lower tooth form a 'Y'.

Learning Aim: Discuss evolutionary trends in primates.

Vision

- Primates have evolved emphasis on vision
  - Due to arboreal lifestyle (in trees) – need to be able to accurately judge jump and branch distance.
  - Decreased emphasis on olfaction (smell)
- Emphasis on vision as an advantage has led to change in skull shape:
  - Nose and snout smaller and flatter
    - Less use of nose and snout to sense environment, greater use of eyes
    - Compare Lemurs who use snout to investigate an object vs apes who use hands and eyes
  - Brain case larger
  - Movement of eyes to face forward
    - Allows stereoscopic (3D) vision, accurate distance perception essential when leaping between branches
    - Field of view narrower – could be disadvantage re: predators – compensated by having mobile head and neck – can "look around"
    - Bony socket protects eyes
  - Retina – rods and cones
    - Rods important for vision in dim light
    - Cones- visual discrimination and colour vision
  - Neural connections between eye and brain also improved
    - Acute vision
    - Coordination between eyes.

Learning Aim: Discuss evolutionary trends in primates.

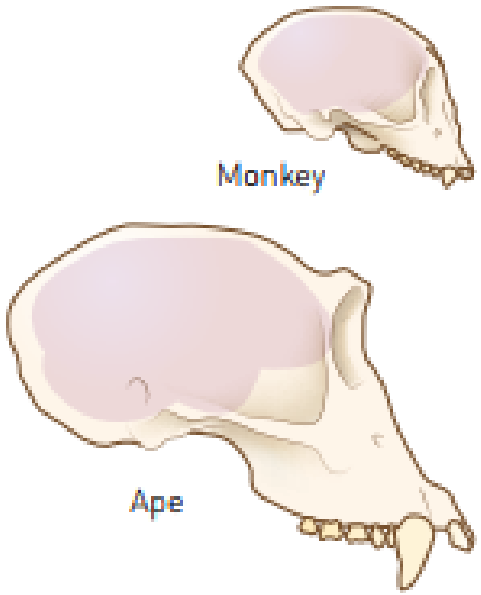


Figure 17.13 Comparison of the size of the brains and skulls of a monkey and an ape (both skulls are drawn to the same scale)

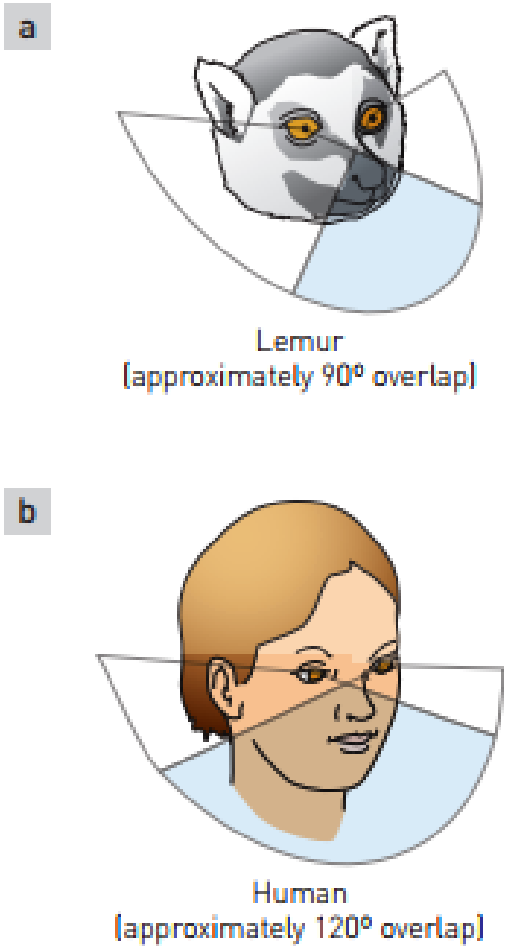


Figure 17.14 Fields of view of **a** a lemur and **b** a human. As the eyes become more forward facing, the total field of view decreases but the degree of overlap of the fields of the two eyes increases. The greater the degree of overlap, the better the stereoscopic vision.

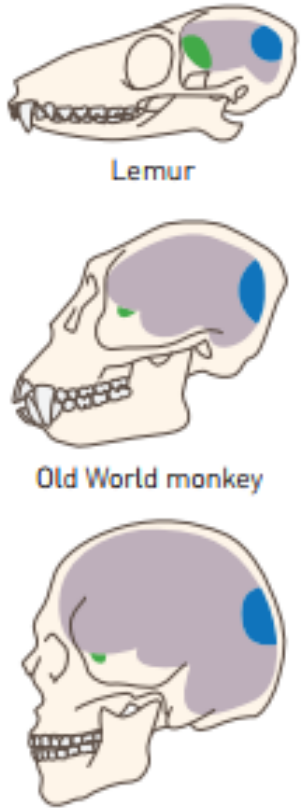
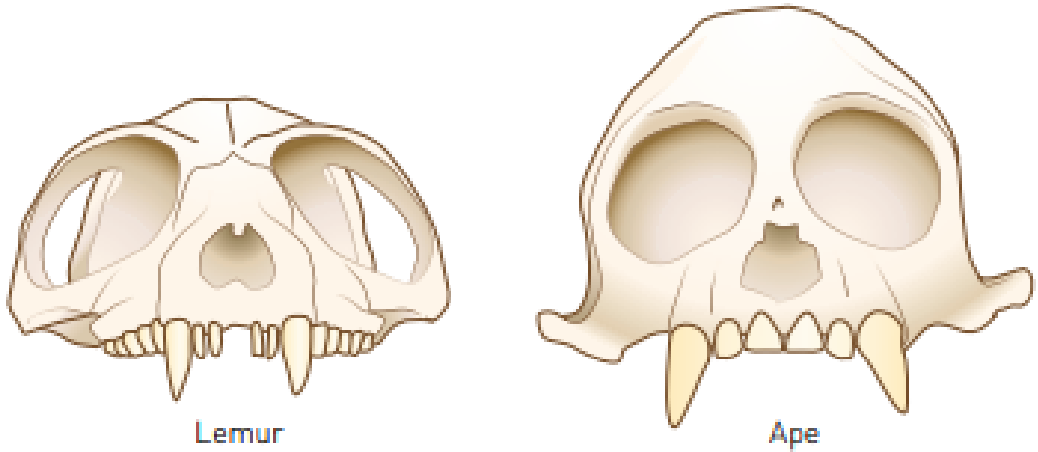


Figure 17.16 Relative sizes of the centres for olfaction (green) and vision (blue) in the brains of a lemur, an Old World monkey and a human

Learning Aim: Discuss evolutionary trends in primates.

Vision

- Can see evolution of eye socket in comparing lemurs and apes:



Lemur

Eyes face slightly sideways and eyeball is not completely enclosed in a socket. The sides and rear of the eyeball are exposed.

Ape

Eyes are facing forward and eyeball is completely enclosed in a bony socket. There is bone at the sides of the socket and a plate of bone at the rear.

Figure 17.15 The change in the shape of the eye sockets for a lemur and an ape

- Brain regions larger for vision, smaller for olfaction in primates more closely related to humans.

Learning Aim: Discuss evolutionary trends in primates.

Cerebral Cortex Size

- Progressive increase in cerebrum as more closely related to humans
- Region of brain concerned with “higher-order” functions
  - Reasoning
  - Memory
  - Manipulation and construction
  - Vision
  - Language
- Noticeable trend from lemurs to monkeys to humans:

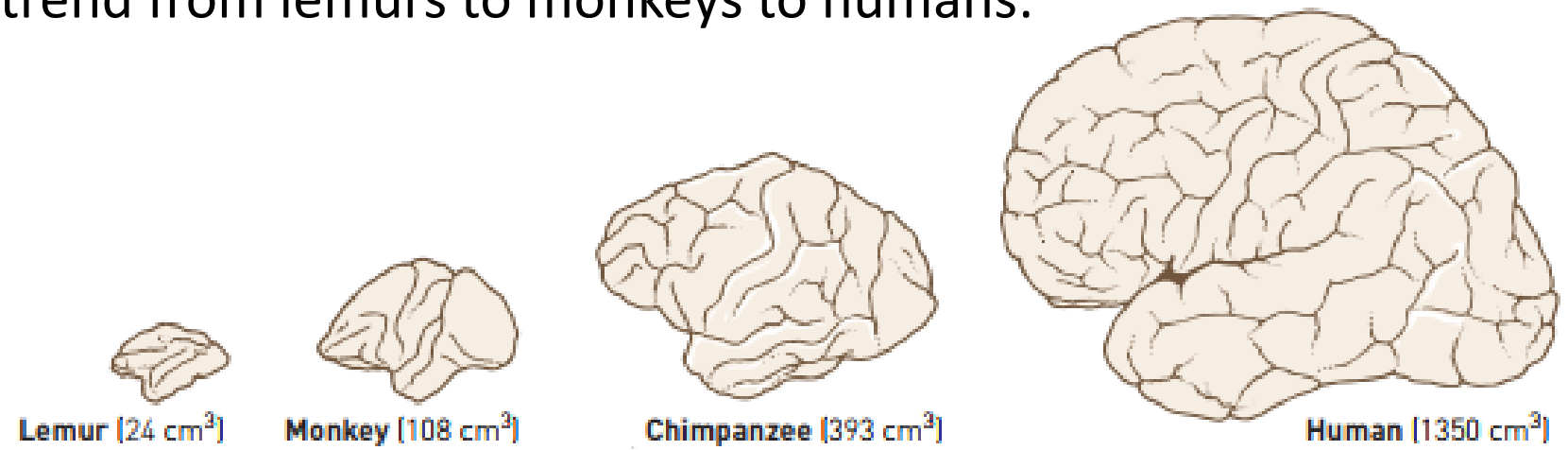


Figure 17.17 The increase in size and complexity of the cerebrum in various primates (drawn to scale)

Learning Aim: Discuss evolutionary trends in primates.

Cerebral Cortex Size

- Large cortex compared to body size probably an advantage in arboreal environment:
  - Accurate visual and tactile perception
  - Coordination and integration of stimulus and response
  - Vision produces large amount of info that must be processed and stored
- Cortex increasingly convoluted (folded)
  - Increases surface area by 50% in humans, compared with no folds
- Increased cerebral cortex size has influenced how primates live
  - Nomadic movement
  - Food location
  - Tool construction and use
  - Variety of behaviour responses – behavioural flexibility
  - Ability to reason and problem solve
- Skull size more large and rounded in humans due to larger brain size.

Learning Aim: Discuss evolutionary trends in primates.

Gestation and Parental Care

- Evolutionary trend in reproductive physiology and behaviour
- Generally single offspring at one time
  - Adaptation to arboreal life?
- Long period of growth and maturation with high parental care
  - Due to increased brain and skull size – need to birth before baby's head gets too big
- Primates are placental mammals
  - Offspring develop in uterus, receive nourishment from mother's blood stream via the placenta
  - Apes and humans – more efficient placenta
- Gestation (pregnancy) is long in primates
  - Tarsier: 1 offspring, 6 month gestation
  - Rodent: 6+ offspring, 3 week gestation

Learning Aim: Discuss evolutionary trends in primates.

Gestation and Parental Care

- Long period of parental care
  - Increases in length as more closely related to humans
  - Lemurs: young weaned at 5 months
  - Apes: young feed from mother for 3-4 years, need protection and guidance for 6+ years
- Associated delay in maturation
  - Sexual maturity later in apes and humans than lorises and monkeys
  - Period of learning extended as a result
  - Allows ideas and skills to be passed on
  - Reduces number of offspring per lifecycle – time and effort must be invested in care as a trade-off

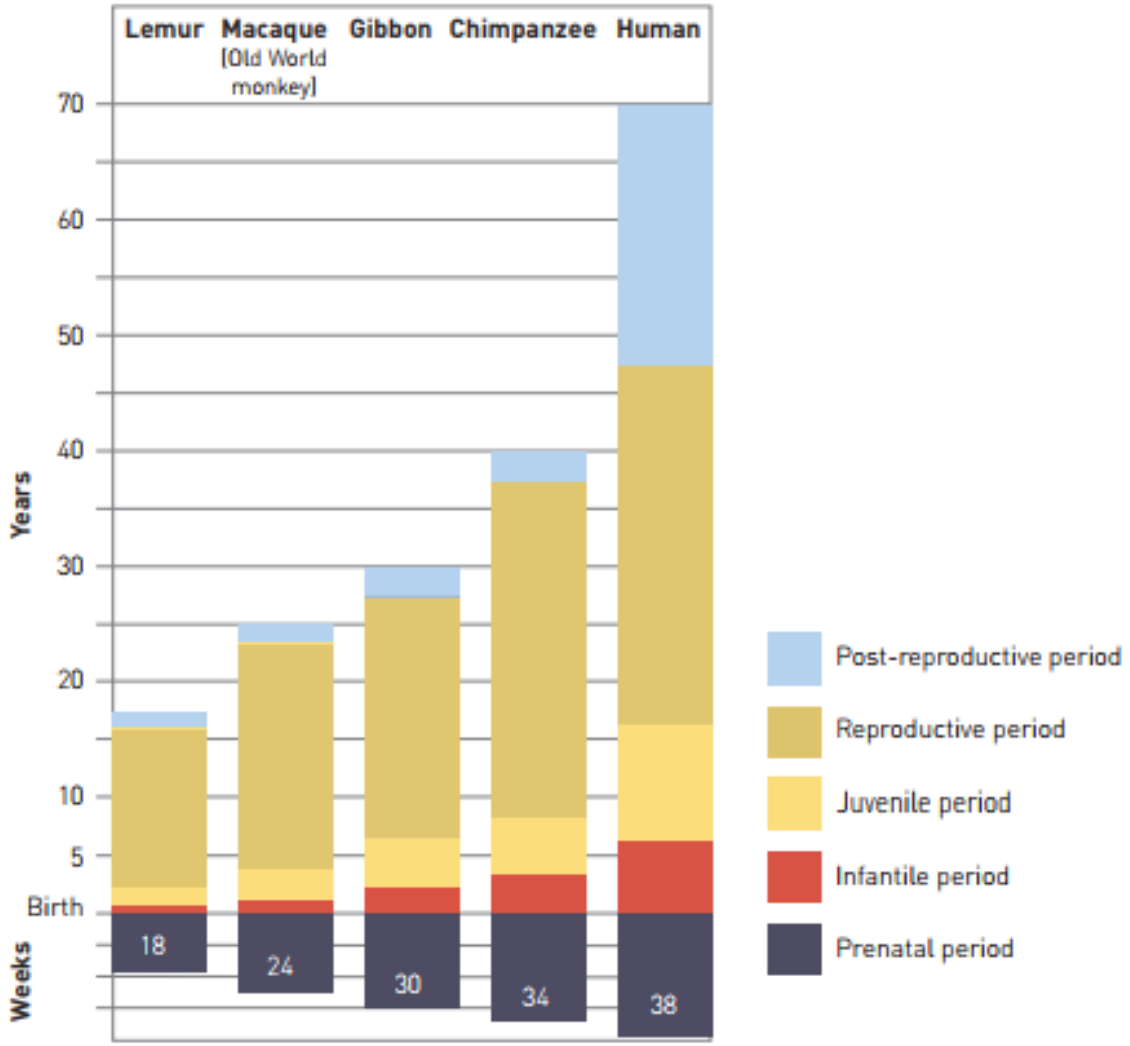


Figure 17.18 The increase in female developmental and reproductive periods with progression from the lemurs to humans

Learning Aim: Discuss evolutionary trends in primates.

Table 17.3 A summary of the evolutionary trends that occur in the order Primates

Characteristic		Trend
Digits	Mobility	Increasing mobility and ability to move digits independently of one another
	Opposability	First digit opposable and increasing length results in increased effectiveness of opposability
	Claws/nails	Primitive primates retain claws on some digits; higher primates have nails on all digits.
Dentition		36 teeth in lemurs, lorises and New World monkeys; 32 in Old World monkeys, apes and humans. Monkeys and apes – large projecting canines with diastema 4-cusped molars in monkeys; 5 cusps in apes and humans
Smell		Sense of smell reduced with gradual reduction in length of the snout
Vision	Eyes	Increasing efficiency in vision Eyes becoming gradually more forward facing, to give stereoscopic vision
	Eye socket	Eyes gradually becoming enclosed in a protective bony socket
	Visual area of brain	Increasing proportion of the cerebrum devoted to vision
Brain	Size	Increasing size of brain relative to size of body
	Convolutions	Gradual increase in the number of folds in the surface of the cerebrum
	Cerebral cortex	Cerebral cortex making up an increasingly large proportion of the brain
Gestation		Increasing length of time between fertilisation and birth
Development	Dependence	Increasing length of time that the offspring are dependent on the parent/s
	Sexual maturity	Increasingly later development of sexual maturity

Learning Aim: Discuss evolutionary trends in primates.