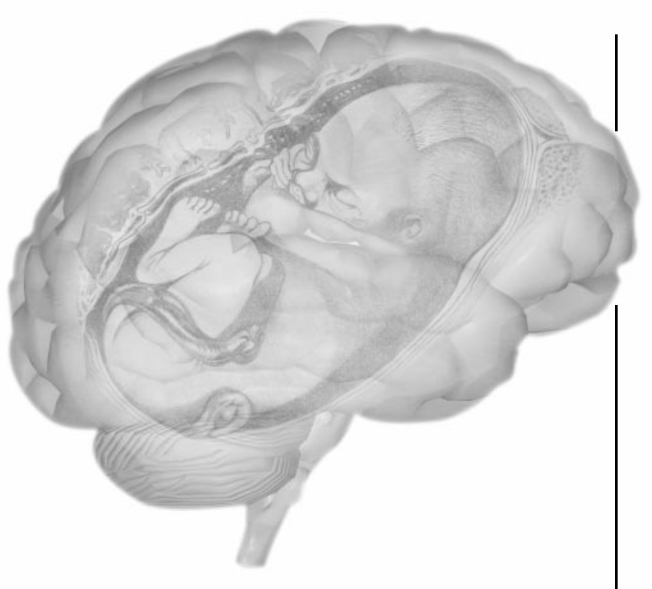


Developmental and Cellular Neurobiology

Lessons and Activities

GRADES 5–12

Section I

Developmental and Cellular Neurobiology

TOPIC

Recent studies have shown that microgravity has an effect upon normal development and function of nerves and muscle.

How will prolonged space flight alter development and normal function of the human neuromuscular system?

INTRODUCTION

The human body is composed of three muscle types: skeletal, smooth, and cardiac muscles (Figure 24). **Skeletal muscle** controls all voluntary movement, such as walking, sitting, or throwing a ball. **Smooth muscles** perform unconscious or involuntary motions, such as moving food through the digestive system. **Cardiac muscle** is heart muscle which is responsible for pumping blood through the body. All three muscle types differ from each other in how the nervous system transmits signals to them and in the types of molecules present within the muscle cells.

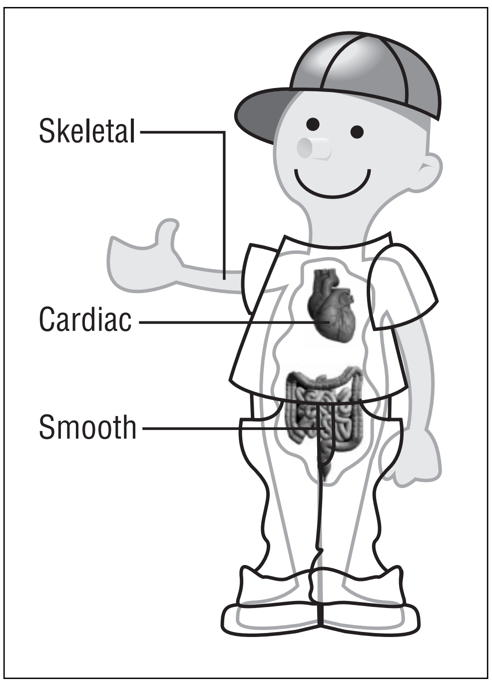


Figure 24 *Diagram of three muscle types.*

Skeletal muscles that are involved in standing and walking are referred to as weight-bearing muscles. Scientists believe **weight-bearing muscles** are profoundly affected by exposure to microgravity. Weight-bearing muscles also consist of two different fiber types known as **slow (or red)** and **fast (or white) twitch muscles**. The two different muscle types are involved in specialized types of movement and activity of neurons of the central nervous system are believed to influence which type of fiber the muscle will become.

The capacity to perform detailed experiments on both human and animal subjects in space provides fascinating opportunities to investigate functional changes in the absence of gravity's effects. Is gravity necessary for normal development and function of skeletal muscle? Does the nervous system require gravity to make functional contact with weight-bearing skeletal muscle correctly? Does gravity alter the manner in which the nervous system communicates with muscle? Experimental research can provide invaluable information about the underlying mechanisms of gravity's effect upon human physiology. The Neurolab team investigated how space flight and microgravity affect the nervous system and its interaction with skeletal muscle.

Things to Know

OVERVIEW OF THE SKELETAL NEUROMUSCULAR SYSTEM

Weight-bearing muscles are attached to the bones of the body by tendons. Both slow twitch (red) and fast twitch (white) weight-bearing muscles control body movement by contraction (becoming shorter). The muscles contract as a result of signals from neurons that are connected to the muscle fiber.

Neurons are the basic unit of the nervous system (Figure 25). Each neuron consists of a cell body with extensions that either send information (axon) or receive information (dendrite). Neurons that send contraction signals to the muscle are known as **motor neurons** and are located in the spinal cord. The motor neuron's axon reaches skeletal muscle early in development and

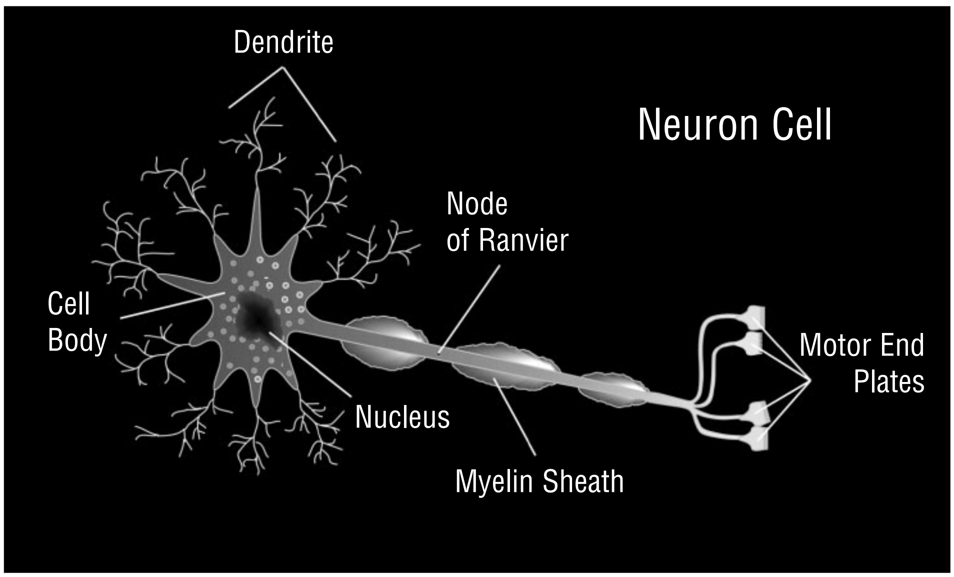


Figure 25 *Diagram of a neuron cell.*

forms a specialized connection known as the **motor end plate** (Figure 25). Scientists believe that axonal signals transmitted from motor neurons to the muscle fiber will determine whether the muscle fiber will become either a slow twitch or fast twitch type. Slow and fast twitch muscles manage different types of motion necessary to function in gravitational fields.

Slow twitch (red) muscles have a rich blood supply and are capable of endurance activities, such as marathon running or standing for prolonged periods. In contrast, fast twitch (white) muscles have a more limited blood supply and are specialized for very fast contractions and forceful movements like lifting heavy weights. In addition, fast twitch muscles fatigue easily. Exposure to microgravity will cause both slow and fast twitch weight-bearing skeletal muscles to shrink. However, slow twitch weight-bearing muscles appear to be more vulnerable to microgravity.

DEVELOPMENT OF THE NEUROMUSCULAR SYSTEM

Motor neurons make connections with muscles early in development. The ability of the neuron to find the muscle and make a connection (synapse) is highly controlled by signals present during the developmental period. When the neuron first contacts its target muscle, it will make more synapses than it requires. Once the muscle matures, the extra synapses are eliminated and the muscle will become either a slow or fast twitch fiber. Maturation into either a slow or fast twitch fiber will determine whether the muscle can perform such functions as standing for prolonged periods in a normal gravitational field or briefly lifting a very heavy weight.

How does microgravity affect neuronal function?

Scientists are studying how microgravity will affect developmental signals from the neuron to the muscle. It is possible that gravity is required for the neuron to form functional motor end plates and behave normally.

DEVELOPMENT OF MOTOR SKILLS

The development of motor skills, such as walking, requires maturation of the neuromuscular system. As these systems develop and become more coordinated, the ability to walk develops over a definite sequence of milestones: the baby lifts its head, then successively supports its body with its arms, turns over, sits up, crawls then walks with assistance (Figures 26A, 26B and 26C). Finally, the baby learns to walk alone. This sequence occurs as muscle and bone strength increase and the nervous system becomes calibrated to control the timing and strength of muscle activity and interpret the incoming sensory signals. Just as one must practice baseball or the piano to play well, it is also necessary to practice to learn how to stand up, walk, jump, and run.

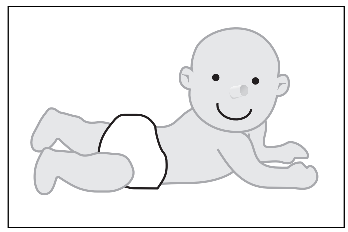


Figure 26A *Diagram of baby supporting body with arms.*

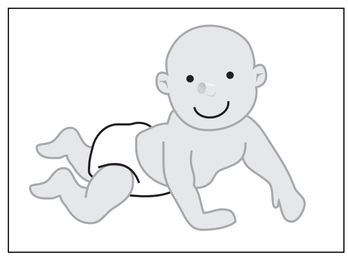


Figure 26B *Diagram of baby crawling.*

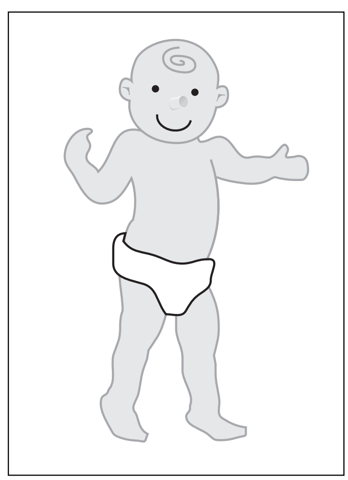


Figure 26C *Diagram of baby walking alone.*

At each step in the process of learning to move in a coordinated fashion, the baby is developing in the presence of Earth's gravity. In microgravity, important developmental signals from the neuron to the muscle may be altered during the critical developmental period making it difficult for this motor system to develop. Experimental studies in microgravity will help scientists determine what role gravity plays in the normal development of human neuromuscular systems.

LEARNING ACTIVITY I:
What Cells Can I See in Muscle and Spinal Cord Tissues?

OVERVIEW

Students will observe, on a prepared slide, cells of muscle and spinal cord tissues.

SCIENCE & MATHEMATICS SKILLS

Observing, comparing, describing, drawing conclusions

PREPARATION TIME

10 minutes

CLASS TIME

50 minutes

MATERIALS

Each student or group of students will need:

- A compound light microscope
- Prepared slides of skeletal muscle and spinal cord tissues (preferably a cross section and longitudinal section)

MAJOR CONCEPTS

- To distinguish between cell types that make up spinal cord and muscle tissues.
- To observe and distinguish the nuclei of cell types and how nuclei differ between muscle cells and motor neurons.

BACKGROUND

The body's motor systems require specialized cells to perform coordinated movement. Skeletal muscle cells fuse during development, forming cylindrical fibers. As a result, muscle fibers are multinucleated (more than one nucleus). The motor neuron sends an axon out of the spinal cord through the nerve and attaches to the muscle to form a motor end plate.

The Neurolab scientists attempted to identify the primary changes that occur in motorneurons and muscle fibers in the microgravity environment. They conducted experiments with frozen, stained muscle fibers and spinal cord tissue from rats that were flown into space. To conduct these experiments, the microscope was used to examine histological sections of muscle fibers and spinal cord tissues. Analysis determined whether the fibers were smaller or whether the neuronal cell body was altered.

This activity will allow you and your students to observe cells in muscle and spinal cord tissues under the microscope.

PROCEDURE

1. Students should be familiar with using the microscope (Figure 27) before carrying out this activity.

2. Divide class into groups of 2 – 4 students. Each student group should have one microscope, which they should check to make sure is clean and working properly.

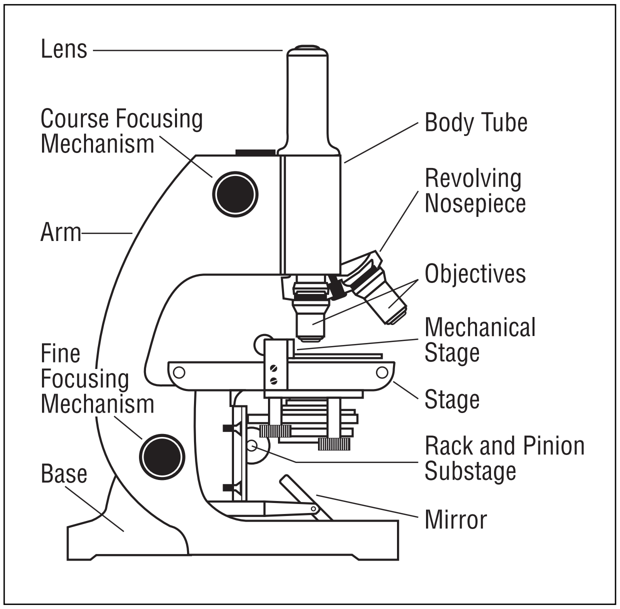


Figure 27 *Diagram of a microscope.*

3. Give each group five prepared slides. Each group should have one slide of rat muscle tissue and four slides of rat spinal cord tissue regions.

4. Instruct the students to use two different magnifications and sketch the cells they observe on a copy of the Student Activity Sheet at the end of this activity. Students should record the magnification used for each sketch.

5. Have students find and label the nuclei and the cytoplasm for each tissue. Also have them identify and label all other parts of the cells.

6. Make overhead transparencies or photocopies of the photographs (Figures 28 and 29) and allow students to compare their sketches to the photographs. Ask students to describe as many differences and similarities between the cells in the two tissues as possible. Have them report the number of cells that were observed of each tissue type.

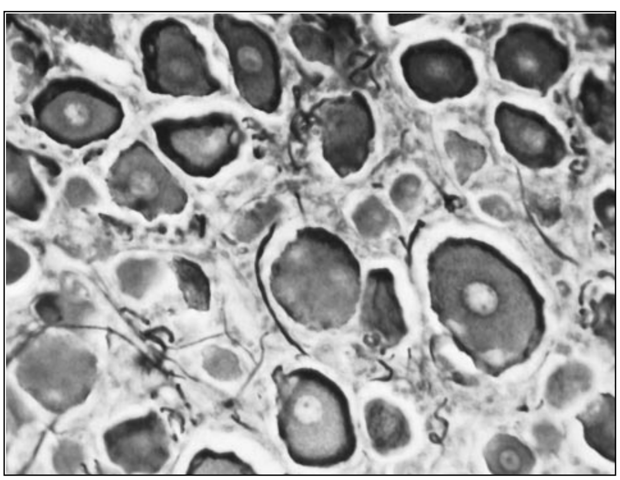


Figure 28 *Photograph of a magnified spinal cord cell (x200).*

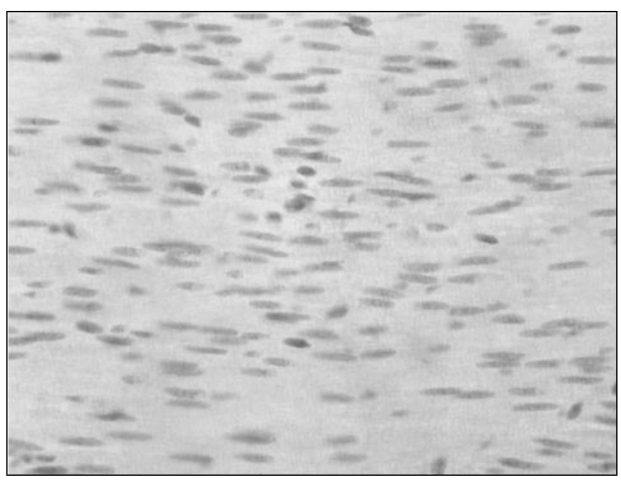


Figure 29 *Photograph of a magnified smooth muscle cell (x248).*

Evaluation

REVIEW QUESTIONS

1. **Describe the shapes of muscle cells.**
   Muscle cells are elongated in shape. The nuclei are fairly uniform.

2. **Do muscle cells look different from spinal cord cells? How do they differ?**
   Yes. The muscle cells are elongated cylinders and the spinal cells are somewhat circular.

THINKING CRITICALLY

1. **If the Neurolab scientists found differences in shapes and/or sizes of these types of cells during their mission, what might this mean about microgravity?**
   If the Neurolab scientists found differences in shapes and/or sizes, it may indicate that microgravity had affected the development or maturation of these cells.

2. **How do you think microgravity may affect human muscle and spinal cord cells?**
   Microgravity may affect human muscle and spinal cord cells by changing the number of cells during the cell division stage of development or by altering the shape and size during change in development.

SKILL BUILDING

1. Obtain slides of human skeletal muscle and human spinal cord tissues and have students compare these to rat tissue.

2. Obtain slides of cardiac and smooth muscles for students to observe. Have them compare these to the slides of skeletal muscle.

Note to teacher: Prestained slides may be obtained from:

Science Kit & Boreal Laboratories	**Muscle tissue**, cat. #69178-05
Phone: 1-800-828-7777	(price: approximately $6.00 ea.)
Fax: 1-800-828-3299	**Spinal cord tissue**, cat. # 69242-03
www.sciencekit.com	(price: approximately $5.00 ea.)
Wards Natural Science	**Muscle tissue**, cat. #33W3542
Phone: 1-800-962-2660	(price: approximately $6.00 ea.)
Fax: 1-800-635-8439	**Spinal cord tissue**, cat. # 93W3699
www.wardsci.com	(price: approximately $5.00 ea.)

STUDENT ACTIVITY SHEET
What Cells Can I See?

Name ______________________________ Date ______________

OBJECTIVE To compare and contrast the cells of smooth muscle and spinal cord tissues.

DIRECTIONS Obtain a group of prepared slides from your teacher. The teacher will give your group a microscope (Figure 30) for you to observe the cells on the prepared slides.

PROCEDURES

1. Your group should have one microscope. Check to make sure that the microscope is clean and working properly.

2. You should have five prepared slides. One slide of rat smooth muscle tissue and four slides of four regions of rat spinal cord tissue.

3. Use two different magnifications and sketch the cells you observe. Record the magnification used for each sketch. (First use the lowest magnification lens, then rotate to the next magnification.)

4. Find and label the nuclei and the cytoplasm for each tissue. Also identify and label all other parts of the cells.

5. Compare your sketches to the photographs or transparencies provided. Describe as many differences and similarities between the cells in the two tissues as possible. Report the number of cells that you observe of each tissue type.

6. After you have completed the muscle tissue, repeat procedures 3 through 5 using the four regions of the spinal cord tissue slides.

Figure 30 *Diagram of student looking through a microscope.*

Name ______________________________ Date ____________

Muscle Tissue

MAGNIFICATION 1: ____________ **MAGNIFICATION 2:** ____________

Diagram of muscle (sketch)

Diagram of muscle (sketch)

Descriptions of number, shape, and size of cells: ______________________

Page 3

Name ______________________________ Date ____________

Spinal Cord Tissue Region 1

MAGNIFICATION 1: ______________ **MAGNIFICATION 2:**______________

Spinal Cord Tissue Region 2

MAGNIFICATION 1: ______________ **MAGNIFICATION 2:**______________

Descriptions of number, shape, and size of cells: ______________________________

Page 4

Name ______________________ Date __________

Spinal Cord Tissue Region 3

MAGNIFICATION 1: ______________ **MAGNIFICATION 2:** ______________

Spinal Cord Tissue Region 4

MAGNIFICATION 1: ______________ **MAGNIFICATION 2:** ______________

Descriptions of number, shape, and size of cells: ______________________

LEARNING ACTIVITY II:
Target Recognition and Synapse Formation During Development

OVERVIEW

Students will learn that growing axons make more connections than they require during development and will maintain only those connections necessary for correct neuromuscular functioning.

SCIENCE & MATHEMATICS SKILLS

Inferring, problem-solving, observing, drawing conclusions

PREPARATION TIME

10 minutes

CLASS TIME

50 minutes

MATERIALS

Each team or group of 10 – 16 students will need:

- Five – eight sections of colored string (each a different color and cut 10 – 20 feet long)—one piece for every two students on the team.

MAJOR CONCEPTS

- Axons must be able to form permanent connections (synapses) with their targets.
- Growing axons must be able to find and identify proper target cells during development.

BACKGROUND

This lesson focuses on neuron/target muscle recognition in neural development. The axon is the long filamentous part of a neuron leading away from the neuronal cell body. The end of the axon is subdivided into many filaments, which form the motor end plate (Figure 25). When messages are transmitted, an impulse flows from the neuron to the target muscle. Only those synapses which are utilized continuously to perform mature motor functions are maintained.

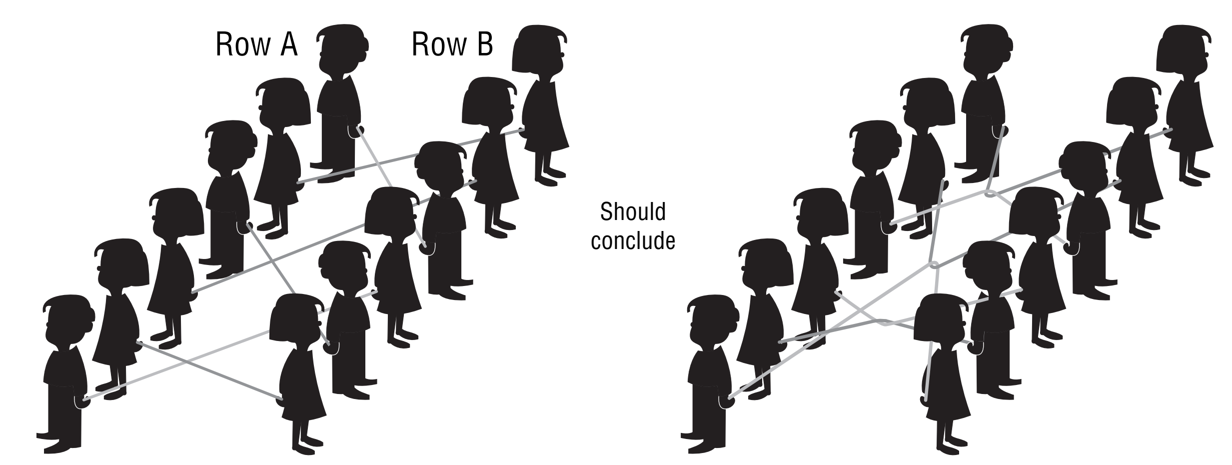
The importance and relevance of gravity's influence on target recognition and synapse formation can be determined through investigations of target selection in space.

PROCEDURE

1. Arrange students in two rows (row A and row B), facing away from each other, with equal numbers in each row. Make sure that the students use string long enough to account for tangling in the middle, as shown in Figure 31. Students in row A will represent axonal growth cones. Students in row B will be target muscles. The appropriate target of each student in row A will be the row B student directly behind him/her.

2. Give each student in row A an end of one of the cut strings.

3. Give the other end of each string to a student in row B. Make sure that none of the strings go straight across to the "proper" student. No correct connections should exist at first, and the strings should be crossed at the outset (Figure 31).



Note: Strings can be tangled in the middle as long as students directly across from each other end up holding the same color.

Figure 31 *Diagram of students demonstrating proper axonal/target connections.*

4. To begin, have the first student in row A (the axonal growth cone) tug on his/her string to simulate the axon searching for its target cells. The student in row B with the other end (an improper target) will not know whether the person tugging is the proper neuron or not.

5. You or another student will act as an observer and provide information about whether the string is connected to the proper target by answering either "yes" or "no," when the row A person tugs on a string. (A proper connection is made when the students across from each other are holding the same colored strings.) If the feedback is "no," ask the student in row B to switch strings with the student next to him/her.

6. Have the first student repeat his/her tug until enough switches have been made to find the "proper" target and elicit the "yes" feedback from you (or the observer).

7. Direct the next student in row A to tug, and repeat the process.

Note to Teacher: *The strings in between the student rows will become tangled. This is fine. In reality, neurons are arranged in bundles called nerves. Crossing will inevitably occur, but since the same colored strings eventually will be held by the students across from each other, students will understand that despite their potentially confusing path, the proper connections are made.*

8. Have the students try the same procedure, but without saying "yes" or "no." (This exercise will prove that the correct connections cannot be made without proper recognition.)

Evaluation

REVIEW QUESTIONS

1. **What is required for axons to properly connect to their targets?**
   Axonal growth cones are required to specifically recognize the appropriate target.

2. **What happens when any part of the system breaks down?**
   If a part of the system breaks down, improper functioning of the sensory system may occur.

THINKING CRITICALLY

1. **How might microgravity affect the connections made?**
   Microgravity may cause binding at improper sites.

2. **Is there point-for-point correspondence between neurons originating in a certain area and their target areas?**
   Yes. There is point-for-point correspondence because the neurons give rise to the axonal growth cones that specifically form connections to target sites.

3. **How are the specific connections made and maintained?**
   Specific connections are made by forming stable connections through target binding.

SKILL BUILDING

1. Have each student in row A record the number of attempts before connecting with the appropriate student in row B. Have students share their data and compute a class average of the number of attempts necessary.

2. Have students create another signaling system for guiding the connection process in the model.

LEARNING ACTIVITY III:
Motor Skills Development

OVERVIEW

Students will construct a timeline of the development of motor skills in humans by pooling observations of children of different ages. They also will construct an autobiographical account of their own development.

SCIENCE & MATHEMATICS SKILLS

Making and recording qualitative and quantitative observations, creating charts and tables, drawing conclusions

PREPARATION TIME

None

CLASS TIME

30 minutes to explain the activity, which requires one week of observation

MATERIALS

Each student will need:

- Note pad
- Pencil or pen
- Tape recorder (optional)

BACKGROUND

Neurolab experiments tested the hypothesis that gravitational fields are necessary during critical periods of mammalian postnatal development (development after birth) for the normal sequence of motor system development to occur. This hypothesis suggested that space rats (and people) would turn out differently than Earth rats (and people) if they were weightless during certain critical times during their development. Neurolab scientists also used information about normal motor system development to make comparisons with development of motor skills of rats under microgravity conditions.

MAJOR CONCEPTS

- Critical periods exist during the development process in which we must interact with our environments for development to progress normally.
- There is a sequential development of motor skills that takes place over time (e.g., from a baby lifting his/her head, to supporting his/her body with his/her arms, to turning over, to sitting up, to crawling, to walking with assistance, and finally, to walking alone).
- The nervous system accounts for the effects of gravity during the "programming" of the motor system.

Reflexes in Babies

The first steps of the investigation will be to find out the ages of babies and children in each student's family and, if possible, in neighboring families. Based on information available to different class members, the group should be able to choose children of different ages to observe. Using the pooled observations made by students, each student or the class as a whole should be able to apply their observations and make a chart, or "timeline" of normal human development.

Should be elicited by a parent and observed by the student.

GRASP REFLEX

The grasp reflex is the easiest baby reflex to observe. If pressure is placed on the baby's hand or foot, the fingers or toes will curl up. The baby will hold tightly onto a finger (Figure 32).

Figure 32 *Photograph of grasp reflex.*

RIGHTING REFLEX

This is a good example of the nervous system developing before muscles do. When a baby is placed in a sitting position, he/she will try to keep his/her head straight. If the neck muscles are not strong enough, the baby will need some help. When the neck muscles develop, the baby will be able to hold his/her head up.

STARTLE REFLEX

This reflex can be elicited by an unexpected noise. After hearing a loud noise, a baby's arms and legs move together, then out, then up, then in. At the same time, the hands and legs open and close.

STEPPING REFLEX

If a baby is held under the arms while his/her feet are touching a solid surface, the baby will lift one foot up and put it down, followed by lifting the other foot (Figure 33). The same reflex can be observed if the baby's feet are pressed against a couch. This reflex is seen from birth to about six to eight weeks of age, and again between eight and twelve months.

Figure 33 *Diagram of stepping reflex.*

TONIC NECK REFLEX

If the baby is lying on his/her back and not crying and his/her head is turned to one side, often the arm on the same side will extend while the leg on the other side will flex (Figure 34). This is the same position you see when a right-handed baseball player extends his/her arm up to catch a ball. His/her head will be turned to the right, the right leg will be extended, and the left arm and leg will be bent.

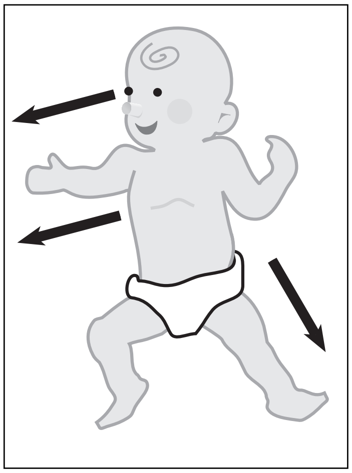


Figure 34 *Diagram of tonic neck reflex.*

For older students, this activity can be extended to include the study of the development of language among children of different ages. The main objective of the activity is to gather information by observation and to learn that there is a time-related course of human development. Students also will learn whether the development of certain skills depends on strength, the nervous system, or both, and if development progresses in a front-to-back, head-to-tail, or other sequence. Over the course of the activity, students will observe human development, take a "family history" from their parents, and write an autobiography. They will then compare the accuracy of what they learned about human motor development by direct observation, "hear-say" information, and memory.

Note to Teacher: *It is important to emphasize that growth and development is a continuous process and that milestones are not reached at a particular age, but over a range of ages.*

PROCEDURE

Part One: Observing Development

1. Survey the students in the class to determine the numbers and ages of each student's siblings (and younger friends and neighbors). From the list provided, choose babies, toddlers, and children (up to about seven – eight years of age) to include in the activity and to be observed by different members of the class. ***Suggest to the students that their parent(s) or guardian(s) provide this information.***
2. Assign students or groups of students to observe babies, toddlers and young children from the list during the course of the following week.
3. Tell the students to observe their subject(s) carefully, take notes and fill out the class survey sheet, listing development skills and reflexes (see Student Activity Sheet on page 50).
4. If this activity is extended to language development (which may be the most interesting for high school students), tape recorders may be used to document sounds.
5. Based on the class data, have each student or group of students describe the timeline of the acquisition of motor (and language, if applicable) skills in children.

STUDENT ACTIVITY SHEET
Observing Development of Younger Subjects

Name ______________________________ Date ____________

1. What are the "vital statistics" of your subject?

_______ weight
_______ height
_______ weight and length at birth
_______ gender
_______ number of siblings
_______ position in family (what number child?)
_______ twin

2. Can your subject do the following? ***Place a check next to each action your subject can perform.***

Movement

_______ lift head
_______ hold head up and look around
_______ support body with arms
_______ roll over
_______ grab something, hold onto it
_______ sit up with support
_______ sit up without support
_______ reach and pick up a toy
_______ crawl
_______ crawl up stairs

Awareness of Self and Others

_______ follow family members with eyes
_______ smile
_______ laugh
_______ recognize self in mirror
_______ recognize hands
_______ recognize feet
_______ recognize own name
_______ point at things
_______ wave good-bye
_______ copy sounds
_______ say first words

Walking

_______ stand up from sitting or crawling position
_______ stand without falling, if holding onto something
_______ stand alone
_______ walk while holding onto something
_______ walk alone
_______ stand on one foot
_______ jump on one foot
_______ hop
_______ skip
_______ jump
_______ run
_______ walk up stairs

Skilled Movement

_______ eat with a spoon
_______ drink from a cup
_______ drink from a glass
_______ use a knife and fork
_______ throw a ball straight
_______ draw a straight line
_______ make a circle around a drawing of a house
_______ copy a circle, triangle or drawing of a house
_______ catch a ball (if so, what size ball?)

3. How many different kinds of controlled movements can your subject make? ___________
Add from above.

Part Two: Autobiographies

1. Have students fill out developmental surveys (as before) about their own development with their parent(s)' or guardian(s)' help (pediatricians often have this type of information from "well child" exams). See Student Activity Sheet on page 53.

2. Student should identify the sources of their information (e.g., self, parent, doctor, document, etc.).

3. Have each student use his or her own developmental surveys to create an autobiographical description of his or her own development from birth until age six.

Evaluation

REVIEW QUESTIONS

1. **Are motor skills acquired in a particular sequence during development?**
   The acquisition of motor skills follows the development of the nervous system. The nervous system, as well as motor skills, develops from the head down. Babies can control their arms before their legs. This is because the motor cortex, which controls fine movements, develops over a roughly three-month period from 4 – 7 months. The development of sensory ability, such as improved vision is due to development of the connections between the retina and the brain.

2. **What determines the sequence? Is it influenced by age, weight or gender?**
   The sequence is determined by the growth of the nervous system. Since strength is also important, developments of the muscular system also plays an important role.

   For the purposes of this discussion, the sequence is not influenced by gender (although girls and boys develop particular skills at different rates). Weight only plays a role in the case of underweight babies—malnutrition can delay development.

3. **Is there a difference between what one observes and what one remembers? Why?**
   Yes. Relying on memory can be worse than not remembering at all because memory can be selective—we only remember some aspects of our experiences. Also, memory can be incorrect or inaccurate because it is influenced by emotion, by what we expect, or by what we want to remember.

THINKING CRITICALLY

1. If available, have students bring in pictures of themselves between the ages of 0 – 2 years and put the photos on a board. Have students use their data bases (Student Activity Sheet: Observing Your Own Development) to try to guess the ages of their classmates in each of the pictures (Figure 35).

Figure 35 *Diagram of student observing development of another student.*

2. Is knowledge of the subject's age useful developmental information? Does this requirement vary according to the overall age of the subject (e.g., each hour, day, week, month, or year)?

3. What might happen to a person that developed under microgravity if he/she were exposed to conditions of increased gravity, such as Earth?

The purpose of the Neurolab experiments was to gather data that would help us answer this question. However, there were some hints from other experiments—it was thought that the motor control and strength of animals that developed under conditions of reduced gravity would be different from those of animals that developed on Earth. As animals learn to walk, the nervous system is fine tuned to the conditions they experience. The fact that babies are born with very little motor control means that what they experience as they gain particular motor skills may influence their development.

An animal from the Moon visiting Earth for the first time would feel very heavy and would find it hard to move. This is because postural muscles needed to support its body against the force of gravity would be very weak. The circulatory system would also have problems because it would be harder for the heart to pump blood up to the head. The animal might feel faint.

SKILL BUILDING

1. What are the advantages and disadvantages of each source of information used in this activity? What is the accuracy of each source? For example, ask each student about jumping rope.

- Can your sister, brother, neighbor jump rope?
- When did the parent of your subject say he/she could first jump rope?
- Do you remember when you could first jump rope?

STUDENT ACTIVITY SHEET
Observing Your Own Development

(from birth to age six)

Name ______________________________ Date ______________

1. What are your "vital statistics"?

_______ weight
_______ height
_______ weight and length at birth
_______ gender
_______ number of siblings
_______ position in family (what number child?)
_______ twin

2. At what age could you do the following?

Movement

_______ lift head
_______ hold head up and look around
_______ support body with arms
_______ roll over
_______ grab something, hold onto it
_______ sit up with support
_______ sit up without support
_______ reach and pick up a toy
_______ crawl
_______ crawl up stairs

Awareness of Self and Others

_______ follow family members with eyes
_______ smile
_______ laugh
_______ recognize self in mirror
_______ recognize hands
_______ recognize feet
_______ recognize own name
_______ point at things
_______ wave good-bye
_______ copy sounds
_______ say first words

Walking

_______ stand up from sitting or crawling position
_______ stand without falling, if holding onto something
_______ stand alone
_______ walk while holding onto something
_______ walk alone
_______ stand on one foot
_______ jump on one foot
_______ hop
_______ skip
_______ jump
_______ run
_______ walk up stairs

Skilled Movement

_______ eat with a spoon
_______ drink from a cup
_______ drink from a glass
_______ use a knife and fork
_______ throw a ball straight
_______ draw a straight line
_______ make a circle around a drawing of a house
_______ copy a circle, triangle or drawing of a house
_______ catch a ball (if so, what size ball?)

3. How many different kinds of controlled movements could you make? ______________
Add from above.