

Where are dinosaurs in Victorian Curriculum F–6 Science?



Using the context of ‘dinosaurs’ to teach
science content and skills

Why aren't 'dinosaurs' in the Primary Science curriculum?

- The Victorian Curriculum is based around knowledge and skills
- 'Dinosaurs' is a context through which scientific understanding, knowledge and skills may be developed at all levels of the Primary Curriculum
- Planning teaching and learning activities requires consideration of:
 - ✓ content descriptions
 - ✓ achievement standards
 - ✓ overarching 'big ideas' in science/key concepts in science:
 - Patterns, order and organisation
 - Form and function
 - Stability and change
 - Scale and measurement
 - Matter and energy
 - Systems

Dinosaurs were once ‘living things’

Band	Content description	Modified content description
F–2	Living things have a variety of external features and live in different places where their basic needs, including food, shelter and water, are met	Dinosaurs have a variety of external features and live in different places where their basic needs, including food, shelter and water, are met
	Living things grow, change and have offspring similar to themselves	Dinosaurs grow, change and have offspring similar to themselves
3–4	Living things can be grouped on the basis of observable features and can be distinguished from non-living things and the environment to survive	Dinosaurs can be grouped on the basis of observable features and can be distinguished from non-living things and the environment to survive Dinosaurs can be distinguished from other living things
	Different living things have different life cycles and depend on each other	Dinosaurs have different life cycles from butterflies/frogs and depend on each other and the environment to survive
5–6	Living things have structural features and adaptations that help them to survive in their environment	Dinosaurs have structural features and adaptations that help them to survive in their environment
	The growth and survival of living things are affected by the physical conditions of their environment	The growth and survival of dinosaurs are affected by the physical conditions of their environment



What do your students already know?

Where are your students on a 'learning continuum'?

15 dinosaur myths

- Dinosauurs and humans lived at the same time.
- All dinosaurs lived at the same time.
- All dinosaurs were big.
- All big reptiles were dinosaurs.
- All dinosaurs were scaly.
- All dinosaurs were green and brown.
- Dinosauurs were slow and sluggish animals.
- Dinosauurs were bad parents.
- All dinosaurs became extinct.
- Dinosauurs became extinct because mammals ate their eggs.
- Dinosauurs were evolutionary failures.
- An asteroid impact alone killed the dinosaurs.
- We have found fossils from most of the dinosaur species.
- *Tyrannosaurus rex* was a giant scavenger.
- *Tyrannosaurus rex* stood upright.

Unpacking dinosaur myths: a curriculum planning perspective

Myth	Key science idea	Content description	Achievement standard
An asteroid impact alone killed the dinosaurs	<ul style="list-style-type: none"> • Stability and change • Matter and energy • Systems 	F–2: Living things ... live in different places where their basic needs, including food, water and shelter, are met	F–2: ... describe how different places meet the needs of living things
		3–4: Different living things ... depend on each other and the environment to survive	3–4: ... describe relationships that assist the survival of living things
		5–6: The growth and survival of living things are affected by the physical conditions of their environment Sudden geological changes or extreme weather conditions can affect Earth’s surface	5–6: ... analyse how structural and behavioural adaptations of living things enhance their survival ... predict and describe the effect of environmental changes on individual living things

How do we know which ancient creatures were dinosaurs?

Here are some basic rules you can use to determine which animals were dinosaurs.

Dinosaurs

- lived between 250 and 65 million years ago
- lived on land
- had straight legs tucked under their body
- were reptiles – but were probably warm-blooded!

Curriculum links: Compare the Biological Sciences sub-strand of the Science Understanding strand of the Science curriculum with the Reasoning strand of the Critical and Creative Thinking curriculum. How are they related when considering the question of whether a dinosaur was a reptile?



Key science idea:

Function relies on form

Deinonychus

deino = terrible
nychis = claws



- A dinosaur's name often tells you something about its structure.
- A dinosaur's structure tells you something about the dinosaur's habits and survival mechanisms.

With thanks to Melbourne Museum for the image of *Deinonychus*

Deinonychus' lifestyle

- Carnivorous
- Up to 3.4 metres in height
- Single, razor-sharp, large, curved claw on each hind foot
- ? Claws to impress opposite sex
- ? Claws to climb trees
- Covered with feathers
- Used hind claws to disembowel prey
- Jaws relatively weak
- Not as fast-moving as other dinosaurs
- ? May have waited for their 'dinner' to bleed to death, rather than directly killing it

Nature of scientific evidence

F–2: Compare observations and predictions with those of others

3–4: Compare results with predictions, suggesting possible reasons for findings

5–6: Compare data with predictions and use as evidence in developing explanations

Dinosaur names

- *deino* = terrible
- *sauros* = lizard
- *cerato* = horn
- *ops* = face
- *pachy* = thick
- *ornitho* = bird-like
- *stegos* = roof-like or plated
- *proto* = first
- *tyranno* = tyrant
- *rex* = king
- *bronto* = thunder
- *apate* = deceit
- *pod* = foot
- *ovi* = eggs
- *rapere* = to seize/rob

Examples:

- *Pachycephalosaurus* = thick-headed lizard
- *Ornithopoda* = bird feet
- *Stegosaurus* = plated lizard
- *Triceratops* = three-horn face

What would the following look like/how would they behave?

- *Apatosaurus*
- *Brontosaurus*
- *Oviraptor*

Invent a 'new' dinosaur. Give it a name and draw its features.

Protoceratops

What type of food did *Protoceratops* eat?

What is the evidence?



With thanks to Melbourne Museum for the image of *Protoceratops*

Protoceratops

It had small horns on the side of its head but a large frill on the back of its head. What could the frill have been used for?

What problems could the head frill have solved?



With thanks to Melbourne Museum for the image of *Protoceratops*

Protoceratops: structure and function

- **Herbivore**
- **2 metres long (including tail)**
- **About the size of a sheep**
- **Small horns**
- **Frill on the back of its head, larger in males than in females – possibly involved in courtship; possibly useful for dinosaurs to recognise own species; possibly used to establish social dominance in herd**
- **Hundreds of fossils found in Central Asia; lived in groups on edges of lakes and rivers**
- **Fossils include eggs and nests, newly hatched, teenagers and male and female adults**
- **Head of young dinosaurs large in comparison to body (like other animals, including humans)**

Designing the features of your dinosaur

Feature	Your preference	Why?	Sketch
Lives on land or in the air			
Preferred climate/weather			
Food choice (meat, vegetarian, vegan, gluten-free, FODMAP, everything)			
Size (large, medium, small)			
Colour			
Walking pattern (on two or four legs; fast or slow; long or short steps; hopping, jumping or striding)			
Leg description (long or short; slim, solid or powerful)			
Type of feet (bird-like, lizard-like, number of toes)			
Number of arms			
Arm description (long or short; thin or thick)			
Head size (large, medium, small)			
Head features (horns, frills, spikes)			
Body covering (feathers, fur, skin)			
Body features (spikes, frills)			
Other special features			

Designing the features of Mariasaurus

Feature	Your preference
Lives on land or in the air	<i>air</i>
Preferred climate/weather	<i>warm</i>
Food choice (meat, vegetarian, vegan, gluten-free, FODMAP, everything)	<i>meat and chocolate</i>
Size (large, medium, small)	<i>small</i>
Colour	<i>red and green</i>
Walking pattern (on two or four legs; fast or slow; long or short steps; hopping, jumping or striding)	<i>two legs, fast, jumping</i>
Leg description (long or short; slim, solid or powerful)	<i>springy</i>
Type of feet (bird-like, lizard-like, number of toes)	<i>bird-like</i>
Number of arms	<i>2</i>
Arm description (long or short; thin or thick)	<i>Short, thin</i>
Head size (large, medium, small)	<i>large</i>
Head features (horns, frills, spikes)	<i>horns</i>
Body covering (feathers, fur, skin)	<i>feathers</i>
Body features (spikes, frills)	<i>frills</i>
Other special features	<i>solar panel in frills, face mask</i>

Flaps that rub together to communicate with friends, make music to attract mates or produce scary sounds to frighten predators

Green frills to camouflage in trees

Waterproof frills that wrap around body and protect from wind and rain

Frills that can flap to stay cool in summer and wrap body to stay warm in winter

Solar panels lining frills to stay warm in winter

Spring-like legs to jump long distances and jump high to run away from predators

Red body and head to attract mates

Large head for good brain capacity

Horns to scare predators and help tear up food

Retractable face mask to protect against poisonous gas release

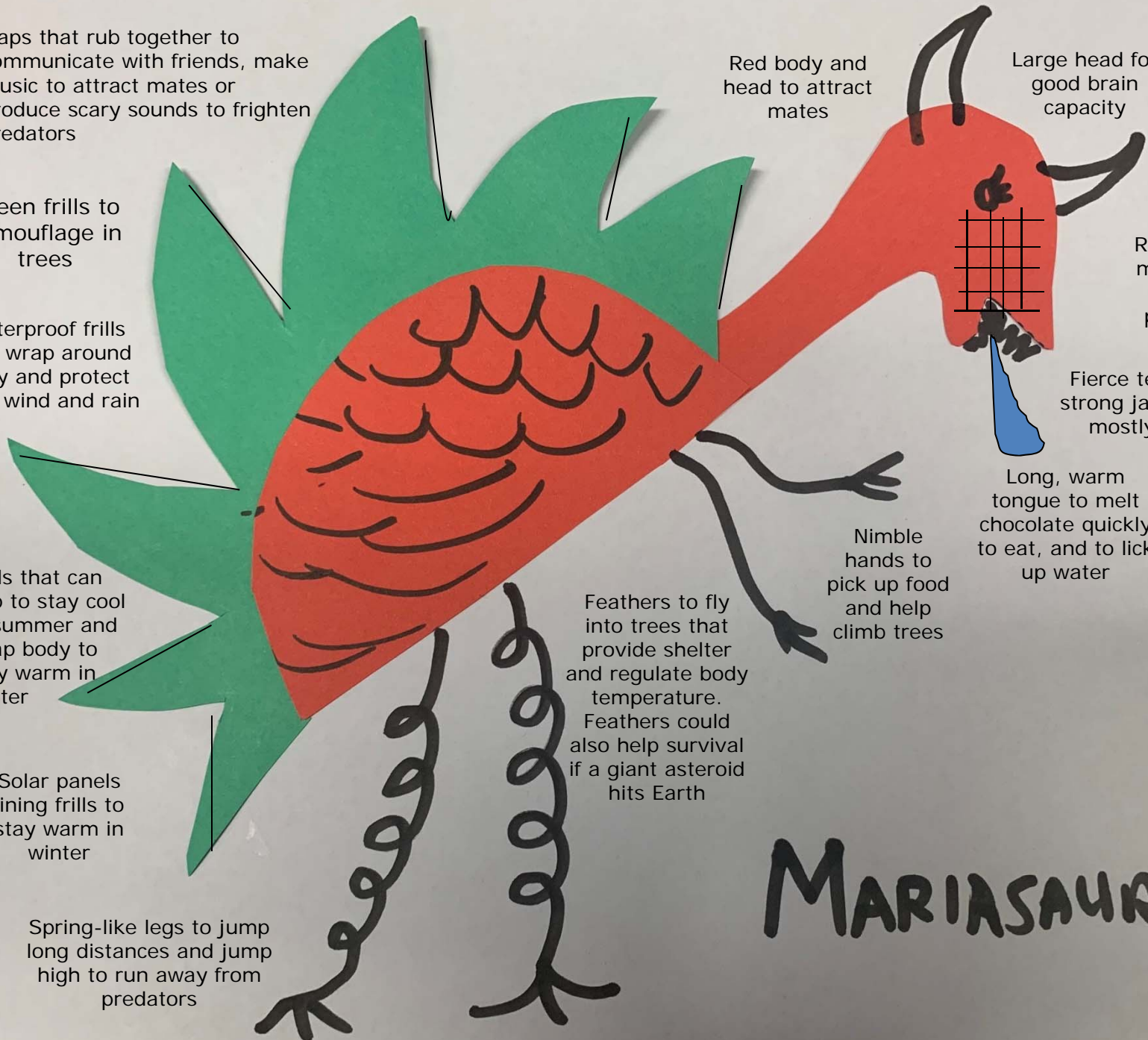
Fierce teeth and strong jaws to eat mostly meat

Long, warm tongue to melt chocolate quickly to eat, and to lick up water

Nimble hands to pick up food and help climb trees

Feathers to fly into trees that provide shelter and regulate body temperature. Feathers could also help survival if a giant asteroid hits Earth

MARIASAURUS



Scientific representations

- **Draw or construct a model of your designosaur, labelling its special features.**
- **Annotate your model to show how your designosaur will:**
 - communicate with other animals
 - defend itself from and/or attack other animals
 - survive in its environment
 - survive if global warming due to volcanic eruption and emission of huge quantities of carbon dioxide (CO₂) leads to significantly increased atmospheric temperatures and increased sea levels.
- **Could your dinosaur become your pet? Why/why not?**
- **What is the biggest threat to your designosaur's survival?**
- **How could the design of your designosaur be improved so that it is better able to survive?**
- **Which class designosaur is yours most similar to?**
 - Of the two dinosaurs (yours and the one that it is most similar to), explain which one would be more likely to survive today.
- **Compare your designosaur with one other designosaur and explain whether the two could successfully live in the same community.**

Sample assessment rubric

- Consider the purpose of the rubric: diagnostic, formative, summative or combination.
- The rubric can relate to one curriculum level or may span several levels.
- You can add rows that relate to relevant elements across the curriculum.

Illustration and explanation of how dinosaur features help it to ...	Very high	High	Medium	Low	Very low	Not shown
meet food needs						
meet water needs						
be protected from the weather						
be protected from predators						
interact successfully with other living things						
attract mates						
survive when the environment changes						

Question: Which dinosaur would have the greatest chance of survival if it were alive today?

Curriculum links:

- Which learning areas and capabilities relate to students investigating this question?
- What learning activities and assessments would be appropriate to support learning in (a) single-level classes or (b) multilevel classes?



Data representations in science

Graphing dinosaurs

- Dinosaur data is easily accessed on the internet
- Sample of data is shown in the table below
- Generate questions, e.g. Is there a relationship between 'X' and 'Y'? Were early dinosaurs larger than later dinosaurs? Are meat-eaters larger than vegetarians? What extra data needs to be collected?

Dinosaur	Infra-order	Height (metres)	Time range
<i>Argentinosaurus</i>	<i>Sauropoda</i>	42	late Jurassic to late Cretaceous
<i>Compsognathus</i>	<i>Coelurosauria</i>	1	late Jurassic to early Cretaceous
<i>Massospondylus</i>	<i>Prosauropoda</i>	4	late Triassic to early Jurassic
<i>Oviraptor</i>	<i>Coelurosauria</i>	2	late Cretaceous
<i>Stegosaurus</i>	<i>Stegosauria</i>	8	late Cretaceous
<i>Triceratops</i>	<i>Ceratopsia</i>	8	late Cretaceous
<i>Tyrannosaurus rex</i>	<i>Coelurosauria</i>	14	late Cretaceous
<i>Velociraptor</i>	<i>Coelurosauria</i>	2	mid Jurassic to late Cretaceous

Graphs and tables in science

Band	Asking questions	Making predictions	Representations
F–2	Respond to and pose questions, and make predictions ...	Compare observations and predictions with those of others	Use ... provided tables to sort information
3–4	With guidance, identify questions that can be investigated and predict what might happen	Compare results with predictions, suggesting possible reasons for findings	Use ... tables and column graphs to represent data and to identify patterns and trends
5–6	With guidance, pose questions to inform a scientific investigation, and predict what the findings of an investigation might be	Compare data with predictions and use as evidence in developing explanations	Construct and use ... tables and graphs to record, represent and describe observations, patterns or relationships in data

Levels F–2: Scaffolded/provided graphs

- provided bar graph scaffolds
- may include lengths of familiar animals (koala, dog, kangaroo, cow, giraffe, elephant)

ANIMAL	LENGTH (m)	GRAPH							
<i>T. rex</i>	14 m	.	.	.	.	.	.	.	.
<i>Compsognathus</i>	1 m	.	.	.	.	.	.	.	.
<i>Maiasaura</i>	10 m	.	.	.	.	.	.	.	.
<i>Iguanodon</i>	11 m	.	.	.	.	.	.	.	.
<i>Ankylosaurus</i>	8 m	.	.	.	.	.	.	.	.
<i>Apatosaurus</i>	30 m	.	.	.	.	.	.	.	.
Human child	1 m								
		4 m	8 m	12 m	16 m	20 m	24 m	28 m	32 m

Dinosaur footprints: linking maths and science

Dinosaur footprints can be analysed in terms of:

- length
- width
- shape
- number of toes
- size of heel impression

Task: Obtain an image of a dinosaur footprint and details about its dimensions. Suggest possibilities for what the dinosaur would have looked like, how it may have moved and how it may have behaved in its day-to-day activities.

Curriculum links: The scientific concept that 'function relies to form' can be investigated from a mathematical perspective.



Life cycles

Dinosaurs compared with other living things

Life cycles of dinosaurs ... and chickens



What will
baby
dinosaurs
look like?



Science inquiry skills: Questioning and predicting

F–2: Respond to and pose questions, and make predictions about familiar objects and events

3–4: With guidance, identify questions in familiar contexts that can be investigated scientifically and predict what might happen based on prior knowledge

5–6: With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be based on previous experiences or general rules

Butterflies, frogs and seahorses



"Pregnant seahorse" by Kelly McCarthy is licensed under [CC BY-SA 2.0](https://creativecommons.org/licenses/by-sa/2.0/)

A female seahorse transfers her eggs to the male, which he self-fertilises in his pouch

Comparisons should be made between living things with different types of life cycles, including living things that may be familiar – as well as unfamiliar – to students

Levels 3–4: Different living things have different life cycles and depend on each other and the environment to survive

Branching out ...

Other teaching ideas related to dinosaurs:

- ❑ **Archaeological digs:** make a 'fossil pit' by adding different bones and fossilised teeth (for example, from birds, chickens, goats, kangaroos) and conduct an archaeological 'dig', including looking at the work of palaeontologists
- ❑ **Life cycles:** put little dinosaurs (models/paper cut-outs) into papier-mâché eggs, break them open and ask students to match the babies to the parents, giving reasons for their decisions
- ❑ **Footprints:** obtain scaled footprints of different dinosaurs and ask students to predict the size of dinosaurs and their method of walking, then compare to actual size and gait



Further information

Dinosaur myth-busting

Myth: Dinosaurs and humans lived at the same time

- **Dinosaurs and humans coexist only in books, movies and cartoons.**
- **The last dinosaurs (other than birds) died out in a mass extinction event about 65 million years ago.**
- **The fossils of our earliest ancestors are only about 6 million years old.**

Myth: All dinosaurs lived at the same time

- Dinosaur communities were separated by both time and geography.
- The ‘age of the dinosaurs’ (the Mesozoic era) included three consecutive geological time periods (the Triassic, Jurassic and Cretaceous periods) and different dinosaur species lived during each of these three periods. For example, *Stegosaurus* would have lived about 150 million years ago (late Jurassic period) and *Tyrannosaurus* evolved about 67 million years ago (Cretaceous period), just a few million years before the mass extinction event.
- More time separates *Stegosaurus* and *Tyrannosaurus* than separates *Tyrannosaurus* from humans today.
- At the beginning of dinosaur history there was one supercontinent on Earth, Pangea, with many dinosaur types spread across it; however, as Pangea broke apart, dinosaurs became scattered across Earth on separate continents, and new types of dinosaurs evolved separately in each geographical area.

Myth: All dinosaurs were big

- Long-necked saurapods like *Dreadnoughtus schrani* could be as big as passenger aeroplanes.
- *Triceratops* and *Stegosaurus* were about as tall as a two-storey building.
- *Tyrannosaurus rex* was about 14 metres long and 4 metres high.
- *Oviraptor* was the size of an adult human.
- The horned dinosaur *Protoceratops* was the size of a sheep.
- *Velociraptor* was the size of a golden retriever (and was scaled up in the movie *Jurassic Park*).
- *Hesperonychus* was a cat-sized raptor.
- *Tianyulong* was a rabbit-sized plant-eater.
- *Parvicursor* was a quail-sized insect-eater.

Myth: All big reptiles were dinosaurs

- All true dinosaurs were terrestrial animals.
- Flying reptiles like pterosaurs (including pterodactyls) and marine reptiles (such as plesiosaurs, pliosaurs, mosasaurs and ichthyosaurs) were not dinosaurs, although they lived during the same time period and suffered the same fate in the mass extinction event.
- Modern birds did not descend from pterosaurs: birds' ancestors were small, feathered terrestrial dinosaurs.
- Although crocodiles, alligators, birds and dinosaurs all evolved from the same common ancestor (*Archosauria*), crocodiles/alligators diverged from birds/dinosaurs about 240 million years ago.
- Crocodiles and alligators diverged from each other about 100 million years ago.

Myth: All dinosaurs were scaly

- Because dinosaurs were related to crocodiles and lizards, most people thought that they must all be scaly.
- Many dinosaurs preserve scaly impressions – duckbills, horned dinosaurs, sauropods and armoured dinosaurs.
- In the 1970s some palaeontologists wondered whether some dinosaurs might have been feathered, like their bird relatives.
- *Sinosauropteryx* (found in 1997) – small carnivorous dinosaur – was covered in soft, fuzzy down.
- Since 1997, feathers have been discovered on plant-eating ornithomimids, fanged heterodontosaurs and many families of carnivorous dinosaurs, including *Tyrannosauridae* (this means that *T. rex* may have had feathers, not scales!)
- Feathers would have helped dinosaurs regulate their body temperature, especially small dinosaurs e.g. velociraptors.

Myth: All dinosaurs were green and brown

- Studies of dinosaur scales and feathers have revealed traces of melanin (the same pigment that gives colour to lizard scales, bird feathers and our skin and hair).
- Dinosaurs came in wide variety of colours, including black, white and ginger.
- Some dinosaur feathers had an iridescent sheen.
- Many dinosaurs were boldly patterned with spots and stripes, white bellies and dark backs.
- Some of the dinosaurs' patterns may have evolved as camouflage, to help dinosaurs hide from predators and prey.
- Bright colours and conspicuous patterns may have served to attract potential mates (like a peacock attracts mates).
- *Sinosauropteryx* probably had a striped brown tail and a raccoon-like bandit mask.

Myth: Dinosaurs were slow and sluggish animals

- Early palaeontologists thought that dinosaurs must have been slow and sluggish to have lost the ‘evolutionary race’ to birds and mammals.
- Modern studies find no evidence that dinosaurs were laggards, lazily dragging their tails behind them.
- Some dinosaurs moved fast, like the raptor dinosaurs, and some were slow, like the big long-necked dinosaurs.
- Most dinosaurs were probably as mobile as large, modern mammals.
- Meat-eating dinosaurs were active predators that probably lay down and rested after a meal,
- The fossilised four-chambered heart of a hadrosaur, more like the heart of a bird or mammal than the heart of a modern reptile, indicates an active bird-like metabolism and warm-bloodedness.
- *Tyrannosaurus rex* probably did not go much faster than a jogging human, due to the stress running would have put on its massive foot bones.

Myth: Dinosaurs were bad parents

- Most reptiles bury their eggs and walk away, leaving their offspring to fend for themselves. This parenting approach is risky since the eggs have little protection – a sea turtle lays thousands of eggs over its lifespan but just a few grow up.
- Dinosaurs were once thought to bury their eggs and walk away.
- Living dinosaur relatives – birds and crocodiles – guard their eggs and their young, and so it is reasonable to think that dinosaurs also guarded their eggs.
- When expeditions to the Gobi Desert found a dinosaur atop a clutch of eggs, it was assumed to have died while plundering the nest and was therefore named *Oviraptor*, meaning ‘egg thief’; when more skeletons were found above egg nests, sitting on them like brooding birds, it was concluded that oviraptors were guarding their eggs, not eating them.

Myth: All dinosaurs became extinct

- Theory of extinction: asteroid striking Earth in Mexico
- A few small feathered dinosaurs, probably fewer than a dozen species, survived (small flying cousins of *Tyrannosaurus rex* and *Velociraptor*, and the direct descendants of the carnivorous dinosaurs) and evolved into tens of thousands of bird species.

Myth: Dinosaurs became extinct because mammals ate their eggs

- **Dinosaurs co-existed with mammals for about 150 million years.**
- **Although dinosaur nests were vulnerable, the most dangerous predators were probably smaller dinosaurs.**
- **Most mammals of the time were probably too small to eat the eggs of large dinosaurs.**

Myth: Dinosaurs were evolutionary failures

- **Stereotype: Dinosaurs were dim-witted, slow-moving uninteresting animals that just sat around waiting to become extinct.**
- **Dinosaur extinction was blamed on dinosaurs' failure to adapt to a changing environment.**
- **Dinosaurs were diverse for more than 100 million years, with fossils found in North and South America, Asia, Europe, Africa and Antarctica.**
- **Our own species, *Homo sapiens*, has existed for only about 200,000 years; our first ancestors appeared 7 million years ago.**

Myth: An asteroid impact alone killed the dinosaurs

- A layer of iridium-rich rock marks the impact 65 million years ago of a 10-km-wide asteroid in shallow water, covering what is now Mexico's Yucatán peninsula, forming a 180-km-wide crater.
- There is no convincing evidence that any non-bird dinosaurs survived the aftermath of the impact.
- Although the impact itself could only have killed the dinosaurs in the immediate vicinity of the impact site, it also produced devastating after-effects, including giant tsunamis, rain that may have been as acidic as battery acid, and clouds of dust that darkened and cooled the globe for months or even decades.
- Another theory suggests that before the impact, dinosaur numbers were already decreasing due to falling sea levels and volcanic eruptions.
- A combination of these factors probably wiped out the dinosaurs.

Myth: We have found fossils from most of the dinosaur species

- **Over 700 species of dinosaurs have been found.**
- **Currently, we know of about 10,000 species of modern avian dinosaurs, or birds.**
- **Reportedly, one new dinosaur species is found each week.**
- **As more countries are opening their borders to palaeontologists, more fossils are being found.**

Myth: *Tyrannosaurus rex* was a giant scavenger

- It was once thought that *Tyrannosaurus rex* was a giant scavenger, lazily roaming around eating carcasses that other predators had killed.
- Researchers have found *Triceratops* bones with *Tyrannosaurus rex* bite marks that had healed up.
- ‘Evolution doesn’t produce a bus-sized animal with a bathtub-sized head and 50-some railroad spike teeth that can crush bone just so that animal can walk around picking up dead carcasses.’

Steve Brusatte, *The Rise and Fall of the Dinosaurs: A New History of a Lost World*, 2018

Myth: *Tyrannosaurus rex* stood upright

- Museums often built *Tyrannosaurus rex* models in an upright position with their tails on the ground.
- Movies generally depicted *Tyrannosaurus rex* in an upright, aggressive position, like Godzilla.
- *Tyrannosaurus rex* held their bodies horizontally.

VCAA contact

Maria James
Curriculum Manager, Science

Email: james.maria.m@edumail.vic.gov.au

Telephone: 9032 1722

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