TEACHER'S GUIDE

# DINOSAUR DETECTIVES

# DIGGING DEEP & DISCOVERING DINOSAURS!

# SPECIMEN LIST

| | |
|---|---|
| **Specimen 1** | (trilobite) |
| **Specimen 2** | (coprolite) |
| **Specimen 3** | (dinosaur bone fragment) |
| **Specimen 4** | (modern mammal bone fragment) |
| **Specimen 5** | (hadrosaur jaw bone cast) |
| **Specimen 6** | (sauropod tooth) |
| **Specimen 7** | (*Tyrannosaurus rex* tooth cast) |
| **Specimen 8** | (carcharodontosaur tooth) |
| **Specimen 9** | (spinosaur tooth) |
| **Specimen 10** | (*Pterodactylus antiquus* cast) |
| **Specimen 11** | (*Archaeopteryx* cast) |
| **Specimen 12** | (turkey wishbone cast) |
| **Specimen 13** | (*Tyrannosaurus rex* wishbone cast) |
| **Specimen 14** | (*Grallator* footprint cast) |
| **Specimen 15** | (tyrannosaur claw cast) |
| **Specimen 16** | (hadrosaur claw cast) |
| **Specimen 17** | (theropod egg cast) |
| **Specimen 18** | (*Lepidotes*–type fish scale) |
| **Specimen 19** | (champsosaur vertebra) |
| **Specimen 20** | (*Onchopristus* tooth) |
| **Specimen 21** | (Tyrannosaur tooth cast) |
| **Specimen 22** | (crocodile tooth) |
| **Specimen 23** | (Gar fish scales) |
| **Specimen 24** | (*Myledaphus* tooth) |
| **Specimen 25** | (basalt crystal) |
| **Specimen 26** | (meteorite fragment) |
| **Specimen 27** | (zircon crystals) |

# DIGGING DEEP & DISCOVERING DINOSAURS!

The **Dinosaur Detectives** travelling outreach case gives students and youth an opportunity to explore and discover the amazing fossilized remains of the largest animals to ever walk the Earth—dinosaurs! Flourishing during the Earth's Mesozoic Era, the fossil record of dinosaurs spans roughly 170 million years of prehistory, and the myriad forms they assumed during this time astound and fascinate youth and adults alike.

# DINOSAUR DETECTIVES:
## AN OVERVIEW

- The **Dinosaur Detectives** outreach kit is organized into eight non-sequential activity centres, each focusing on a certain aspect of prehistory, fossils, and/or life during the time of the dinosaurs.

- Students work through self-guided activity books which encourage them to interact with the information, objects, and other materials provided.

- While some centres rely only on printed materials, the majority include a combination of real fossil, bone, and/or mineral specimens, as well as detailed casts (durable replicas made from molds of real fossil specimens). The **Specimen List** on pg. 2 provides a detailed list of the real and cast specimens included in this kit.

- As much as possible, this **Teacher's Guide** includes supplemental information related to the content of the activity centres.

# OVERALL CURRICULUM

**Dinosaur Detectives** has been designed to be (hopefully) both applicable and helpful in achieving a number of curricular goals.

Dinosaurs, generally speaking, are no longer mentioned or listed in Ontario curricular documents. That said, dinosaurs were living animals that interacted with each other and their environments in complex ways, very much like what takes place today. Concepts and theories pertaining to basic biological, ecological, and environmental phenomena are as applicable to dinosaurs as they are to the living biota, with the added bonus of dinosaurs having a singular capacity to fascinate.

## THIS OUTREACH KIT HAS BEEN DESIGNED TO TARGET

**Grade 4**

- Science and Technology – Habitats & Communities, Rocks & Minerals
- Math

## IT BUILDS ON KNOWLEDGE FROM PREVIOUS GRADES

**Grade 2**

- Growth & Change in Animals

## IT IS STILL APPLICABLE TO THE CURRICULAR EXPECTATIONS OF OLDER STUDENTS

**Grade 6**

- Biodiversity

# HOW TO USE THE KIT

Before students can begin, the teacher will need to remove the student activity booklets and accompanying specimens and equipment from the case, and place them at their respective centres. The specimens and materials required for each centre are outlined in the **Inventory List** on each centre's envelope.

You may want students to record their answers to activity book questions in their workbooks or in data tables of their own design (some are provided).

Or you may prefer students to simply use the questions as springboards for small-group discussion.

The Activity Centres are likely best worked on by small groups of students – groups of four are recommended.

There are several ways this case and its contents could be used in the classroom:

- All students work on the case at the same time. Divide the class into eight groups, so that each group works at one centre. Each group reports their findings to the rest of the class.

  **NOTE**

  Activity Centres 2 and 7, as well as 5 and 7, use some of the same specimens, so these stations should be set up close together.

  Activity Centre 5, with its large roll-out dinosaur trackway, will require additional space.

- All students work on the case, one activity centre at a time, with each group rotating to a new centre until all students have done all the activity booklets. Students and teachers then summarize their findings.

  **NOTE**

  Depending on the Activity Centre, students may need up to 45 minutes to work through each centre. For everyone to complete all activity centres, you will want to allocate approximately 6 to 7 hours of class time.

- Set up the kit one station at a time in a corner of the classroom, and have students cycle through them, one group at a time, over the course of several days. Afterwards, students and teachers summarize their findings.

# CENTRE BY CENTRE
## BACKGROUND INFORMATION & ADDITIONAL CONSIDERATIONS

The following sections aim to help with questions, answers, and discussions specific to each of the **Activity Centres**.

1

# CENTRE 1:
# PREHISTORIC PRELUDE

This centre provides a basic overview of important geological (e.g. geologic time and plate tectonics) and biological (e.g. evolution) concepts, as well as what makes a dinosaur a dinosaur, and how dinosaurs are classified. It provides a basic familiarity with the "big picture" context for other **Dinosaur Detectives** stations.

## CURRICULUM CONNECTIONS

This centre has moderate curricular ties to:

**Grade 2**
- Growth & Change in Animals

**Grade 4**
- Habitats & Communities; Rocks & Minerals

**Grade 6**
- Biodiversity

The primary function of this centre, however, is to provide pertinent palaeontological background knowledge to facilitate a deeper understanding of the information in all other centres.

1

# ACTIVITY TIPS, TRICKS, AND/OR NOTES

## CAN YOU CALCULATE? (pg. 7)

Students may be thrown by the idea of subtracting 66 000 000 from 235 000 000. Some may need guidance to discover that 235–66 = 170 million years.

## ACTIVITY 01.2: CONTINENTS ADRIFT (pg. 9)

Peeking at the back of the cards will give away the answers! Lay these cards "map up" if possible.

The flipbook may help students if they are having trouble. It doesn't contain direct answers, but a far more complete series of maps to show more comprehensively how the continents have changed and moved over time.

## ACTIVITY 01.2: CONTINENTS ADRIFT (Digging Deeper, pg. 10)

Students may provide a number of different answers, such as…

**Q: What do you see happening to the continents through time?**
**A:** moving, separating (in some places), coming/crashing together (in other places)

**Q: How about the oceans?**
**A:** some noticeably growing (e.g. Atlantic), others shrinking or "moving off" continents (e.g. shallow inland seas in N. America, S. America, Africa, Europe, and/or Australia)

**Q: Are there any other changes you notice?**
**A:** brown areas (i.e. deserts) getting bigger/smaller/moving, ice appearing at the poles

1

## **BONUS FACT** (pg. 12)

**The three major rock types are:**

**IGNEOUS:** rocks formed by the cooling of magma or lava (e.g. basalt, granite, pumice)

**SEDIMENTARY:** rocks that form when material eroded from other rocks gets compressed and cemented together (e.g. conglomerate, sandstone, shale). This is the only type of rock that preserves fossils.

**METAMORPHIC:** rocks that form when either sedimentary or igneous rocks are chemically and/or physically altered by heat and/or pressure, without melting (e.g. marble, slate, gneiss)

## **EVOLUTIONARY CHANGE** (pg. 14)

Natural selection, as a major driver of biological evolution, is a concept that students often struggle with, and is seldom touched on with elementary students. For teachers and students who might be interested in exploring evolution in a little more depth, we have provided a supplemental activity ***(OF MOTHS & MICRORAPTOR)*** in which students can simulate the process of natural selection and its effects over generations in a dinosaur-related scenario. See the teacher's guidelines below, and additional sheets for students included in the **Teacher's Materials** envelope.

# ACTIVITY 01.5
# OF MOTHS & *MICRORAPTOR*

## SUPPLY LIST (not provided in this kit)

Every group of students will require:

- A sheet of white paper – roughly the size of an opened newspaper
- One pair of tweezers or forceps
- A clock with a second hand or a stopwatch
- 30 circles of white paper & 30 circles of newspaper (made with a hole punch) – these are the "moths"
- Writing materials to record their observations & data

## DATA TABLE

Students can record their data in a table (and, if desirable, construct a graph) modeling the change in moth population "through time". A sample data table is provided below, which you can photocopy for your students, if desired.

| POPULATION COUNTS | | | | |
|---|---|---|---|---|
| | STARTING POPULATION | | FINAL POPULATION (i.e. how many "survive") | |
| GENERATION# | WHITE | NEWSPAPER | WHITE | NEWSPAPER |
| **1** | **30** | **30** | | |
| **2** (starting population = double the final population from previous round) | | | | |
| **3** (starting population = double the final population from previous round) | | | | |
| **4** (starting population = double the final population from previous round) | | | | |
| **5** (starting population = double the final population from previous round) | | | | |

# SERIOUS SCIENCE

## THE REAL STORY

The feathered theropod, *Microraptor*, is known from the Early Cretaceous Period in China. It lived in a volcanically active area, and ate a variety of small prey – and indeed moths had evolved by that time. So, the situation described in this activity would have, hypothetically, been possible.

The **REAL** example this moth game is based on, however, is that of the Peppered Moth (*Biston betullaria*): a species found across parts of Europe, Asia, and North America.

White-bodied Peppered Moth

Black-bodied Peppered Moth

Photos © Olaf Leillinger

In the 1800s, peppered moths were mostly light with dark speckles. When England was in the middle of its Industrial Revolution, factories and homes were burning **A LOT** of coal to produce energy and heat.

As pollution killed off the lichens and mosses that grew on the light-coloured trees, and blackened their trunks with soot, black-coloured moths became more and more common. Why? Birds were having a much easier time finding the speckled moths on the now blackened trees.

Now, as coal-dust pollution has reduced in England, the trees have become lighter again and the speckled moths have made a comeback!

## ACTIVITY 01.3: WHO'S THE DINOSAUR? (pg. 23)

Placing the cards "creature" side up during set up will keep the students from jumping ahead. While the information on the back of the cards is intended for use by students in helping to determine what is and isn't a dinosaur, their first impressions from the "creature" side of the card is also important.

## ANSWERS

*Dimetrodon* – **NOT** a dinosaur!

*Deinosuchus* – **NOT** a dinosaur!

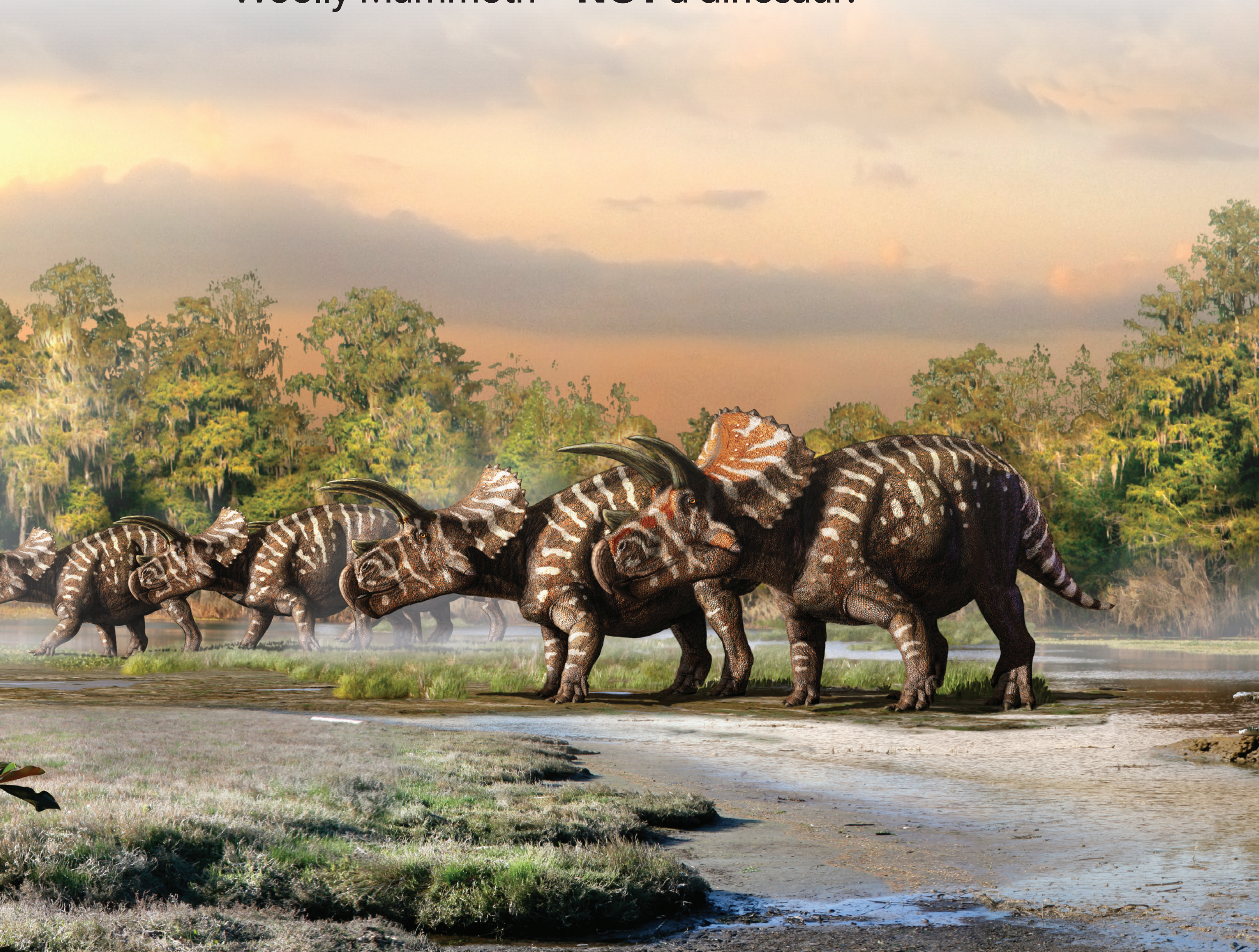
*Pteranodon* – **NOT** a dinosaur!

*Triceratops* – a **DINOSAUR**!

*Tylosaurus* – **NOT** a dinosaur!

*Tyrannosaurus* – a **DINOSAUR**!

Woolly Mammoth – **NOT** a dinosaur!



2

# CENTRE 2: FANTASTIC FOSSILS

As a general introduction to the science of Palaeontology, this centre focuses on what fossils are, how they form, and how they're collected and finally come to be in the museum. An amazing variety of ancient life is preserved in fossils, offering palaeontologists such astonishing insight into the history and development of life on our planet.

## CURRICULUM CONNECTIONS

This centre has moderate curricular ties to:

**Grade 4**

- Rocks & Minerals

The exploration of fossilization and how it can occur is intimately related to sedimentary processes such as weathering, erosion, transport, and deposition.

2

# ACTIVITY TIPS, TRICKS, AND/OR NOTES

## FOSSIL QUIZ (pg. 5)

A note on the "hard parts" of plants: students will likely not answer "pollen", but the outer walls of plant spores and pollen grains are tough, and therefore are often preserved. The incredible volume of spores and pollen grains plants produce during reproduction means an extensive fossil record – providing great insight into the evolution of these groups, as well as invaluable information about ancient environments and climates.

## ACTIVITY 02.1: HOW FOSSILS ARE FORMED (Part 1, pg. 9)

Correct answers can be found on the backs of the cards.

## ACTIVITY 02.2: HOW FOSSILS ARE FORMED (Part 2, pg. 9)

Differences students may observe between the two specimens could include… colour, size, shape, weight, and/or density (density is usually expressed as feeling more "solid").

## ACTIVITY 02.3: FROM DISCOVERY TO DISPLAY (pg. 10)

Correct answers can be found on the backs of the cards.

# CENTRE 3: DINOSAUR DIETS

By adopting a wide variety of diets, dinosaurs were able to thrive, and for a time become the most prominent large-bodied animals on the landscape. In this centre, students will examine and discuss adaptations of dinosaur teeth and jaws – for herbivores and carnivores – prehistoric food webs, and interactions between dinosaurs and their environments.

## CURRICULUM CONNECTIONS

This centre has strong curricular ties to:

**Grade 1**

- Characteristics & Needs of Living Things

**Grade 2**

- Growth & Change in Animals

**Grade 4**

- Habitats & Communities

**Grade 6**

- Biodiversity

This centre examines a variety of adaptations in herbivores and carnivores, and implies the role of dinosaurs within their local food webs.

3

# ACTIVITY TIPS, TRICKS, AND/OR NOTES

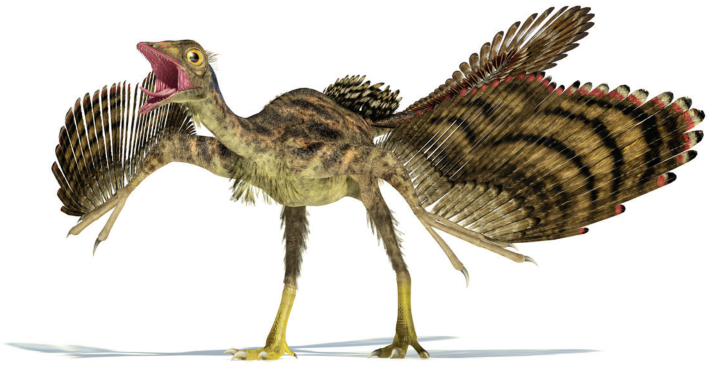
## LET'S TALK: IMAGINE YOU HAD A BEAK **(pg. 8)**

If students show interest, or need clarification, there are a lot of great videos on sites like **YouTube** that can demonstrate the differences between wide and narrow beaks. Show them a video of a goose grazing and one of a parrot eating fruits or nuts, or a finch eating seeds.

## LET'S TALK: ABOUT HOW THESE THEROPODS ATE **(pg. 15)**

The difference between biting and chewing is sometimes tricky for students to grasp. The idea that incisors and molars function in one mouth (i.e. their own) makes teasing out the separate functions difficult. But dinosaur teeth aren't differentiated like that. Ornithischians have beaks for cropping and snipping, while their teeth were efficient for shredding plant material. Theropods used their teeth for piercing, ripping, and tearing. As a result, they swallowed large chunks of meat whole – and a lot of bone along the way (which wouldn't have hurt the chances of their feces becoming a coprolite!).

4



# CENTRE 4:
# WINGED WONDERS & FEATHERED FRIENDS

This centre's focus is two-fold: to examine the first flying vertebrates, pterosaurs, in comparison with birds, and to learn about the anatomy of flight. Second, to more closely examine birds and their anatomy, gaining a better appreciation for their similarities with meat-eating dinosaurs, and the implications this has on the evolution of our feathered friends. **Spoiler Alert: birds ARE dinosaurs!**

## CURRICULUM CONNECTIONS

This centre has moderate curricular ties to:

**Grade 2**
- Growth & Change in Animals

**Grade 4**
- Habitats & Communities

**Grade 6**
- Biodiversity

This centre looks at the structural adaptations of pterosaurs (flying reptiles) and birds for flight, as well as other functions of feathers among both living birds and dinosaurs.
The distinguishing characteristics uniting birds with dinosaurs are discussed at length.

# ACTIVITY TIPS, TRICKS, AND/OR NOTES

## LET'S TALK: WAS ARCHAEOPTERYX A BIRD OR A DINOSAUR? (pg. 14)

Getting students to write down what they think the defining characteristics of a bird are, or of doing so with the class, is key here – we will be revisiting their answers later.

## ACTIVITY 04.2: COMPARING ARCHAEOPTERYX WITH MODERN BIRDS (pg. 15)

A printable copy of the Creature–Feature worksheet is included. Teachers will want to create enough copies for one sheet per group or per student, as they see fit.

## WHAT SCIENTISTS KNOW: FOR DISCUSSION (pg. 17)

Once again, suggesting students write these down is ideal, as they will be revisited in activities to come.

## ACTIVITY 04.3: (pg. 19)

The furcula (wishbone) is one of the features that was long thought to be unique to birds. Only in the last couple decades have palaeontologists come to discover that furculae are common in a wide variety of theropod dinosaurs.

## ACTIVITY 04.4: WHAT EXACTLY IS A BIRD? (pg. 20–21)

Understanding phylogenetic (i.e. evolutionary) tree diagrams can be complex. Keep in mind when using the fold-out tree that characteristics are marked where they FIRST occur. For example, "hard shelled eggs", the characteristic at the base of the tree, is shared by ALL of the animals above that point. A "toothless beak" is shared by the fewest animals, and so only those two (the blue jay and the turkey) occur above that branch. The blue jay and the turkey possess ALL of the other characteristics listed as well, but they are united by the feature they share, but that none of the others possess.

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# CENTRE 5:
# TRACKING TITANS

This centre focuses on how footprints and trackways provide additional information about dinosaurs. Using simple measurements and calculations, as well as some relatively straight-forward detective work, students will relate footprints to the foot skeletons of different dinosaurs, and ultimately work with a reproduction of a partial trackway to learn about the dinosaurs that made it. They will determine dinosaur behaviour in a way that lets them (almost) actually observe it, gaining insight into how these animals might have been adapted to improve their chances of survival.

## CURRICULUM CONNECTIONS

This centre has moderate curricular ties to:

**Grade 4**

- Habitats & Communities; Number Sense & Numeration; Measurement; Data Management & Probability

**Grade 6**

- Biodiversity

In this centre, students will take measurements, record data, and use simple algebra to form interpretations about track makers and their possible interaction. While the mathematical operations are primarily at a fourth grade level, teachers may adapt this for slightly younger students (e.g. by working it as a class).

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# ACTIVITY TIPS, TRICKS, AND/OR NOTES

## DINO MATH & ACTIVITY 05.2 **(pg. 8–15)**

This full scale (life size) rollout trackway is based on a section of an actual Late Cretaceous dinosaur trackway (the Paluxy River trackway) from Texas, which is on display at the American Museum of Natural History in New York City.

### INSTRUCTIONS:

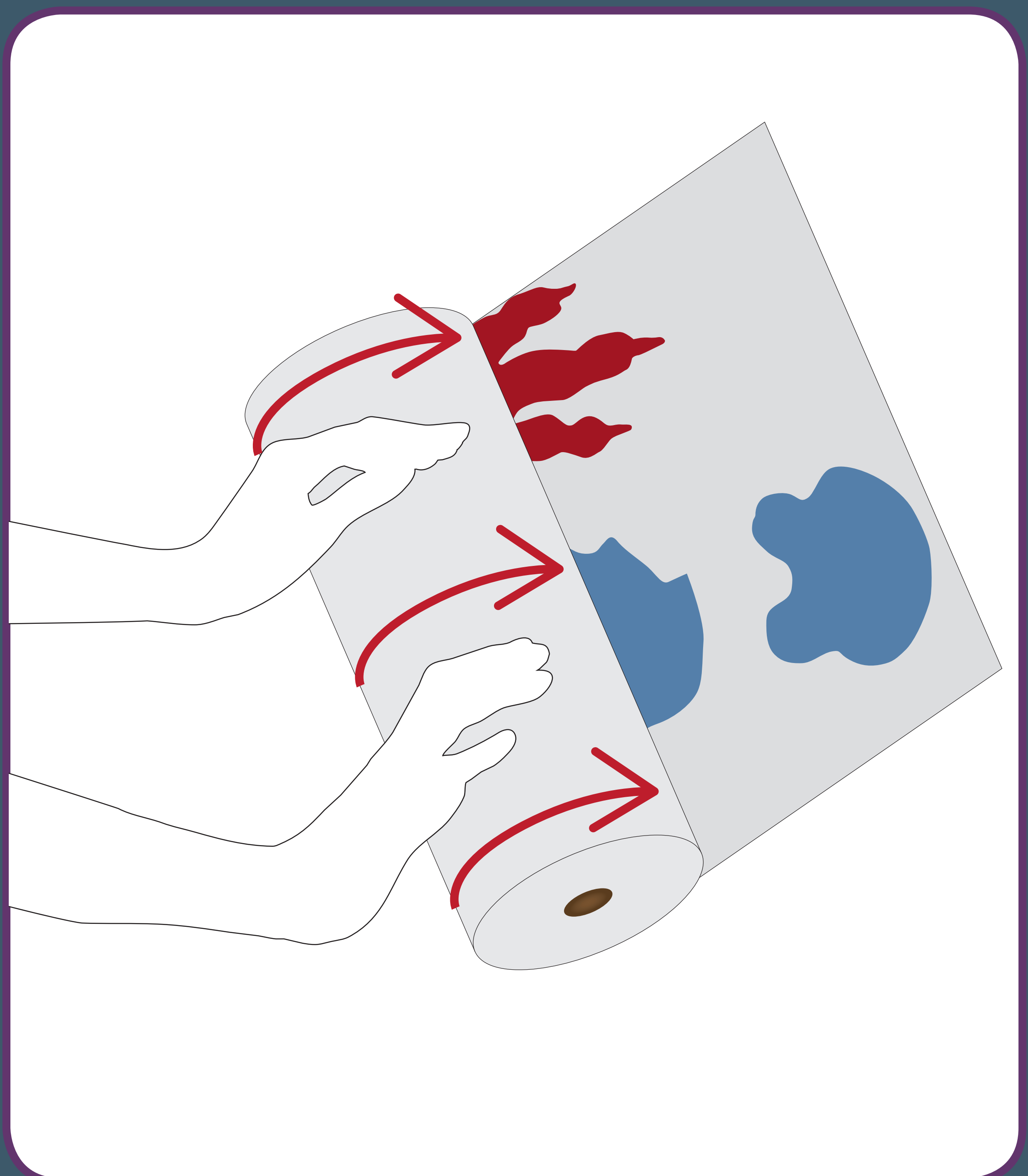
Teachers should set up the trackway before the students begin the activity. But setting it up as a class is an option as well.

1. **Take out all 4 rolls of the trackway and unroll them.**
2. **Place them side by side in order – from roll #1 on the left to roll #4 on the right.**

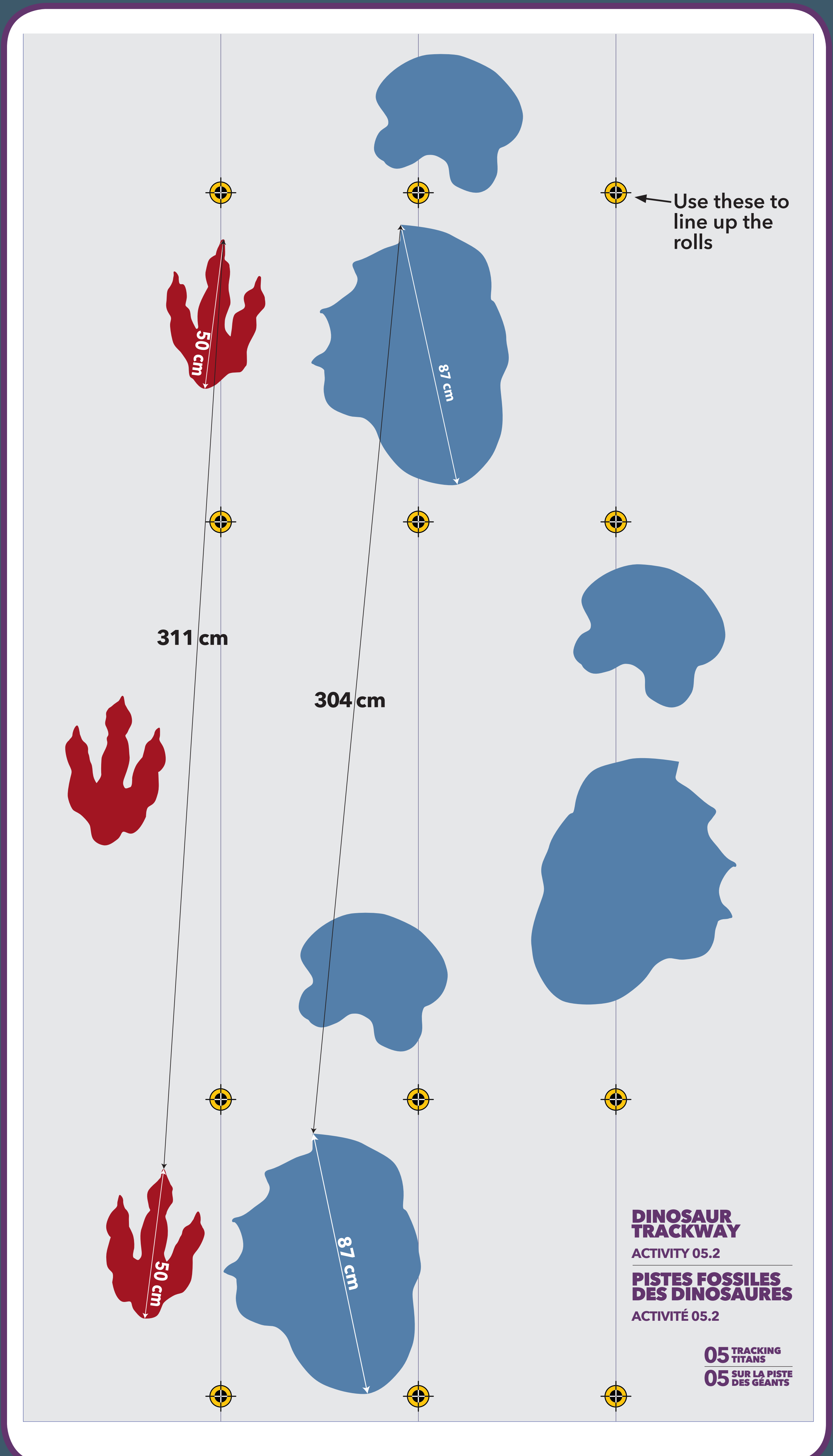
### TIPS FOR SET-UP:

- You will need a clear floor space approximately 5 m x 3 m to unroll the complete trackway. If you can't clear enough space in your classroom, you can use a wide hallway, gymnasium, or other large space.
- If you need to weigh down the corners of the rolls, please do not use tape.
- **Please ask students to remove their shoes before walking on the trackway** (shoes make excellent weights for weighing down the corners!).
- Worksheets are provided for students to record their measurements and calculations. For older students, you may want to have them produce their own data sheet.
- When you've completed the activity, roll up each piece of the trackway separately. Begin with the printed side up, and start rolling from the bottom.

# HOW TO ROLL THE TRACKWAY



# TRACKWAY FULL VIEW (WITH ANSWERS)



5

**pg. 10–11**

Try to help your students take their measurements as accurately as possible along the way. Slight errors will affect the calculations they do later. Having them show their work will be important for discussion, if their answers are slightly off those provided.

# ACTIVITY 05.2

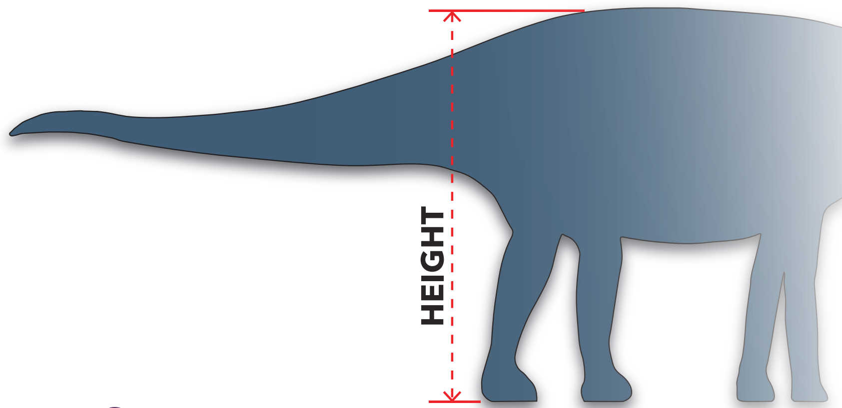
## TRACK-MAKER WORKSHEET – ANSWERS

| LEFT TRACK-MAKER (RED) | RIGHT TRACK-MAKER (BLUE) |
|---|---|
| DINOSAUR TYPE: **THEROPOD** | DINOSAUR TYPE: **SAUROPOD** |
| ☑ BIPEDAL (two-legged) – measure any foot<br>☐ QUADRUPEDAL (four-legged) – measure one of back (bigger) feet | ☐ BIPEDAL (two-legged) – measure any foot<br>☑ QUADRUPEDAL (four-legged) – measure one of back (bigger) feet |
| FOOTPRINT LENGTH = **50 cm** | FOOTPRINT LENGTH = **87 cm** |
| STRIDE LENGTH = **311 cm**<br>(is it a quadruped? If so, use the back feet!) | STRIDE LENGTH = **304 cm**<br>(is it a quadruped? If so, use the back feet!) |
| HIP HEIGHT = **245 cm** | HIP HEIGHT = **400.2 cm** |
| RELATIVE STRIDE LENGTH = **1.27** | RELATIVE STRIDE LENGTH = **0.76** |
| WAS IT WALKING, TROTTING, OR RUNNING? | WAS IT WALKING, TROTTING, OR RUNNING? |
| SPEED = **6.6 km/h** | SPEED = **3.6 km/h** |

## ACTIVITY 05.2: STEP 3 – CALCULATING HEIGHT

**(pg. 12)**

Palaeontologists don't measure the height of a dinosaur the same way we do in humans. How high a dinosaur might "typically" hold its head, versus how high it might be able to lift its head is quite variable. To be consistent, palaeontologists measure "height" as the height of the hip (i.e. from the bottom of the foot to the top of the hip, near the back).




## WHAT DOES IT ALL MEAN? (pg. 15)

**In your final discussion, consider this:**

Just how fast are 3.6 and 6.6 km/hr? Here's some context: the average human walking speed is usually 5 km/hr (though obviously this can be highly variable). The fastest recorded human running speed (as of 2015) is 44.72 km/hr, set by Usain Bolt in 2009 at the World Championships in Berlin, Germany. Interested students could research the walking or running speeds of other animals, or calculate their own for comparison.

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# CENTRE 6: GROWING GIANTS

This centre focuses on the amazing growth and development of dinosaurs. Students will explore, in simple terms, how dinosaurs reproduce. They will also get a chance to look at how quickly we now think dinosaurs grew and how their bodies changed as they grew, while comparing against human growth.

## CURRICULUM CONNECTIONS

This centre has strong curricular ties to:

**Grade 1**

- Characteristics & Needs of Living Things

**Grade 2**

- Growth & Changes in Animals; Healthy Living

**Grade 4**

- Habitats & Communities; Number Sense & Numeration; Measurement; Data Management & Probability

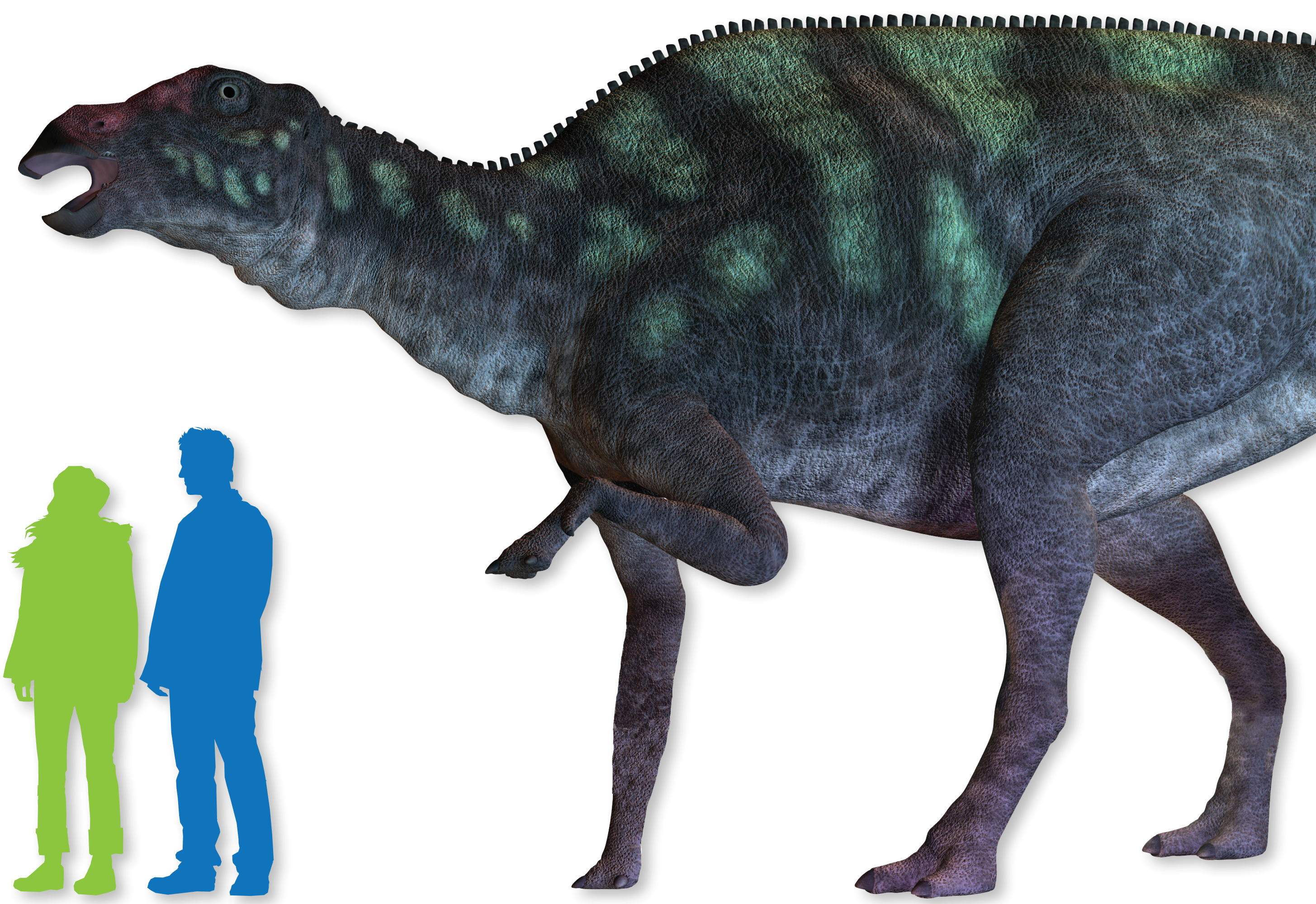
Examining dinosaur reproduction and growth uses simple multiplication and division to compare the masses of infant and adult dinosaurs and humans, and qualitatively examine how different parts of animal bodies grow at different rates.

# ACTIVITY TIPS, TRICKS, AND/OR NOTES

## ACTIVITY 06.2: COMPARING *MAIASAURA* AND HUMANS (pg. 9-12)

The math in this activity primarily involves multiplication and division of weights (in kg) – younger students could work as a class or with calculators. Older students could be challenged to make their own data tables to organize their calculations, or research other growth data for comparison.

The human weights cited are 50th percentile values from World Health Organization growth charts for North Americans, averaged for sex-differences.



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# CENTRE 7: SCRAMBLED SKELETONS

This centre explores what palaeontologists can learn from fragmentary dinosaur remains. Students learn about different ways dinosaur skeletons may be preserved, and how even scrambled skeletal remains can provide great insight. Finally, students examine multiple fossils to compare and contrast distinct fossil groups from different areas in the northern and southern hemispheres, offering insight into the diversity of life during the time of the dinosaurs.

## CURRICULUM CONNECTIONS

This centre has strong curricular ties to:

**Grade 2**

- Growth & Changes in Animals

**Grade 4**

- Habitats & Communities

**Grade 6**

- Biodiversity

Relatively intact skeletons can inform our understanding of anatomy, while scrambled skeletal material (involving multiple species) can give us significant insight into potential ecological interactions.

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# ACTIVITY TIPS, TRICKS, AND/OR NOTES

## ACTIVITY 07.1: ARTICULATED VS. SCRAMBLED

**(pg. 6–8)**

The questions in this activity are purposefully repetitive, to help demonstrate how different types of fossilized remains yield different information.

If students are having difficulty estimating the number of dinosaurs in the bonebed, tell them to look for nasal horns. Bones that only appear once on a dinosaur (like nasal horns) are used by palaeontologists to establish a **minimum** number of individuals for a bonebed.

Similarly, if students aren't sure whether or not these dinosaurs cared for their young, the hint is to look for juvenile dinosaur bones in the bonebed, and consider what that could mean.

## ACTIVITY 07.2: VERTEBRATE MICROFOSSIL ID GUIDE **(pg. 11)**

If students are struggling to figure out what was a carnivore and what was a herbivore using such fragmentary fossils, instruct them to look at the shapes of the teeth and/or claws.

8

# CENTRE 8: END OF AN ERA

There have been many theories about the extinction of the dinosaurs at the end of the Cretaceous Period. While some theories have more supporting evidence than others, the reality is that there were a number of different phenomena taking place, interacting with one another in complicated ways. In this centre, students review some of that evidence, reach their own conclusions, and compare against the scientific consensus.

## CURRICULUM CONNECTIONS

This centre has moderate curricular ties to:

**Grade 2**

- Growth & Changes in Animals

**Grade 3**

- Growth & Changes in Plants

**Grade 6**

- Space

This centre has strong curricular ties to:

**Grade 4**

- Habitats & Communities; Rocks & Minerals

**Grade 6**

- Biodiversity

**Grade 7**

- Interactions in the Environment

When considering the factors contributing to extinction, younger grades can look at the basic needs of animals and plants for survival, as well as the extraterrestrial origin of the meteorite/comet that struck the Earth 66 million years ago. Students in Grade 4 and up can examine the geologic, oceanographic, and atmospheric phenomena that coincided with the Cretaceous–Paleogene Mass Extinction and consider their impacts on food webs, biodiversity, and ecosystems across the globe.

8

# ACTIVITY TIPS, TRICKS, AND/OR NOTES

## GENERAL NOTE:

The questions in this centre are primarily discussion-based, and are meant to get students thinking, rather than emphasizing any particular "right" answer. The following are meant to give examples, additional points, and/or context to guide discussion.

## ACTIVITY 08.2 – SHIFTING SHORELINES (pg. 8–10)

*What differences do you see between the Earth today and 90 million years ago?*

**90 million years ago there were...**

- No polar ice caps
- Many inland seas
  (shallow seas on the continents or "more water")
- Fewer deserts
- The Atlantic Ocean was much smaller
  (and the Pacific was bigger)
- India was an island, much further south
- Australia was attached to Antarctica

*What differences do you see between the Earth 66 and 90 million years ago?*

**66 million years ago…**

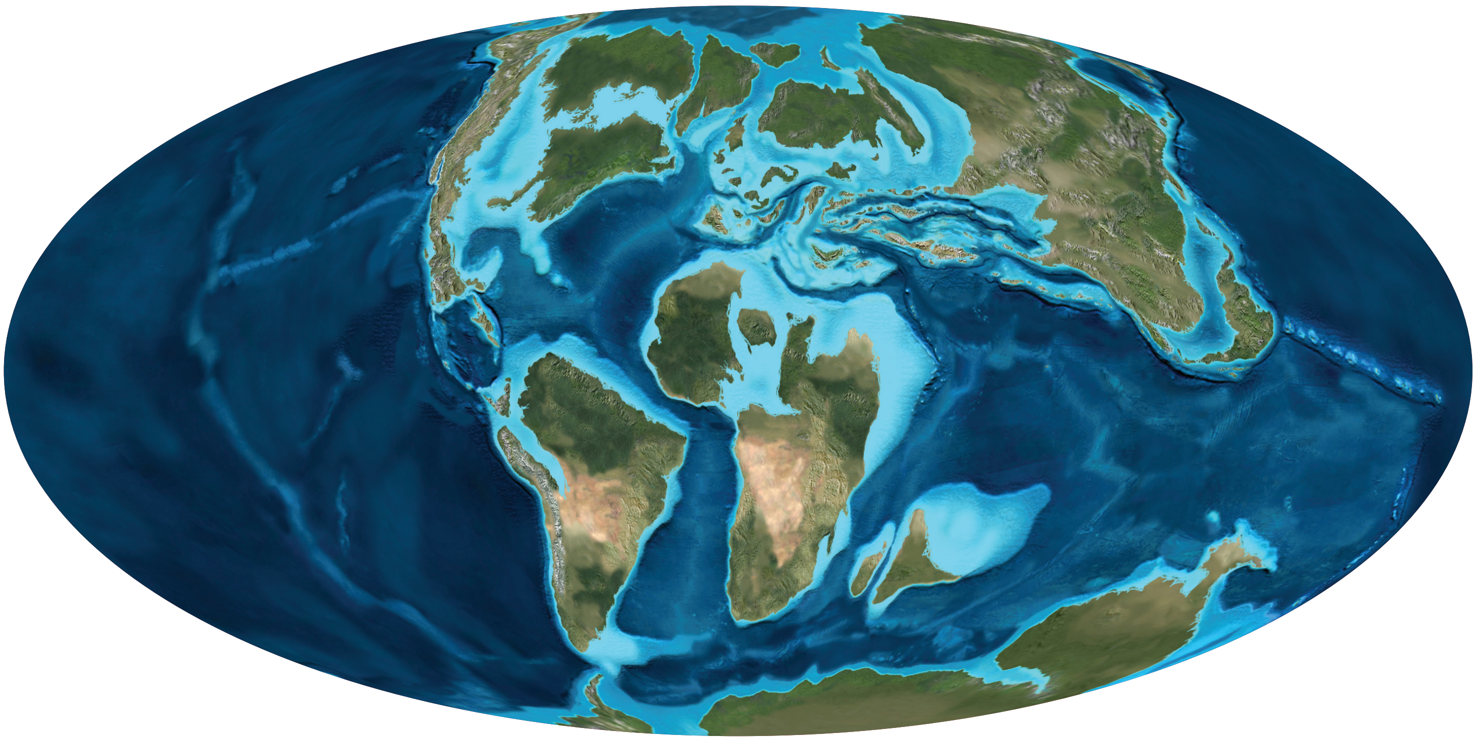
- Most inland seas were smaller
  (e.g. see N. America, Eurasia, Africa, India)
- The Atlantic Ocean was a little bit wider
- There were more/larger areas of desert
- India had moved further away from Africa and Antarctica
- Australia had detached from Antarctica

*How do you think the shrinking of inland seas and cooling water temperatures might have put life in the seas under stress at the end of the Cretaceous?*

For everything that lived in the shallow, warm, inland seas, this was a serious loss of habitat. As the oceans were getting colder, warm-water species would have a much harder time finding food and reproducing.

*What about life on land?*

As the seas retreated and the life within disappeared, all the land animals which relied on it for food would also suffer. Warm seas and oceans have a big effect on keeping the weather moderate and moist on land. So the retreat and cooling would have made the weather cooler, drier, and more variable between summer and winter.



## ACTIVITY 08.3: LOTS OF LAVA! **(pg. 11–12)**

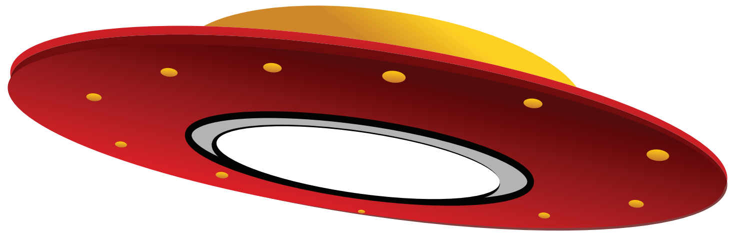
***How do you think the Deccan Trap eruptions affected life locally, in India?***

The lava would burn vegetation, kill animals, and start forest fires. Poisonous gases would also kill plants and animals living in the area. The mixing of sulphurous gases with water vapour in the atmosphere would cause acid rain across the region.

***How do you think it might have put stress on life, both on land and in the sea, around the rest of the world at the end of the Cretaceous?***

The acid rain would definitely not have been good for life in the oceans around India. But the main global affect, for life on land and in the sea, would be the cooling that would come from so much ash and dust being thrown high into the atmosphere and blocking the sun.

8

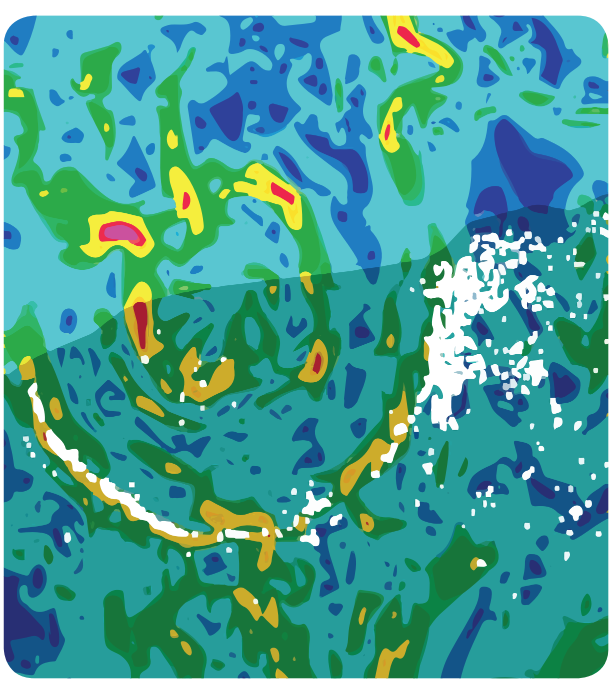


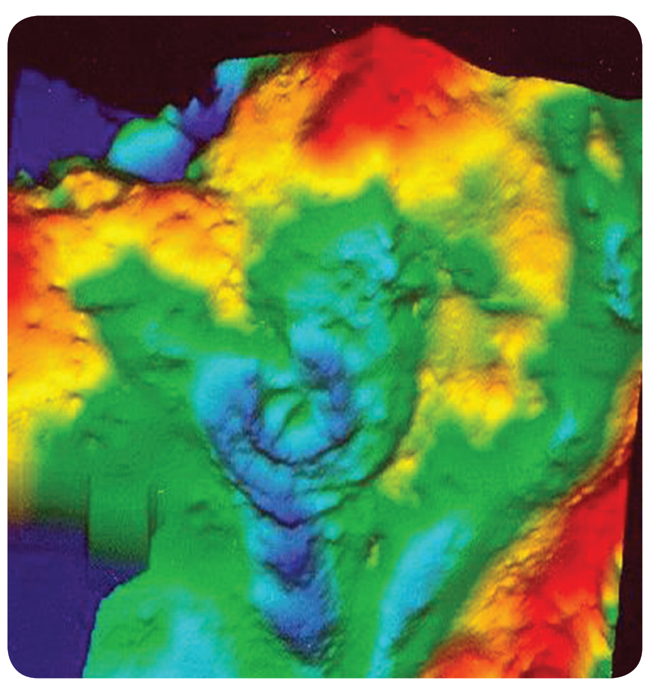
## IT CAME FROM OUTER SPACE! **(pg. 15)**

***How do you think the Chicxulub impact would have affected life in the sea?***

The Chicxulub impact is thought to have taken place in a shallow sea, so the effects on the ocean would have been extreme.

- The impact would have flash-boiled millions of gallons of water, and created a blast of super-heated steam, killing a significant amount of life in the surrounding sea.
- It would have caused kilometres-high megatsunamis, which would have scoured much of the sea floor around what is now the Caribbean and the gulf of Mexico.
- The massive clouds of ash and dust that were spewed into the atmosphere would have blocked out the sun, cooling the oceans and shutting down photosynthetic algae and bacteria, and seriously affecting the animals that depend on them around the world.





*How would it have affected life on the land?*

- The blast wave of superheated steam and air would have flattened anything standing within several kilometres and roasted many animals alive.

- Earthquakes and volcanic eruptions would have been triggered worldwide.

- The impact would have vaporised huge quantities of rock from the sea floor, which would mix with water vapour in the atmosphere causing strongly acidic rain to fall over the land, poisoning fresh water sources and killing wildlife.

- As red-hot pieces of rock and fragments of the meteorite blasted out of the impact site, massive forest fires would result in the death of many plants and animals.

- With the sun blocked out for a decade or more, plant life would die off, and the animals that relied on those plants would follow.

## WHAT HAPPENED TO THE DINOSAURS? (pg. 18)

*Which do you think was most to blame for the extinction of the dinosaurs (and so many other forms of life) at the end of the Cretaceous Period?*

This question is truly up to the students for debate. It is meant to lead them towards the idea that something as major as a mass extinction event may be more complicated than any single cause.

That said, the majority of palaeontologists would likely say that the Chicxulub impact event was the final straw for many Late Cretaceous plants and animals. With terrestrial and marine ecosystems under stress from the combined effects of significant long-term sea level changes, climatic shifts, and massive volcanism, a meteorite impact was simply more than the majority of dinosaurs could handle.

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