

*hands-on*  
**science**  
*An Inquiry Approach*

**Grade 5**

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**An Inquiry Approach**

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# **Introduction to** ***Hands-On Science, Grade 5***

# Introduction to *Hands-On Science*

## Program Introduction

*Hands-On Science* helps develop students' scientific literacy through active inquiry, problem solving, and decision making. With each activity in the program, students are encouraged to explore, investigate, and ask questions as a means of heightening their own curiosity about the world around them. Students solve problems through firsthand experiences, and by observing and examining objects within their environment. In order for young students to develop scientific literacy, concrete experience is of utmost importance – in fact, it is essential.

## The Foundations of Scientific Literacy

*Hands-On Science* focuses on the four foundation statements for scientific literacy in Canada, as outlined in the Pan-Canadian Protocol.<sup>1</sup> These foundation statements are the bases for the learning outcomes identified in *Hands-On Science*.

### Foundation 1: Science, Technology, Society, and the Environment (STSE)

Students will develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and environmental contexts of science and technology.

### Foundation 2: Skills

Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

### Foundation 3: Knowledge

Students will construct knowledge and understandings of concepts in life science, physical science, and earth and space science, and apply these understandings to interpret, integrate, and extend their knowledge.

### Foundation 4: Attitudes

Students will be encouraged to develop attitudes that support responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

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**NOTE:** While these foundation statements form the bases for the science program, it is important for teachers to recognize and honour that some students might identify with science from a cultural knowledge base. For example, Indigenous students might not respond to in-class questioning, as they might view this as opposing traditional protocol of respectful listening; therefore, the teacher may have to clarify the intent of questioning in the classroom and acknowledge the different ways students may demonstrate knowledge, basic skills, values, and attitudes.

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## Program Principles

1. Effective science programs involve hands-on inquiry, problem solving, and decision making.
2. The development of students' skills, attitudes, knowledge, and understanding of STSE issues form the foundation of the science program.
3. Children have a natural curiosity about science and the world around them. This curiosity must be maintained, fostered, and enhanced through active learning.
4. Science activities must be meaningful, worthwhile, and relate to real-life experiences.

<sup>1</sup> *Common Framework of Science Learning Outcomes: Pan-Canadian Protocol for Collaboration on School Curriculum*, 1997

5. The teacher's role in science education is to facilitate activities and encourage critical thinking and reflection. Children learn best by doing, rather than by just listening. The teacher, therefore, should focus on formulating and asking questions rather than simply telling.
6. Science should be taught in correlation with other school subjects. Themes and topics of study should integrate ideas and skills from several core areas whenever possible.
7. The science program should encompass, and draw on, a wide range of educational resources, including literature, nonfiction research material, audio-visual resources, technology, as well as people and places in the local community.
8. The science program should be infused with knowledge and world-views of the Indigenous Peoples of North America, as well as other diverse multicultural perspectives.
9. Assessment of student learning in science should be designed to focus on performance and understanding, and should be conducted through meaningful assessment techniques carried on throughout the unit of study.

## Program Implementation

### Program Resources

**Hands-On Science** is organized in a format that makes it easy for teachers to plan and implement. The book is divided into four units, which are the selected topics of study for the grade level, as well as a main introduction at the beginning of the book. The units relate directly to the learning outcomes, which complement those established in the Pan-Canadian Protocol and related provincial/territorial documents.

Each unit also has its own introduction, which summarizes the general goals for the unit. This

introduction provides background information for teachers, planning tips, lists of vocabulary related to the unit, as well as other pertinent information such as how to embed technology, sustainability, and Indigenous and multicultural perspectives into units of study.

Also included at the beginning of each unit is a Curriculum Correlation Chart for Knowledge and Understanding Outcomes, and another for Scientific Inquiry and Design Process Skills Outcomes. These are based on the Pan-Canadian Protocol for Science outcomes, as well as on provincial/territorial science curriculum documents.

Additionally, the introduction to each unit includes a list of related books suitable for students and a list of annotated websites. References for Teachers is located at the end of the book.

Each unit is organized into numbered lessons comprised of topics and activities based on the learning outcomes. Lessons are arranged in the following format:

**Lesson Title:** The title of each lesson is posed as a guided inquiry question, which identifies the outcomes students will be addressing or the question they will be answering.

**Information for Teachers:** Some lessons provide teachers with the basic scientific knowledge they will need to present the activities. This information is offered in a clear, concise format, and focuses specifically on the topic of study.

**Materials:** A complete list of materials required to conduct the main activities is provided. The quantity of materials required will depend on how you conduct activities. If students are working individually, you will need enough materials for each student. If students are working in groups, the materials required will

be significantly reduced. Many of the identified items are for the teacher to use for display purposes, or for making charts for recording students' ideas. In some cases, visual materials (large pictures, sample charts, and diagrams) have been included with the activity to assist the teacher in presenting ideas and questions, and to encourage discussion. You may wish to reproduce these visuals, mount them on sturdy cardstock, and laminate them so they can be used for years to come.

**Engage:** This activity is intended to activate prior knowledge, review previous lessons, and engage students in the lesson. The guided inquiry question for the lesson is also introduced in this section. Teachers may choose to record the question for display throughout related investigations. For example, the guided inquiry question might be recorded on a sentence strip and displayed.

**Explore:** This section details a step-by-step procedure, including higher-level questioning techniques, and suggestions for encouraging the acquisition of new knowledge and skills. In some cases, one lesson may involve several Explore activities, which are identified as Explore: Part One, Explore: Part Two, and so on.

**Learning Centre:** Included with most lessons are independent student learning opportunities that focus on the learning outcomes. They are designed as learning centres, and to promote differentiated instruction, the centres are based upon multiple intelligences research.<sup>2</sup> Each centre focuses on a different multiple intelligence, to provide opportunities for students to use areas of strength and also to expose them to new ways of learning. The following

intelligences, identified by the accompanying icons, are focused on in **Hands-On Science**:

- **Verbal-Linguistic:** These learners think in words and enjoy reading, writing, word puzzles, and oral storytelling. When a learning centre focuses on Verbal-Linguistic intelligence, the following icon is used:



- **Logical-Mathematical:** These learners think by reasoning and enjoy problem-solving, puzzles, and working with data. When a learning centre focuses on Logical-Mathematical intelligence, the following icon is used:



- **Visual-Spatial:** These learners think in visual pictures and enjoy drawing and creating visual designs. When a learning centre focuses on Visual-Spatial intelligence, the following icon is used:



- **Bodily-Kinesthetic:** These learners think using their physical bodies, and enjoy movement, sports, dance, and hands-on activities. When a learning centre focuses on Bodily-Kinesthetic intelligence, the following icon is used:



- **Musical-Rhythmic:** These learners think in melodies and rhythms and enjoy singing, listening to music, and creating music. When a learning centre focuses on Musical-Rhythmic intelligence, the following icon is used:



<sup>2</sup> Conklin, Wendy. *Differentiation Strategies for Science*. Huntington Beach, CA: Shell Education, 2004.

Katz, Jennifer. *Teaching to Diversity: The Three-Block Model of Universal Design*. Winnipeg: Portage and Main Press, 2012.

- **Interpersonal:** These learners think by talking to others about their ideas and enjoy group work, planning social events, and taking a leadership role with friends or classmates. When a learning centre focuses on Interpersonal intelligence, the following icon is used:



- **Intrapersonal:** These learners think within themselves and enjoy quietly thinking, reflecting, and working individually. When a learning centre focuses on Intrapersonal intelligence, the following icon is used:



- **Naturalistic:** These learners learn by classifying objects and events and enjoy anything to do with nature and scientific exploration of natural phenomena. When a learning centre focuses on Naturalistic intelligence, the following icon is used:



- **Existential:** These learners learn by probing deep philosophical questions and enjoy examining the bigger picture as to why ideas are important. When a learning centre focuses on Existential intelligence, the following icon is used:



Teachers are encouraged to explore the topic of multiple intelligences with their students and to have students identify ways they learn best, and ways that are challenging for them. Guidelines for this process are included in the book *Teaching to Diversity* (cited in the footnote on the previous page).

Each learning centre is described on a task card that remains at the centre, along with any required supplies and materials. When implementing the learning centres, it is important to review the task card prior to having students work at the centre, to ensure they are familiar with the content and the expectations.

**NOTE:** Many of the learning centre tasks also offer excellent assessment opportunities – both formative and summative – that teachers can take advantage of through student conferences/interviews. Teachers can then use the Individual Student Observations sheet, on page 19, to record assessment data. See the next section of *Hands-On Science, Assessment Plan*, for more information on assessment.

**Embed: Part One:** The activities in this section are intended to review the main ideas of the lesson, focusing on specific learning outcomes. The guided inquiry question for the lesson is also reviewed in this section, and students are encouraged to share their knowledge, provide examples, and ask further inquiry questions. This section also includes directions for any reproducible activity sheets found in the lesson, which are designed to correlate with the learning outcomes of the main activity. Activity sheets are included to be used during the main activity in a lesson, often to record results of investigations. In some lessons, the same activity sheets are used as follow-up to the main activities.

Students may work independently on the sheets, in small groups, or you may read over the sheets together and complete them in a large group setting. Activity sheets can also be made into overheads or large experience charts. Since it is important for students to learn to construct their own charts and recording formats, teachers may decide to use the activity sheets as examples of ways to record and communicate ideas about an activity. Students can then create their own sheets rather than use the ones provided.

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**NOTE:** Activity sheets are meant to be used only in conjunction with, or as a follow-up to, the hands-on activities. The activity sheets are not intended to be the science lesson in itself or the sole assessment for the lesson.

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**Embed: Part Two:** With each lesson, teachers are also encouraged to embed learning by adding to graphic organizers; having students record, describe, and illustrate new vocabulary; and adding new vocabulary to the classroom word wall (a bulletin board or piece of poster paper for displaying new science terminology. Both teachers and students can then add to the word wall throughout the unit, or even all year.) New vocabulary may include terminology in Indigenous and other languages that reflect the cultural diversity of the classroom and the community.

**Enhance:** This section includes optional activities to extend, enrich, and reinforce the learning outcomes.

**Assessment for, as, and of Learning:** Based on current research about the value of quality classroom assessment (Davies 2011), suggestions are provided for authentic assessment, which includes assessment *for* learning, assessment *as* learning, and assessment *of* learning. These assessment strategies focus specifically on the learning outcomes that are related to a particular lesson.

Keep in mind that these suggestions are merely ideas to consider; teachers are also encouraged to use their own assessment techniques and to refer to the other assessment strategies outlined in detail in the Assessment section of *Hands-On Science*, on pages 15 to 28.

## Classroom Environment

The classroom setting is an important aspect of any learning process. An active environment, one that gently hums with the purposeful conversations and activities of students, indicates that meaningful learning is taking place. When studying a specific topic, teachers are encouraged to display related objects and materials, student work, pictures and posters, graphs and charts made during activities, and summary charts of important concepts taught and learned. An active environment reinforces concepts and skills that have been stressed during science activities.

## Timelines

No two groups of students will cover topics and material at the same rate, and so planning the duration of units is an important responsibility of the teacher. In some cases, students will not complete the lesson's activities during one block of time, and students may be especially interested in one topic and want to expand upon it. The individual needs of the class should be considered; there are no strict timelines involved in *Hands-On Science*. It is important, however, to spend time on every unit in the program so that students focus on all the curriculum outcomes established for the grade level.

## Classroom Management

Although hands-on activities are emphasized throughout this program, how these experiences are handled is up to the individual teacher. In some cases, teachers may have all students manipulating materials individually; in others, teachers may choose to organize the class into small group settings. Small groups encourage the development of social skills, enable all students to be active in the learning process, and mean less cost in terms of materials and equipment.

## Classroom Safety

Occasionally, especially when safety concerns are an issue, teachers may decide to demonstrate an activity, while still encouraging as much student interaction as possible. Again, classroom management is up to the individual teacher, since it is the teacher who ultimately determines how the students in his or her care function best in the learning environment.

The nature of science and of scientific experimentation means that safety concerns do arise from time to time. Throughout ***Hands-On Science***, when there is a potential safety issue that teachers need to be aware of, the concern is flagged with the following safety icon:



## Scientific Inquiry Skills: Guidelines for Teachers

The ***Hands-On Science*** program is based upon a scientific inquiry approach. While involved in the activities of ***Hands-On Science***, students use a variety of scientific inquiry skills as they answer questions, solve problems, and make decisions. These skills are not unique to science, but they are integral to students' acquisition of scientific literacy. The skills include initiating and planning, performing and recording, analyzing and interpreting, as well as communicating and the ability to work in teams.

The following guidelines provide a framework that can be used to encourage students' skill development in specific areas.

## Observing

Students learn to perceive characteristics and changes through the use of all five senses. Students are encouraged to use sight, smell, touch, hearing, and taste safely, in order to gain information about objects and events. Observations may be qualitative (by describing properties such as texture or colour), or quantitative (such as size or number), or both. Observing includes:

- gaining information through the senses
- identifying similarities and differences, and making comparisons

It is important to encourage students to communicate their observations in a variety of ways, including orally, in writing, and by sketching labelled diagrams.

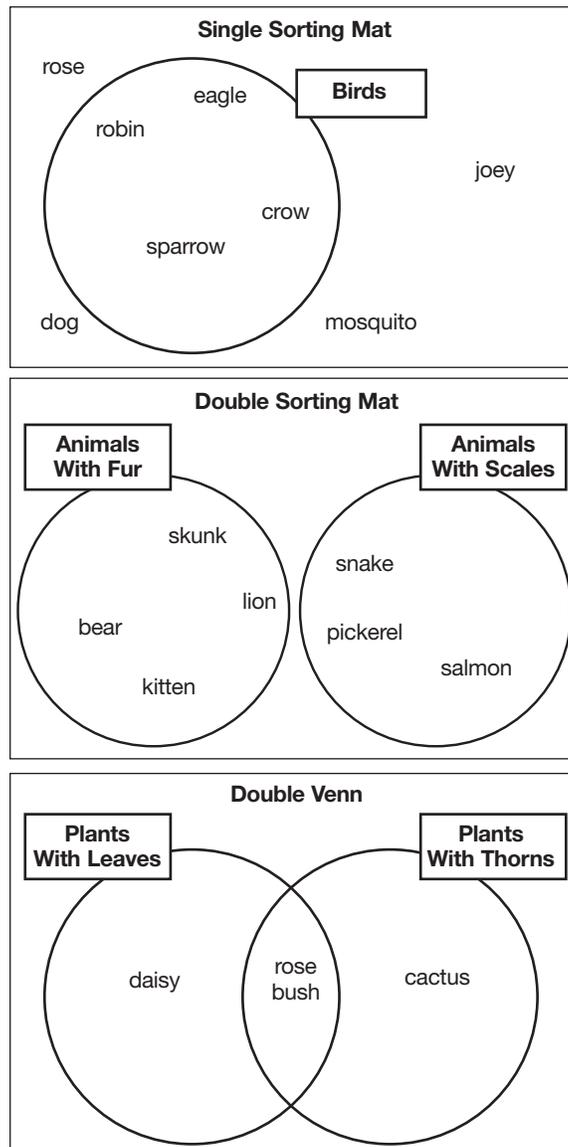
## Exploring

Students need ample opportunities to manipulate materials and equipment in order to discover and learn new ideas and concepts. During exploration, students need to be encouraged to use all of their senses and observation skills. Oral discussion is also an integral component of exploration; it allows students to communicate their discoveries.

## Classifying

Classification is used to group or sort objects and events and is based on observable properties. For example, clouds can be classified as cumulus, stratus, and cirrus. One strategy for sorting involves the use of a sorting mat or a Venn diagram. Sorting mats show distinct groups, while Venn diagrams intersect to show similar characteristics among sets.

For example:



## Measuring

Measuring is a process of discovering the dimensions or the quantity of objects or events. In the early years, measuring activities first involve the use of nonstandard units of measure, such as interlocking cubes or paper clips to determine length. This allows students to build understanding of how to observe, compare, and

communicate dimensions and quantity. This is a critical preface to measuring with standard units. By grade 5, students use standard measuring tools. For example, they will measure mass/weight, length, volume, and temperature using standard units. They will also measure the passage of time using seconds, minutes, and hours. In addition, they will use weather devices to measure and record weather conditions.

An essential skill of measurement is estimating. Students should be encouraged regularly to estimate before they measure, whether in nonstandard or standard units. Estimation allows students opportunities to take risks, use background knowledge, and learn from the process.

## Communicating, Analyzing, and Interpreting

In science, one communicates by means of diagrams, graphs, charts, maps, models, and symbols, as well as with written and spoken languages. Communicating includes:

- reading and interpreting data from tables and charts
- making tables and charts
- reading and interpreting data from pictographs, bar graphs, double bar graphs, frequency tallies, line plots, and broken line graphs
- making pictographs, bar graphs, double bar graphs, frequency tallies, line plots, and broken line graphs
- making labelled diagrams
- making models
- using oral and written language
- sequencing and grouping events, objects, and data according to attributes

When presenting students with charts and graphs, or when students make their own as part of a specific activity, there are guidelines that should be followed:

- A **tally chart** is a means of recording data as an organized count. The count is grouped in 5s for ease of determining the total by counting by 5s.

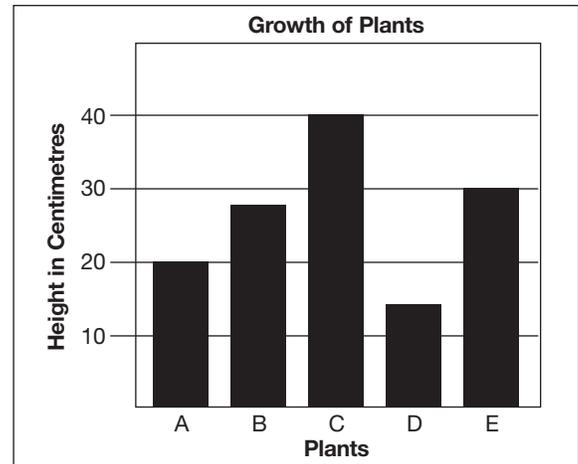
Favourite Sport		
Sport	Tally	Total
Baseball		6
Hockey		10
Soccer		12

- A **pictograph** has a title and information on one axis that denote the items being compared (note that the first letter on both the title and the axis text is capitalized). There is generally no graduated scale or heading for the axis representing numerical values.

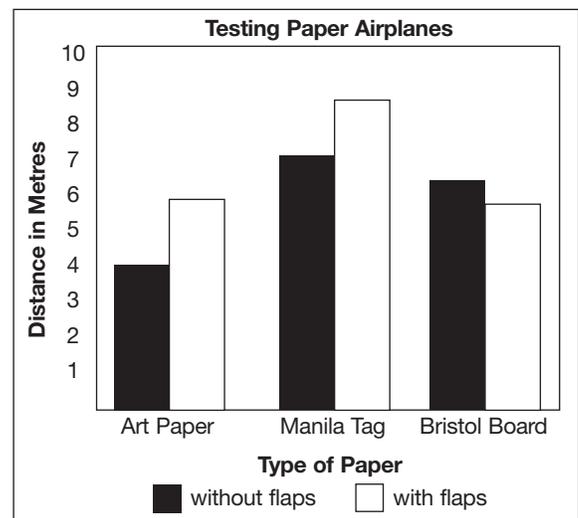
Favourite Dessert				
				
				
				
				
Cake	Pie	Ice Cream		

- A **bar graph** is another common form of scientific communication. Bar graphs should always be titled so the information communicated is easily understood. These titles should be capitalized in the same manner as one would title a story. Both axes of the graph should also be titled and capitalized in the same way. In most cases, graduated markings are noted on one axis and the objects or events being compared

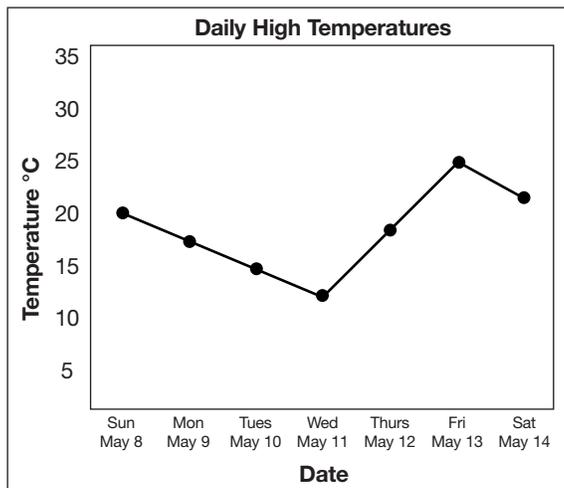
are noted on the other. On a bar graph, the bars must be separate, as each bar represents a distinct piece of data.



- A **double bar graph** can also be used to communicate scientific results. This type of graph is commonly used when comparing similar attributes in different objects. For example, an investigation in flight may have students constructing a model airplane with and without flaps, from different types of paper. The resulting double bar graph may look as follows:



- A **broken line graph** is used to communicate data when measuring an object or event over a period of time. For example, a broken line graph may be used to present daily outdoor high temperatures over a period of one week.



By grade 5, students should also be constructing pictographs and bar graphs using many-to-one correspondence, as in the example below:

Number of Birds Observed	
Jeremy	
Judy	
David	
Kelly	
Emily	

Each stands for 5 birds.

- A **chart (table)** requires an appropriate title, and both columns and rows need specific headings. Again, all titles and headings require capitalization of the first letter as in the title of a story. In some cases, pictures can be used to make the chart easier for young students

to understand. Charts can be made in the form of checklists or can include room for additional written information and data.

**Checklist Chart**

What Substances Dissolve in Water?		
Substance	Dissolves in Water	Does Not Dissolve in Water
Beads		✓
Sugar	✓	
Drink mix	✓	
Rice		✓
Pepper		✓

**Data Chart**

Local Snowfall		
Month	2015–16 Snowfall (cm)	Average Snowfall (cm)
October	7	5
November	9	8
December	23	20
January	29	25
February	16	18
March	11	10

Communicating also involves using the language and terminology of science. Teachers should encourage students to use the appropriate vocabulary related to their investigations (e.g., *object, metal, pliable, absorbent, and characteristic*). The language of science also includes terms such as *predict, infer, estimate, measure, experiment, and hypothesize*. Teachers should use this vocabulary regularly throughout all activities and encourage their students to do the same. As students become proficient at reading and writing, they can also be encouraged to use the vocabulary in written form. Consider developing whole-class or individual student glossaries in which students can record the terms they have learned and define them in their own words.

## Predicting

Predicting refers to the question, “What do you think will happen?” For example, ask students to predict what they think will happen to a blown-up balloon that is placed in a basin of water. It is important to provide opportunities for students to make predictions and for them to feel safe doing so.

## Inferring

In a scientific context, inferring generally refers to asking why something occurs. For example, ask students to infer why a blown-up balloon floats when placed into a basin of water. Again, it is important to encourage students to take risks when making such inferences. Before explaining scientific phenomena to them, they should be given opportunities to infer for themselves, using a variety of perspectives.

## Inquiry Through Investigating and Experimenting

When investigations and experiments are conducted in the classroom, planning and recording both the process and the results are essential. There are standard guidelines for leading these hands-on inquiries:

- Purpose: what we want to find out, or a testable question we want to answer
- Hypothesis: a prediction; what we think will happen, and why
- Materials: what we used to conduct the experiment or investigation
- Method: what we did
- Results: what we observed and measured
- Conclusion: what we found out
- Application: how we can use what we learned

Both the purpose and the hypothesis should be in present tense, as these are determined by students prior to the hands-on experiment.

In *Hands-On Science* lessons, there are often investigations that can be explored using this version of the standard experimental design.

Throughout the inquiry process, it is important that students be guided through these steps, and be given the opportunity to communicate their questions, predictions, observations, and conclusions. This may be done in a variety of ways: orally as a class, recording findings as a class, having students use drawings and writings, or a combination of these.

## Inquiry Through Research

Research is another aspect of inquiry that involves finding, organizing, and presenting information related to a specific topic or question. Scientific inquiry involves making observations, exploring, asking questions, and looking for answers to those questions. Even at a young age, students can begin to research topics studied in class if they are provided with support and guidelines. Accordingly, guided research is a teaching/learning strategy that is encouraged throughout *Hands-On Science*. Guided research provides an opportunity for students to seek further information about subjects of inquiry, personal interest, or topics of their choice. As such, students are empowered and engaged in the process. Guided research encourages students to:

- Ask questions of interest related to a topic being studied by the class.
- Choose resources.
- Collect information.
- Make a plan to present findings.
- Present research in a variety of ways.

Guided research encourages teachers to:

- Provide opportunities for students to ask questions of personal interest.
- Provide accessibility to appropriate resources.

- Model and support the research process.
- Offer opportunities for students to present their findings in a variety of ways and to a variety of audiences.

In *Hands-On Science*, the approach for scientific inquiry is one of gradual release. The teacher provides substantial support in initial inquiry experiences, and gradually presents students with more and more opportunities for directing their own research. Suggestions for guiding research are presented regularly throughout *Hands-On Science*.

### Online Considerations

As our technological world continues to expand at an accelerating rate, and increasing information is available online, students will turn to the Internet more and more to expand their learning. Accordingly, *Hands-On Science, Grade 5* is replete with opportunities for students to research and investigate using online resources.

Teachers are encouraged to talk often with students about safety protocols when online. Particularly when students are using the Internet to make connections with other people (for example, in search of information about a topic they are exploring), it is important they are fully aware of how to keep themselves safe when connecting with strangers. At all times, teachers should be vigilant in supervising student use of the Internet.

Teachers are also encouraged to discuss copyright and plagiarism with regards to the Internet, reminding students that copying information word for word is wrong. If they are quoting information from the Internet, quotation marks are required, along with appropriate citation of the source. Otherwise, information should always be paraphrased. Photos, drawings, figures, and other images found online should also be used only with permission and

citation of the source. Alternatively, students can source images for which permission has already been granted for use, such as through Creative Commons Canada (a nonprofit organization that “promotes and enables the sharing of knowledge and creativity...[and which] produces and maintains a free suite of licensing tools to allow anyone to easily share, reuse, and remix materials with a fair ‘some rights reserved’ approach to copyright.” See <<http://creativecommons.ca>>.)

### Addressing Students’ Literacy Needs

The inquiry process involves having students ask questions and conduct investigations and research to answer these questions. At the grade-5 level, students may benefit from support for research, reading, and writing. Consider having volunteers, student mentors, or educational-assistants support students during these processes to help students with reading, research, and writing.

### Using the Design Process

Throughout *Hands-On Science*, students have opportunities to use the design process to plan (design) and construct objects. For example, in Unit 1, students design and construct a model of a human body system.

The design process involves having students seek solutions to practical problems. There are specific steps to the process:

1. Identify a need: Recognize practical problems and the need to solve them.
2. Create a plan: Seek alternate solutions to a given problem, create a plan based on a chosen solution, and record the plan in writing and using labelled diagrams.
3. Develop a product: Construct an object that solves the given problem, and use predetermined criteria to test the product.

4. Communicate the results: Identify and make improvements to the product, and explain the changes.

The design process also involves research and experimentation.

When the design process is featured in a lesson of **Hands-On Science**, the following icon is used:



### Developing Attitudes Related to Science, Technology, and Society

According to the *Manitoba Curriculum Framework of Outcomes: Grades 5 to 8 Science (2000)*:

Attitudes refer to generalized aspects of behaviour that are modelled for students and reinforced by selective approval. Attitudes are not acquired in the same way as skills and knowledge. They cannot be observed at any particular moment, but are evidenced by regular, unprompted manifestations over time. Development of attitudes is a lifelong process that involves the home, the school, the community, and society at large. The development of positive attitudes plays an important role in students' growth by interacting with their intellectual development and by creating a readiness for responsible application of what they learn (p. 2.10).

The science-, technology-, and society-related attitudes focused on at the grade-5 level and which are fostered and encouraged throughout **Hands-On Science** lessons include:

- Appreciate that women and men of diverse cultural backgrounds can contribute equally to science.
- Show interest in the activities of individuals working in scientific and technological fields.
- Demonstrate confidence in their ability to carry out investigations.

- Appreciate the importance of creativity, accuracy, honesty, and perseverance as scientific and technological habits of mind.
- Be sensitive to and develop a sense of responsibility for the welfare of other humans, other living things, and the environment.
- Frequently and thoughtfully evaluate the potential consequences of their actions.

### Cultural Connections

To acknowledge and celebrate the cultural diversity represented in Canadian classrooms, it is important to infuse cultural connections into classroom learning experiences. It is essential for teachers to be aware of the cultural makeup of their class, and to celebrate these diverse cultures by making connections to curricular outcomes. In the same way, it is important to explore other cultures represented in the community and beyond, to encourage intercultural understanding and harmony. Throughout the **Hands-On Science** program, suggestions are made for connecting science topics to cultural explorations and activities.

### Indigenous Connections

As the original human inhabitants of Canada, Indigenous peoples are central to the Canadian context. As such, it is important to infuse the knowledge of our Indigenous forebears and their descendants into the learning experiences of all students. There are three groups of Indigenous peoples in Canada: First Nations, Métis, and Inuit.

Throughout the **Hands-On Science** program, there are many opportunities to incorporate culturally appropriate teaching methodologies from an Indigenous world-view. As one example, Indigenous Elders offer a wealth of knowledge that can be shared with students. Consider

inviting an Elder as a guest into the classroom in connection with specific topics being studied (as identified within the given lessons throughout the unit). An Elder can guide a nature walk, share stories and legends, and help students understand an Indigenous perspective of the natural world. An Elder will provide guidance for learners and opportunities to build bridges between the school and the community.

It is important to acknowledge any visiting (or visited) Elder, as Elders have traditionally been recognized within Indigenous communities as highly esteemed individuals. There are certain protocols that should be followed when inviting an Elder into your classroom; “TPAC Elder Protocol – Policies and Procedures” is a document from the University of Manitoba Student Affairs Aboriginal Student Centre that includes helpful information in this regard. See: <[www.umanitoba.ca/student/asc/tpac/protocol.html](http://www.umanitoba.ca/student/asc/tpac/protocol.html)>.

**NOTE:** Although both cultural connections and Indigenous connections are generally included in the Enhance section of a lesson of *Hands-On Science*, teachers should not regard this content as supplementary. First and foremost, the central science outcomes are focused on in the Engage and Explore sections of each lesson, while other curricular connections – such as literature, art, Indigenous connections, and other cultural connections – are usually featured in the Enhance section.

## Technology

Digital learning, or learning with information and communication technology (LwICT), is an important component of any classroom. As such, technological supports available in schools – including digital cameras, computers/tablets, interactive whiteboards (IWB), projectors, document cameras, and even calculators – can be used with and by students to enhance

their learning experiences. When technology connections are made in *Hands-On Science* lessons, the following icon is used:



## Sustainability

*Hands-On Science* provides numerous opportunities for students to investigate issues related to sustainable development. Asking students the following question can often help to clarify for them what is meant by sustainability: “Is there enough for everyone, forever?” Exploring sustainability also connects to the Indigenous world-view about respecting and caring for the earth.

The three pillars of sustainability are the environment, society, and the economy. When sustainability links are made in *Hands-On Science* lessons, any or all of the sustainability pillars may be the focus of this connection, and are identified by the following icon:



# The Hands-On Science Assessment Plan

**Hands-On Science** provides a variety of assessment tools that enables teachers to build a comprehensive and authentic daily assessment plan for their students. Based on current research about the value of quality classroom assessment (Davies 2011), suggestions are provided for authentic assessment *for* learning, assessment *as* learning, and assessment *of* learning:

## Assessment for Learning

It is important to assess student understanding before, during, and after a science lesson. The information gathered helps teachers determine students' needs and then plan the next steps in instruction. Students may come into class with misconceptions about science concepts. By identifying what they already know, you can help them make connections and address any problem areas.

To assess students as they work, use the assessment for learning suggestions and questions provided with many of the activities. Questions focus on the lesson outcomes and are intended to promote higher-level thinking skills, active inquiry, and decision making.

While observing and conversing with students, use the **Anecdotal Record** sheet, as well as the **Individual Student Observations** sheet to record assessment for learning data:

- **Anecdotal Record:** To gain an authentic view of a student's progress, it is critical to record observations *during* science activities. The **Anecdotal Record** sheet, presented on page 18, provides the teacher with a format for recording individual or group observations.
- **Individual Student Observations:** When teachers wish to focus more on individual students for a longer period of time, consider using the **Individual Student**

**Observations** sheet, found on page 19.

This reproducible provides more space for comments and is especially useful during conferencing, interviews, or individual student performance tasks.

When assessment *for* learning is suggested in a lesson, the icon shown at left is used.

## Assessment as Learning

It is also important for students to reflect on their own learning about science. For this purpose, teachers will find a **Student Self-Assessment** sheet on page 25.

**NOTE:** This reproducible requires students to describe a science skill on which they are working. This offers a valuable opportunity to discuss with students the scientific inquiry skills emphasized in grade 5, and to encourage a focus on these skills during all science activities. Refer to the description of these skills in the subsection of the introduction, **Scientific Inquiry Skills: Guidelines for Teachers** (pages 7–11), as well as to the **Curriculum Correlation Chart: Scientific Inquiry and Design Process Outcomes**, at the beginning of each unit.

In addition, a **Science Journal** sheet, found on page 20, will encourage students to reflect on their own learning. Teachers can copy several sheets for each student, cut them in half, add a cover, and bind the sheets together. Students can then create title pages for their own journals. For variety, you may also have students use the blank reverse sides of each page for other reflections. For example, have students draw or write about:

- new science challenges
- favourite science activities
- real-life experiences with science
- new science terminology

Students should also be encouraged to reflect on their cooperative group work skills. For this purpose, a **Cooperative Skills Self-Assessment** rubric is included on page 26.

Student reflections can also be done in many ways other than in writing. For example, students can:

- Interview one another to share their reflections on science.
- Write an outline or brief script, and make a video reflection.
- Create an electronic slide show with an audio recording of their reflections.

When assessment as learning is suggested in a lesson, the icon shown on the preceding page is used.

### Assessment of Learning

Assessment of learning provides a summary of student progress related to the accomplishment of the outcomes at a particular point in time. It is important to gather a variety of assessment data to draw conclusions about what a student knows and can do. As such, consider collecting student products, observing processes, and having conversations with students. Teachers should also consider which student work is formative and which is summative in their deliberations. Only the most recent and consistent evidence should be used.

Assessment of learning suggestions are provided throughout the **Hands-On Science** program. Use the **Anecdotal Record** sheet, found on page 18, and the **Individual Student Observations** sheet, found on page 19, to record student results.

Always assess the individual student's accomplishments, not group work. However, you may also assess how the individual student

works within a group. Such skill development includes the ability to “respond respectfully to the ideas and actions of others ... assume roles and share responsibilities as group members ... listen to and consider differing opinions.”<sup>3</sup> For this purpose, a **Cooperative Skills Teacher Assessment** form is included on page 24.

When assessment of learning is suggested in a lesson, the icon shown in the preceding column is used.

### Performance Assessment

Assessment of learning also includes performance assessment, which is planned, systematic observation and assessment based on students actually doing a specific science activity. Teacher- or teacher/student-created rubrics can be used to assess student performance.

A **Sample Rubric** and a **Rubric** for teacher use are included on pages 21 and 22. For any specific activity, the teacher and students discuss criteria for completing a task successfully before the work is done. The teacher then selects four criteria that relate directly to the learning outcomes, and records these criteria on the **Rubric**. Students receive a check mark point for each criterion accomplished to determine a rubric score from a total of four marks. These rubric scores can then be transferred to the **Rubric Class Record** form found on page 23.

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**NOTE:** Performance tasks can be used for both assessment *for* learning and assessment *of* learning.

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Consider using four levels of achievement for your rubrics, to determine performance levels:

<sup>3</sup> Manitoba Education and Training, 1999, p.3.37

4. Thorough understanding and in-depth application of concepts and skills
3. Very good understanding and application of concepts and skills
2. Basic understanding and some application of concepts and skills
1. Limited understanding and minimal application of concepts and skills<sup>4</sup>

**Hands-On Science** provides numerous opportunities for students to apply their skills. By considering the same levels throughout the year, you should be able to track skill development and determine when students have a thorough understanding and in-depth application of concepts and skills.

## Portfolios

A portfolio is a collection of work that shows evidence of a student's learning. There are many types of portfolios; the showcase portfolio and the progress portfolio are two popular formats. Showcase portfolios highlight the best of the students' work, with students involved in the selection of pieces and justification for choices. Progress portfolios reflect the students' progress as they improve, and aim to demonstrate an in-depth understanding of the material over time.

Select, with student input, work to include in a science portfolio or in a science section of a multi-subject portfolio. This should include representative samples of student work in all types of science activities. Reproducibles are included to organize the portfolio (**Portfolio Table of Contents** sheet is on page 27, and **Portfolio Entry Record** sheets are on page 28).

**NOTE:** In an Indigenous context, portfolio creation may differ in that the student and teacher may select completed work from a coming-to-know perspective that reflects participatory learning. Students reflect on their own understanding of the world around them or a sense of negotiating another point of view.

<sup>4</sup> Manitoba Education, 2012, p. 22

## An Important Note to Teachers

Throughout the **Hands-On Science** program, suggestions are provided for assessment *for* learning, assessment *as* learning, and assessment *of* learning. It is important to keep in mind that these are merely suggestions. Teachers are encouraged to use the assessment strategies presented in a wide variety of ways, and to ensure that they build an effective assessment plan using these assessment ideas, as well as their own valuable experience as educators.

**NOTE:** From an Indigenous perspective, assessment is community-based, qualitative, and holistic, and includes input from all the people who influence an individual student's learning – parents, caregivers, Elders, community members, and educators. An assessment that includes all these perspectives provides a balanced understanding of what represents success for Indigenous students and their families/community. A strong partnership between parents/guardians/communities and school improves student achievement. Teachers should be aware some Indigenous students may feel apprehensive about a formal process of assessment; others may find Western achievement goals do not fit their Indigenous world-view.

# Unit 1

## **Maintaining a Healthy Body**

# Introduction

The focus of this unit of *Hands-On Science, Grade 5* is the human body, including its various systems and the care of each system. Students will investigate each system and explore ways to maintain healthy bodies through proper nutrition and exercise. They will relate this knowledge to medical advancements and the impact of media influences on lifestyle choices. Throughout the unit, students will be inquiring, experimenting, building models, conducting research, role-playing, and conducting interviews.

## Planning Tips for Teachers

- The individual lessons in *Hands-On Science* rely on good reference materials for both students and teachers (see Resources for Students on page 37, Websites and Online Videos on page 38, and References for Teachers on page 480), including a good dictionary of biological terms. As much as possible, collect these resources in advance.
- Contact local healthcare organizations and government departments well in advance for classroom materials. There are many resources related to the human body available for the asking – check at local clinics, dental offices, public health nurse offices, as well as at pharmacies.
- Collect reference materials about illness and disease from local clinics, medical professional offices, and hospitals.
- Collect nutrition panels from food packages, illustrated grocery-store flyers, food magazines, reference materials about nutritional elements, and cookbooks for children.
- Collect various materials related to and including the Canada Food Guide (*Eating Well With Canada's Food Guide*). Posters, brochures, and individual copies of the food guide are available from Health Canada (see <[www.hc-sc.gc.ca/fn-an/food-guide-aliment/index-eng.php](http://www.hc-sc.gc.ca/fn-an/food-guide-aliment/index-eng.php)>).

**NOTE:** Health Canada also offers a version of the Canada Food Guide tailored specifically to Indigenous peoples (see *Eating Well With Canada's Food Guide – First Nations, Inuit and Métis*), including both traditional and store-bought foods. As well, the guide is translated into a variety of other languages, including French, Farsi, Tagalog, and several others. See: <[www.hc-sc.gc.ca/fn-an/food-guide-aliment/order-commander/guide\\_trans-trad-eng.php](http://www.hc-sc.gc.ca/fn-an/food-guide-aliment/order-commander/guide_trans-trad-eng.php)>.

- Specific scientific equipment is required for this unit, and should be collected in advance: model of human skeleton, microscopes, slides, cover slips, and commercially prepared slides of human skin cells.
- For displaying classroom reproducibles, images, and other materials, it is helpful to have access to an interactive whiteboard, a document camera, or another type of projection device.
- Develop a Makerspace centre. Classroom Makerspaces are usually designed as centres where students create do-it-yourself projects, learn together, and collaborate on projects. Give students opportunity to work with a variety of tools, as well as with everyday objects and recycled materials. Makerspace centres also integrate well with arts-and-crafts activities.

For this unit, set up a Makerspace centre in the classroom to encourage informal learning about growing healthy fruits and vegetables, or about making healthier recipes. You can use recycled materials (e.g., plastic trays, ice-cube trays, measuring cups) or lab materials (e.g., beakers, graduated cylinders, pan balances). Ask your students for ideas on how to stock the Makerspace, and then visit secondhand stores and garage sales.

Work with students to develop a collaborative culture, where students tinker, invent, and improve on their creations throughout the unit. As you pose questions with each

lesson, students can determine solutions through the creating. It is important to not direct the learning at this centre; simply create the conditions for it to happen.



**SAFETY NOTE:** Consider any student allergies when selecting food for this centre.

This unit of *Hands-On Science, Grade 5* presents new opportunity for students to explore Indigenous understandings specifically related to healthy bodies. Historically hunters and gatherers, Indigenous peoples sought balance between daily exercise and proper nutrition. Recognizing the connection between the person, the food they ate, and their daily activities, Indigenous peoples took an integrative approach toward a balanced mind, body, and lifestyle. Today, this lifestyle might incorporate more traditional foods, to care for the body in a more holistic way.

### Science Vocabulary

Throughout this unit, teachers should use, and encourage students to use, vocabulary such as:

- *Canada's Food Guide to Healthy Eating, carbohydrate, circulatory system, digestive system, fat, food group, integumentary system, mineral, muscular system, nervous system, nutrient, protein, respiratory system, serving size, skeletal system, vitamin.*

Due to the extensive new vocabulary presented in this unit, new terminology is often suggested within the context of a diagram of the body system. Students are able to make more sense of unfamiliar words through both visual and hands-on experiences. Presenting a visual demonstration, such as attaching a “pancreas” to a model of the digestive system, for example, keeps students engaged, inspiring them to find out more about the organ than they would if they were simply told the word *pancreas*. In

the same way, having students construct the lever action of muscles and bones in the arm is far more motivating than having them simply learn the names of muscles and bones in the arm. There are various computer programs that allow students to examine simulated bodies and better understand their three-dimensionality. For example, InnerBody (<[www.innerbody.com](http://www.innerbody.com)>) is an interactive site that includes animation, images, and descriptions of the skeletal, digestive, muscle, and cardiovascular systems.

Teachers should also consider using, and encouraging students to use, vocabulary related to scientific inquiry skills. This vocabulary can be displayed in the classroom throughout the year, as the terms are related to all science clusters (units). Teachers and students can then brainstorm which skills they are being asked to use as they conduct particular activities. They can also discuss what that skill looks and sounds like as they explore and investigate. Vocabulary related to scientific inquiry skills includes:

- *access, ask, brainstorm, collect, compare, connect, consider, construct, cooperate, create, describe, develop, estimate, explain, explore, find, follow, graph, identify, improve, investigate, measure, observe, order, plan, predict, recognize, record, repeat, research, respond, select, sequence, test.*

Throughout the unit, a science glossary is referred to, as well as a class word wall. The word wall can be created on a bulletin board or simply on a piece of poster paper, so as not to take up too much space. On the bulletin board or poster paper, record new vocabulary as it is introduced throughout the unit. Ensure the word wall is placed in a location where all students can easily see and access the words. Refer frequently to new vocabulary, and encourage students to use it in both their writing and conversation.

## Promoting Scientific Inquiry

Throughout the inquiry process, it is essential for teachers and students to generate thoughtful questions about the scientific information and issues presented. There are many questioning systems that can be implemented; the point is to apply them to the scientific material within the unit. Often simply changing a question can turn the intent from a focus on knowledge and understanding to an emphasis on scientific inquiry, which can then lead to use of the design process.

The chart below shows how questions related to topics of study in this unit, and that address specific curriculum outcomes, can either focus

on knowledge and understanding (column two) or encourage more in-depth inquiry and higher-level thinking (column three) and then lead to the design process (column four).

A questioning system such as this can be used by both teachers and students to reach beyond factual content toward rich, inquiry-based investigations.

**NOTE:** A Fitbit (as mentioned in the chart below) is a device with a 3-D motion sensor that tracks calories burned, steps taken, distance travelled, and sleep quality.

Unit Topic	Knowledge and Understanding (Content questions that range in complexity)	Scientific Inquiry (Testable questions by students or by scientists)	Design Process (Prototype questions designed or critiqued by students)
Heart rate	What is a pulse?	What impact does exercise have on your pulse?	What is useful information for a Fitbit to record?
Skin	Why does the skin need protection from the sun?	Can tanning be a safe practice?	What features do the best sunscreens have?
Food choices	How many servings of fruits and vegetables should you have each day?	How is appropriate serving size determined?	Why was the Canada Food Guide recently updated?

# 8 How Do Healthy Joints, Bones, and Muscles Help You Move?

## Information for Teachers

Bones are made up of protein, which is organic, and minerals, which are inorganic. They provide a structure for the body's soft tissues and protect organs like the brain (inside the skull) and heart and lungs (inside the rib cage). Bones grow and are constantly changing physiologically, exchanging minerals with the bloodstream and housing white blood cells, which help to fight certain diseases.

Babies have more bones than adults; bones fuse as growth occurs, such as the carpal bones in the wrist. Not everyone has the same number of bones; for example, about 1 in 20 humans has an extra set of ribs.

Bones provide both support and a framework for muscles to make the body move. The main joints that show bone and muscle working together are:

**Ball-and-socket:** a spherical head (ball) fits into a bowl-shaped cavity (socket) (e.g., shoulder, hip)

**Hinge:** move in only one direction (plane) (e.g., knee, elbow, fingers)

**Saddle:** two saddle-shaped bones fit together snugly (e.g., thumb)

**Washer:** gliding or sliding joint is a special feature of the spinal column (backbone). The vertebrae are connected by flexible cartilage that allows them to bend. Washer joints are also found in the wrists and ankles.

The main types of muscles found in the vertebrate body are:

**Voluntary:** a bundle of fibres that contracts to move bones by pulling only

**Smooth:** sheets of fibres (rather than bundles) found in hollow organs (e.g., blood vessels and the gastrointestinal tract). These muscles are involuntary, because they are controlled

by the automatic nervous system and are not connected to bone.

**Cardiac:** the heart, a combination of skeletal and smooth muscles, never tires and, therefore, needs the great amount of regular blood supply that flows through it. It consists of involuntary muscles controlled by the autonomic nervous system.

Other useful terms:

**Antagonistic:** term applied to pairs of muscles producing opposite movements so that as one contracts (pulls), the other must relax

**Callus:** the substance that grows to fill in a gap in a broken bone

**Cancellous tissue:** spongy bone with spaces for blood vessels

**Osseous tissue:** hard, compact bone with no spaces

Bones are made up of both osseous and cancellous tissues; the amount of each depends on the bone type and its function.

**Marrow:** a soft substance that fills the cavities of most bones

**Cartilage:** skeletal tissue that is softer and more bendable than bone, but is still strong (e.g., the nose framework)

**Ligament:** stretchy bands that hold bones together in and around joints

**Tendon:** cord or band of connective tissue attaching muscle (usually) to a bone

**Periosteum:** the covering of a bone

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**Materials**

- human skeleton model (small models are available from science suppliers. If a model is not available at your school, consider borrowing one from a local middle or senior school or through a museum outreach program.)
- computer/tablet with Internet access
- Diagram: The Human Skeletal System (1.8.1)
- Diagram: The Human Muscular System (1.8.2)
- Diagram: The Digestive System (from lesson 3) (1.3.2)
- Diagram: The Urinary System (from lesson 4) (1.4.2)
- Diagram: The Circulatory System (from lesson 6) (1.6.2)
- Diagram: The Respiratory System (from lesson 6) (1.6.3)
- projection device
- chart paper
- markers
- elastic bands
- stiff cardboard
- paper fasteners
- 30-cm rulers
- single-hole punchers
- scissors
- broom handle
- thick string or rope
- clean, empty tin can (with sharp edges taped)
- Activity Sheet: Joint Effort (1.8.3)
- Learning-Centre Task Card A: How Do Muscles and Bones Work Together? (1.8.4)
- pencils
- thin string
- bottle caps
- stopwatches
- Learning-Centre Task Card B: Comparing Skeletons and Bones (1.8.5)
- sticky notes

- Learning-Centre Activity Sheet: Compare and Contrast Bones (1.8.6)
- skeletal systems of various animals (optional)
- Diagram: Vole Skeletal System (1.8.7)
- Diagram: Frog Skeletal System (1.8.8)
- Diagram: Turtle Skeletal System (1.8.9)
- Diagram: Bat Skeletal System (1.8.10)
- KHWL chart (from lesson 1)
- Science Glossary (1.1.3)

**Engage**

Display the human skeleton model. Have students discuss what they know about bones in the body. Record their ideas on chart paper.

Encourage students to share stories related to their bones (e.g., broken bones, casts).

Teach students “The Skeleton Dance,” a rhythmic rendition of the traditional song “Dem Bones.” A parts-identifying video of “The Skeleton Dance” (Super Simple Learning, 1:58) is available at: <http://supersimplelearning.com/songs/themes-series/halloween/the-skeleton-dance>.

Introduce the guided inquiry question: **How do healthy joints, bones, and muscles help you move?**

**Explore: Part One**

Project Diagram: The Human Skeletal System (1.8.1). Ask students:

- What is the skeletal system?
- What is this system made up of?
- What are bones?
- How do bones help you? (organ protection and support of the body)
- What would happen to your body if you had no bones inside of you?
- Where are some of the organs you have studied so far?

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- How does the skeletal system protect your brain?
- How does the skeleton protect your heart and lungs?

Now project, one at a time, Diagram: The Digestive System from lesson 3 (1.3.2); Diagram: The Urinary System from lesson 4 (1.4.2); Diagram: The Circulatory System from lesson 6 (1.6.2); and Diagram: The Respiratory System from lesson 6 (1.6.3). Discuss the position of most of the body's major organs in relation to the protective bones of the rib cage.

Display the human skeleton model again. Focus on how the skeleton is able to move. Ask:

- How is this model made to move? (fasteners, string, or wires, depending on the model)
- How do you move?
- What part of the body helps bones move?

### Explore: Part Two

Project Diagram: The Human Muscular System (1.8.2). Ask:

- What do you use your muscles for?
- How do muscles help bones to move?

Using the skeleton model as an example, introduce students to the four types of joints: ball-and-socket, hinge, saddle, and washer. Discuss how the muscles attached to these joints help them to move.

Divide the class into pairs of students. Provide each pair with a copy of Activity Sheet: Joint Effort (1.8.3), cardboard, a 30-cm ruler, a hole punch, a paper fastener, elastic bands, and scissors. Have students use the activity sheet as a guide to investigate how muscles and bones work together in a joint.

Following this investigation, discuss the role of muscles and bones in body movement.

### Activity Sheet

Directions to students:

Use the activity sheet as a guide to construct a hinge joint. Answer the questions (1.8.3).

**NOTE:** This is a two-page activity sheet.

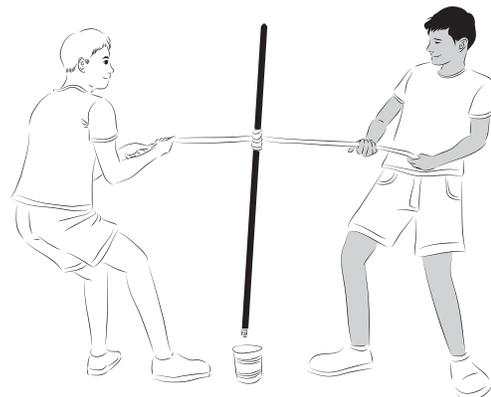
### Assessment of Learning

Conference with students individually after they have constructed their hinge joints. Focus on their ability to follow instructions, measure accurately, and relate models to functions of the joints in the human body. Use the Individual Student Observations sheet, on page 19, to record results.

### Explore: Part Three

Using their models of the hinge joint, have students discuss and demonstrate how muscles work in pairs. Now, investigate how muscles work together to help the body move.

Tie a long piece of thick string to a broom handle. Explain the broom handle represents a bone in the body. Ask a pair of students to keep the stick upright by each holding tightly one end of the string and pulling on it. Explain the string and students represent muscles on each side of the bone. Place an empty tin can on the floor between the two students, and challenge them to manoeuvre the broom handle into it.



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As students attempt this task, discuss how this model replicates the role of muscles surrounding a bone. Ask:

- As one muscle moves toward the broom, what does the other muscle do?
- How do the muscles work together to perform a function?
- How is this like the model of the hinge joint you made?

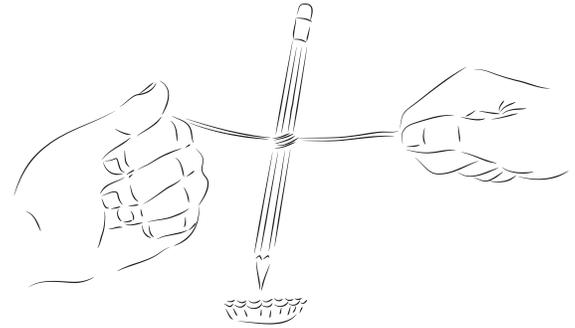
Allow all students an opportunity to attempt the broomstick challenge. Place the equipment at an activity centre for students to try again at a later time.

### Learning Centre A

At the learning centre, provide pencils, thin string, bottle caps, stopwatches, a copy of the Learning-Centre Task Card A: How Do Muscles and Bones Work Together? (1.8.4), and a large data chart for recording results at the centre (such as below):

Moving With Muscles					
Student Pair	Times/Trials				
	1	2	3	4	5

Have students repeat the broomstick investigation on a smaller level. As in the class activity, tell students to tie the string around the pencil, then hold the ends of the string while attempting to move the upright pencil so the point drops into the bottle cap. Have students measure how long it takes them to accomplish this task.



Encourage pairs of students to do several trials and record their times on the data chart.

When all students in the class have visited the centre, invite them to discuss their investigations. Ask:

- Do you see improvement after several trials?
- What factors might affect this?
- Do you think muscles also improve with practice (exercise)?
- What are some examples of muscles performing better with exercise?

As an extension to this activity, have students graph the class results.

### Learning Centre B

At the learning centre, provide models of skeletal systems of different animals (from a science supply company, a middle or senior school, or a museum outreach program). As an alternative, provide diagrams at the centre, including Diagram: The Human Skeletal System (1.8.1); Diagram: Vole Skeletal System (1.8.7); Diagram: Frog Skeletal System (1.8.8); Diagram: Turtle Skeletal System (1.8.9); and Diagram: Bat Skeletal System (1.8.10). Also, include a copy of the Learning-Centre Task Card B: Comparing Skeletons and Bones (1.8.5) and copies of the Learning-Centre Activity Sheet: Compare and Contrast Bones (1.8.6).

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Have students continue their study of osteology by comparing and contrasting different vertebrate skeletons at the learning centre. Have students record their observations on the activity sheet.

### Embed: Part One

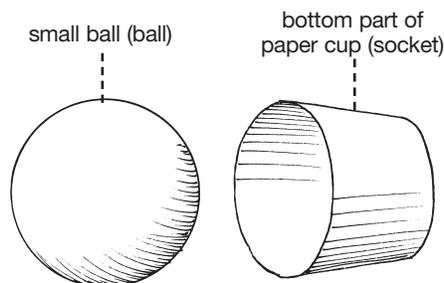
Revisit the guided inquiry question: **How do healthy joints, bones, and muscles help you move?** Have students share their knowledge, provide examples, and ask further inquiry questions.

### Embed: Part Two

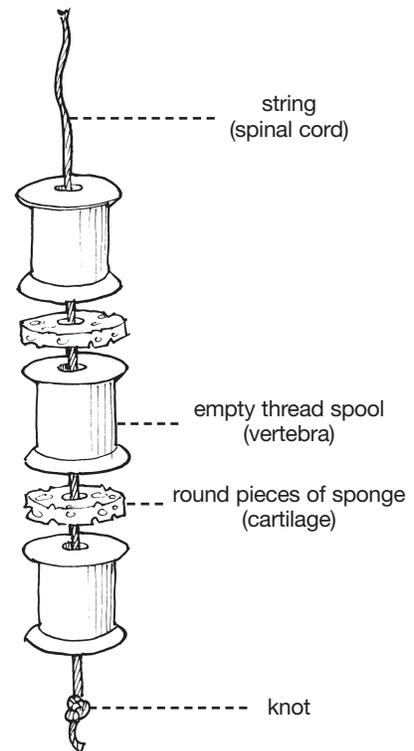
- Have students add to the KWLH chart as they learn new concepts, answer some of their own inquiry questions, and ask new inquiry questions.
- Add new terms and illustrations to the class word wall. Also, include the words in other languages, as appropriate.
- Have students add new terms, illustrations, and definitions to their Science Glossary (1.1.3). When possible, encourage them to add the words in other languages, including Indigenous languages, reflective of the classroom population.

### Enhance

- Have students make simple models of a ball-and-socket hinge using a ball and a paper cup. Students can use scissors to cut down the paper cup so the ball fits and rotates on this “socket.”



- With students, make a model of a washer joint: cut several circles out of thin sponge, and punch a hole into the centre of each one. Tie a large knot at one end of a piece of string – this represents the spinal cord. Thread a spool onto the string, followed by a sponge circle. Repeat this several times. The spools represent vertebrae, and the sponge represents cartilage.



To add to the model and show how body systems work together, tie the top of the string to an old light bulb, which can represent the brain.

- Have students investigate what bones are made of by immersing a clean chicken bone into a jar of vinegar, which is an acid. Change the vinegar every few days for 4–5 weeks. At the end of this time, the bone will be soft

# 8

and pliable – only the protein is left. Minerals, such as calcium, have dissolved. Also, try this investigation with bones from pork and beef, and draw comparisons.

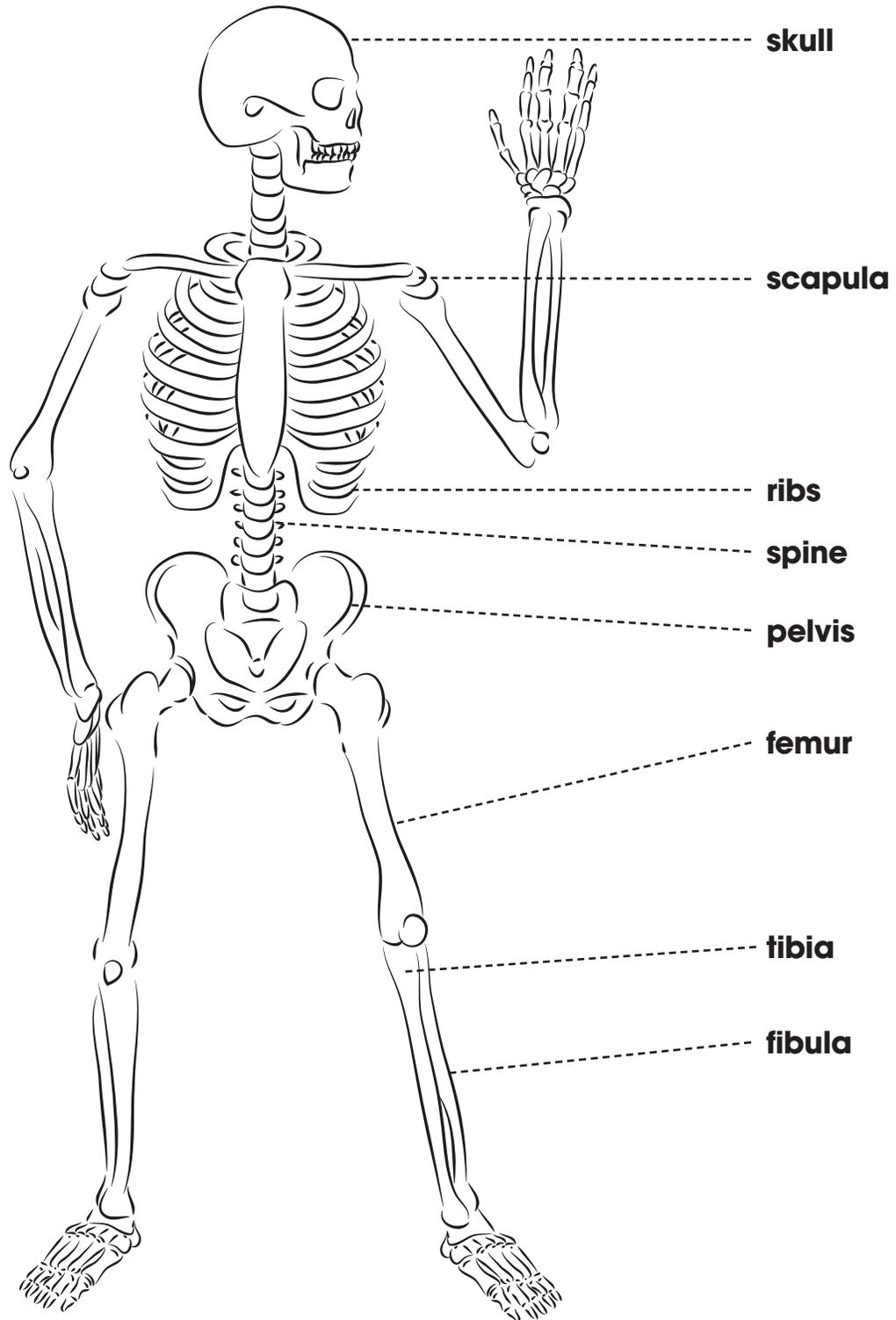
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**NOTE:** The above activity is a dramatic demonstration of the importance of calcium.

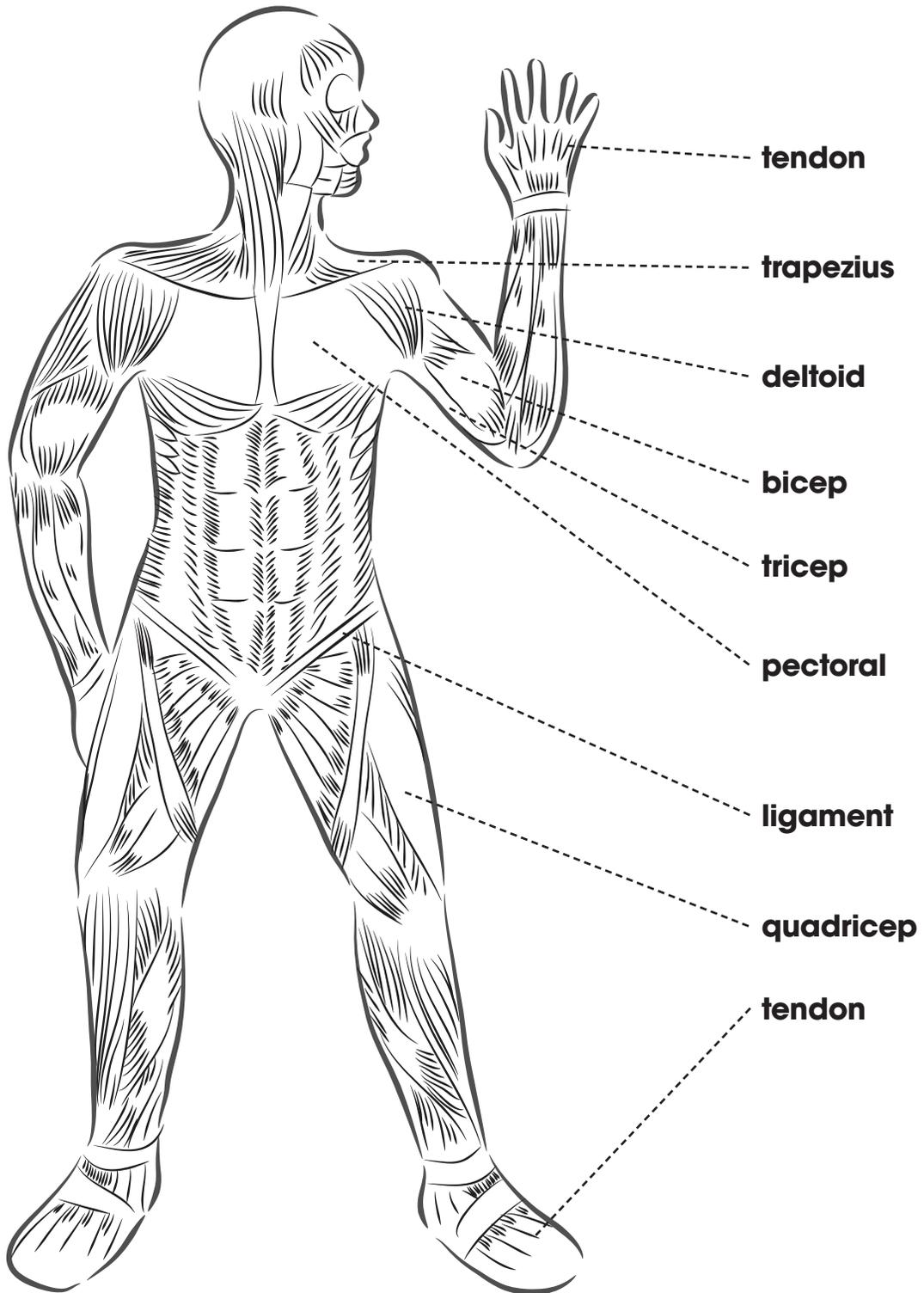
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- Research with students the causes of osteoporosis and how good nutrition and exercise can help reduce this degeneration of the bones.
- Research with students how the technology of prosthetics (artificial limbs) has helped people with limb amputations to function better and live fuller lives. Contact the War Amps (<[www.waramps.ca/home](http://www.waramps.ca/home)>) for resource materials and videos.
- Source actual bones of wildlife by contacting a natural resources officer. Bird bones, which are very porous inside to aid in flight, are especially interesting.
- Investigate with students prosthetic (artificial) hips and other joints for suitability (in terms of design) and sustainability (i.e., durability). Have students research how this technology has improved over time, and ask some of these questions:
  - What practical problem were scientists trying to solve?
  - Which was the best method they could use to solve the problem?
  - How did they know if the prototype was doing its job?
  - What were the strengths and weaknesses of the prototype?
  - How did scientists improve upon the prototype over time?
- Have students continue their do-it-yourself projects at the Makerspace centre.

# The Human Skeletal System



# The Human Muscular System

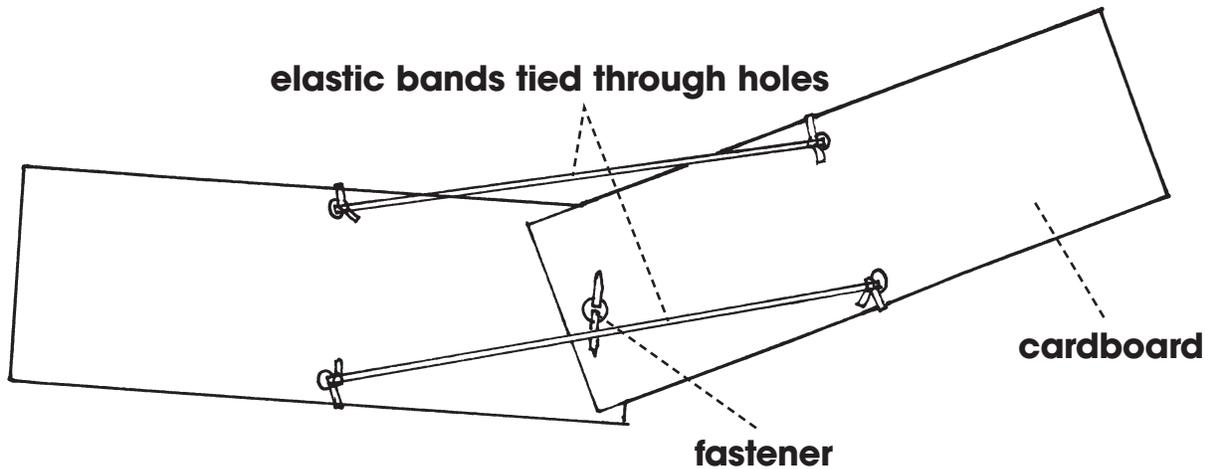


Date: \_\_\_\_\_

Name: \_\_\_\_\_

## Joint Effort

Make a model of a hinge joint (knee, elbow). Construct your model, using the diagram and instructions as a guide.



1. Cut 2 pieces of cardboard, 15 cm by 5 cm each.
2. On one end of each piece of cardboard, mark the centre point.
3. At this point, push a paper fastener through one piece of cardboard, and attach it to the second piece of cardboard at this same point.
4. Punch holes in both pieces of cardboard about halfway along each side.
5. Cut the elastic bands to make two 12-cm strips.
6. Tie pieces of elastic to connect the holes on each piece of cardboard.



Date: \_\_\_\_\_

Name: \_\_\_\_\_

## Joint Effort (continued)

Answer these questions:

1. Which parts of your model represent the bones? \_\_\_\_\_

\_\_\_\_\_

2. Which parts represent muscles? \_\_\_\_\_

\_\_\_\_\_

3. What happens to the muscles when the joint is bent? \_\_\_\_\_

\_\_\_\_\_

4. What happens to the muscles when the joint is straightened?

\_\_\_\_\_

\_\_\_\_\_

5. Where do you think the commands to make your muscles move come from?

\_\_\_\_\_

\_\_\_\_\_

6. (a) What do you think it would be like if you were not able to move the muscles in your legs and arms? \_\_\_\_\_

\_\_\_\_\_

(b) What could cause this to happen? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

7. How do you think people who cannot move some part of their body (legs, arms, or both) manage to do their daily activities? (Think of some ways that technology has helped them.) \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

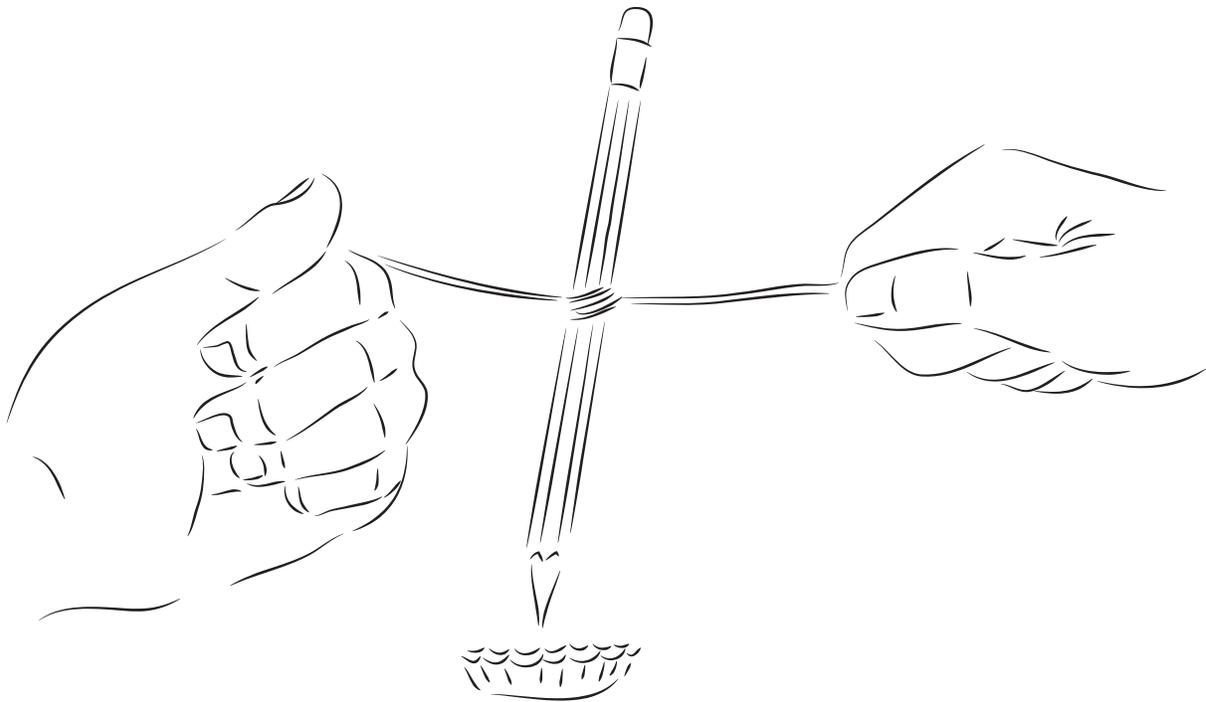
8. How does technology help people who have lost a limb or are born without an arm or leg? \_\_\_\_\_

\_\_\_\_\_

## How Do Muscles and Bones Work Together?

With a partner, you are going to investigate how muscles and bones work together to move the body.

1. Tie the string around the pencil.
2. Hold the ends of the string while moving the upright pencil. Your goal is to drop the pencil point onto the bottle cap.
3. Use a stopwatch to measure how long it takes to accomplish this task.
4. Do several trials, and record your times on the data chart at the centre.

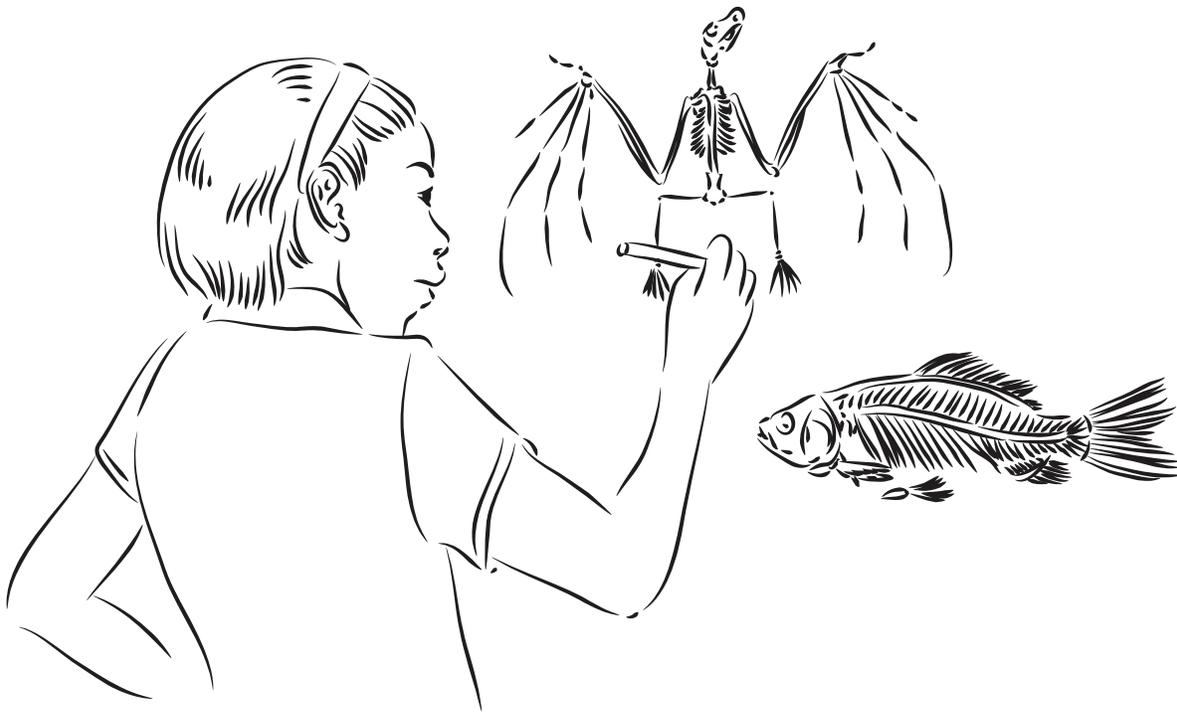




# Comparing Skeletons and Bones

Imagine you are an osteologist - someone who studies the bones of various animals.

1. Use models or diagrams included at the centre to compare and contrast the skeletons of different vertebrate.
2. Record your observations on the activity sheet: Compare and Contrast Bones.



**Date:** \_\_\_\_\_

**Name:** \_\_\_\_\_

## Compare and Contrast Bones

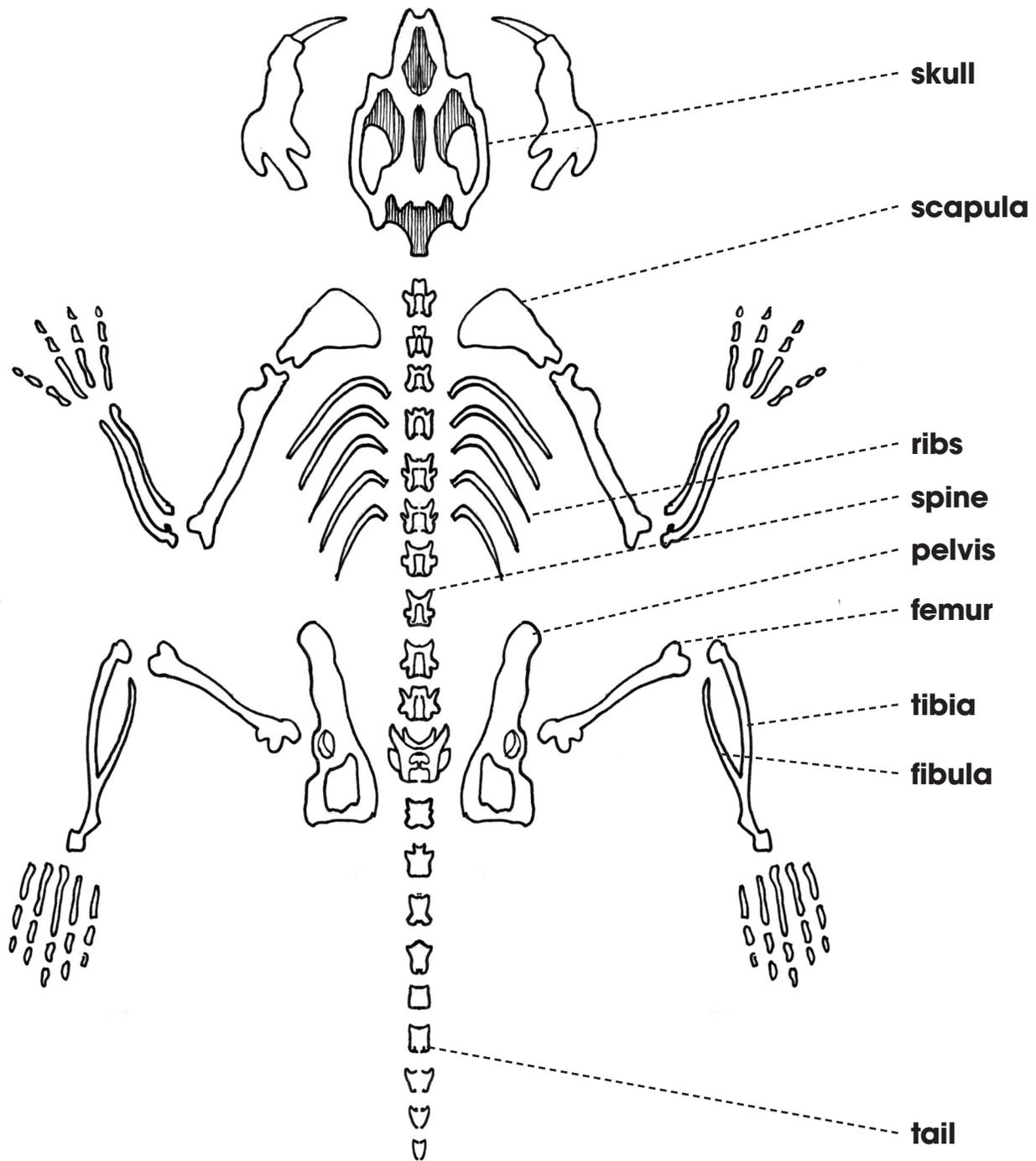
How are the bones of the \_\_\_\_\_ and \_\_\_\_\_ alike?

How are the bones of the \_\_\_\_\_ and \_\_\_\_\_ different?

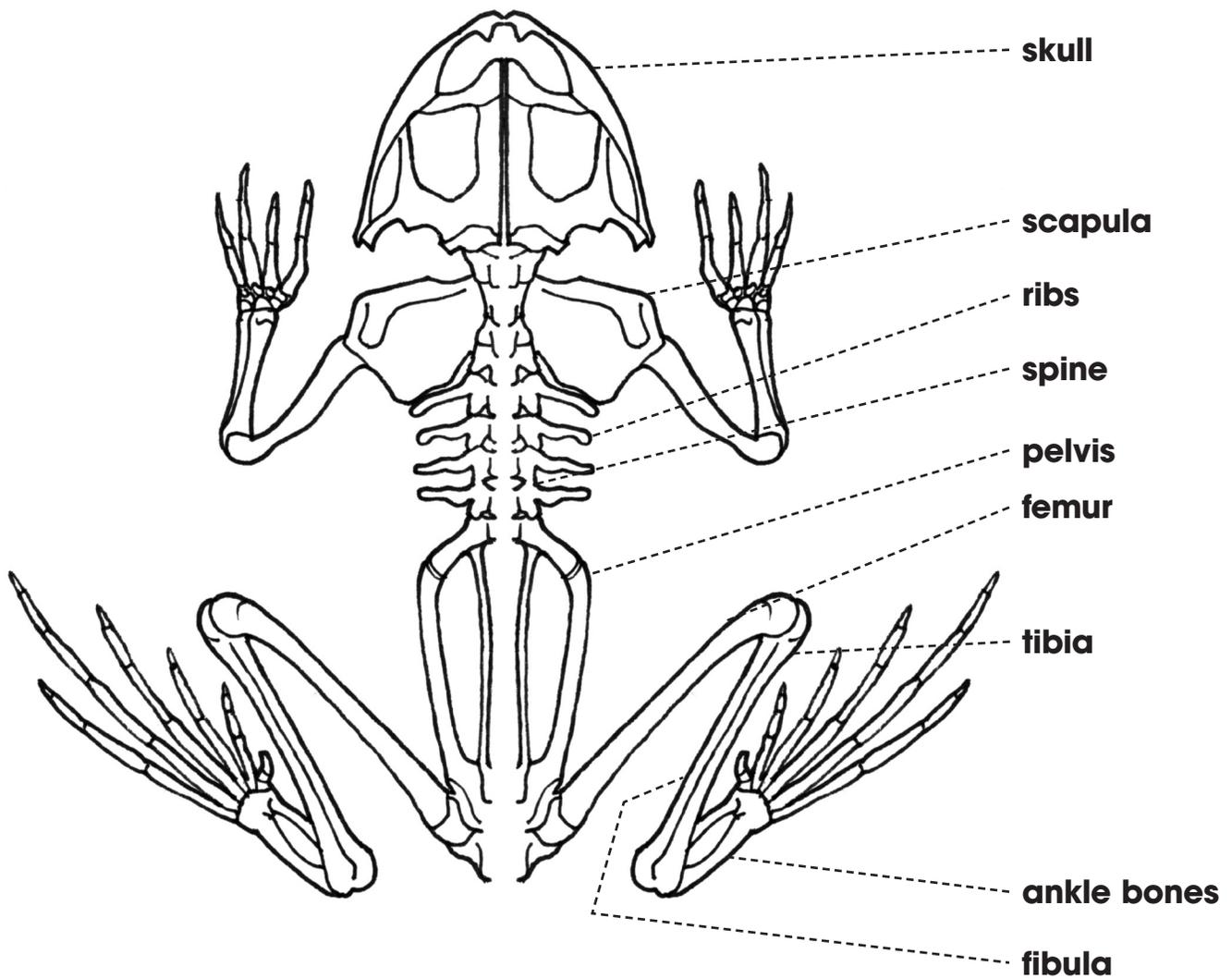
**Write a statement to compare and contrast the two skeletal systems.**



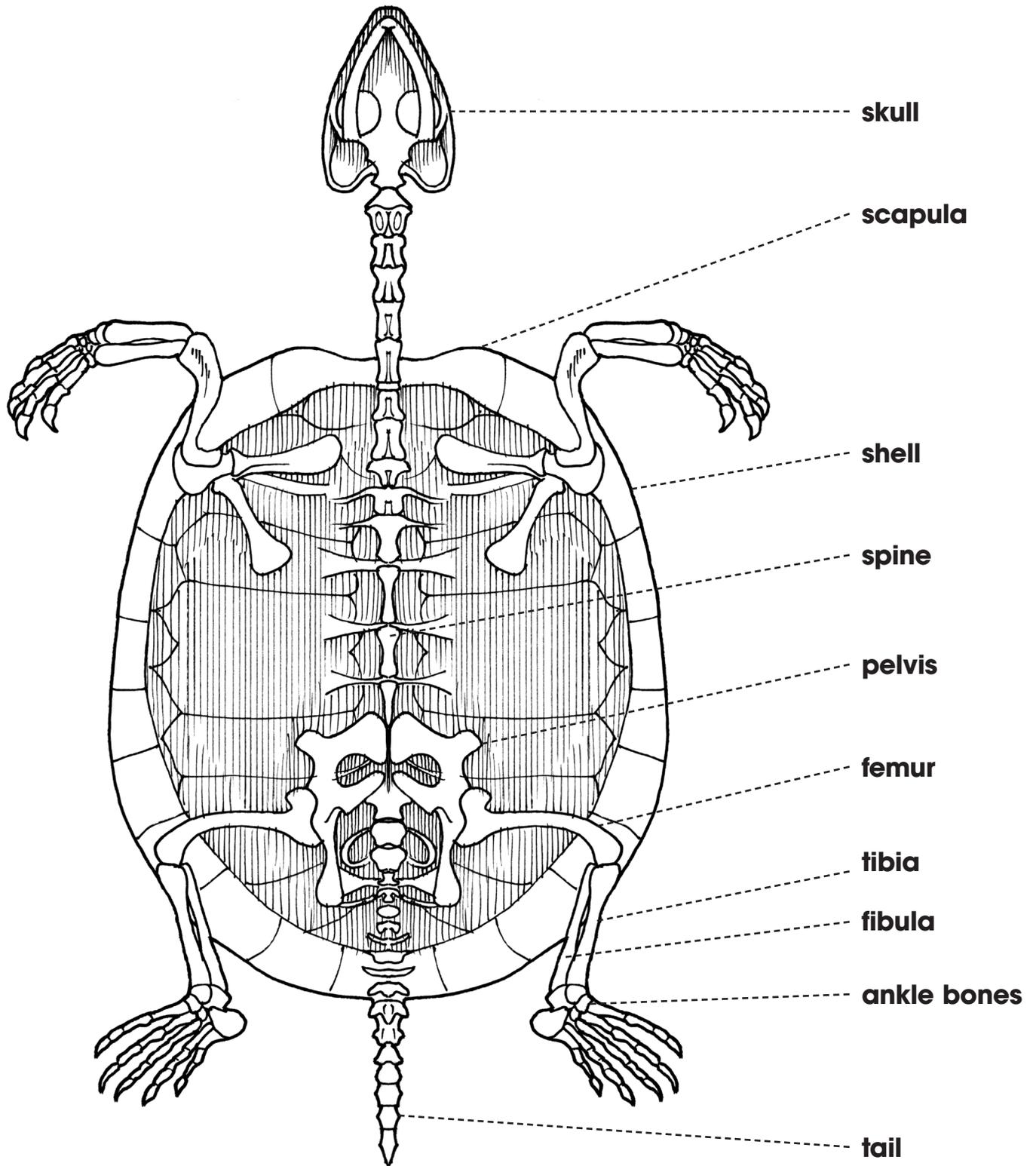
# Vole Skeletal System



# Frog Skeletal System



# Turtle Skeletal System



# Bat Skeletal System

