UNIT A: LESSON 3

LEARNING TARGETS

<table>
<tr><td colspan="2">INSTRUCTIONS FOR TEACHERS:
• Refer students to the standards and objectives.
• Review the standards and objectives with students one at a time.
• At the end of the lesson, ask students what they did in class to meet the standards.</td></tr>
<tr><td colspan="2">INSTRUCTIONS FOR STUDENTS:
Listen as your teacher reviews the standards and objectives. Your teacher will call on an individual or pair to explain what they mean.</td></tr>
<tr><td>Learning Target:
I can compare and contrast written and digital presentations of ideas.

Learning Target:
I can explain how the different aspects of a presentation contribute to my understanding.</td><td>compare and contrast – decide what is the same and what is different
digital – electronic
explain – talk about what something means
aspect – part
contribute – add</td></tr>
</table>

ACQUIRING AND USING VOCABULARY

INSTRUCTIONS FOR TEACHERS:

Prepare the materials below and assign roles to students. In a larger class, you might divide student into groups to perform for each other. Allow students time to practice before performing. The teacher should serve as the narrator.

Materials

- Name tags for each of the characters
- One roll of toilet paper (myelin sheath)
- 10 objects to pass (like rulers, tennis balls, small books, etc.)

As a follow-up, familiarize students with their glossary. It is located in Appendix A (Glossary; labeled "Appendix: Glossary" in the student version). Tell students to use the glossary throughout the lesson.

INSTRUCTIONS FOR STUDENTS:

Follow your teacher's instructions to participate in a vocabulary play. You will practice using vocabulary about the brain from previous lessons.

Use your glossary for the rest of the lesson. You can find it at the end of each lesson in the Appendix to the lesson. Any words that are **bolded** in the text or word banks can be found in the glossary.

WORD PLAY

Characters

Brain	Axon #2	Dendrite #3
Axon #1	Dendrite #2	Neurotransmitter
Dendrite #1	Axon #3	Myelin

Script

Narrator: Welcome to your brain in action. Here we have three neuron cells: Axon and Dendrite #1, Axon and Dendrite #2, and Axon and Dendrite #3. (*The six students should stand together in groups of two. The groups should be far enough away that they cannot touch each other with outstretched arms.)*

Narrator: One day, an electrical impulse came down from the brain. (*Brain hands one of the 10 objects to Dendrite #1).*

Brain: Hey Cell Body #1, pass this electric message to Cell Body #2.

Dendrite #1: (to Axon #1) Oh, no? How will you pass the message to Dendrite over at Cell Body #2?

There's a big empty synapse in the way! (*Axon #1 looks sad.)*

Narrator: Suddenly a big, handsome Neurotransmitter came on to the scene.

Neurotransmitter: I'll help you. Bridging the synapse is what I do best! (*Neurotransmitter grabs the object and passes it to Dendrite #2.)*

Narrator: This was working pretty well. So the brain kept giving electric impulses. And another. And another. (*Brain, Axon #1, Dendrite #1, Neurotransmitter, and Dendrite#2 keep passing three objects.)*

Axon #1: (to Brain) You know, Brain, we could use some help. You know what would make this easier? If we had some myelin sheath—why, that would help us work faster and more efficiently.

Brain: You know, that's a good idea. Since this is a pathway that gets used a lot, I will send over a message to the cells in the Myelin Department. They will wrap you up.

Myelin: Here I am. Did someone order some neural insulation?

Axon #1: I did! (*Myelin wraps the Axon's arms in toilet paper.)*

Narrator: Axon #1 was right. Myelin helped him/her pass the electric impulse faster. So the brain sent more messages. And more myelin. And more messages. And more myelin. (*Students repeat the sequence of sending a message, wrapping the arms in toilet paper, and sending a message three more times. Each time the message gets sent faster.)*

Axon and Dendrite #3: Hey, no one is passing us an electric impulse! We're shriveling up here. (*Students sink to the ground.)*

Brain: Yeah, you're right. Turns out we don't need you guys. I guess you've been pruned.

Narrator: And so, since Cell Body #1 and Cell Body #2 were used all the time, they grew more and more efficient at sending messages. Tune in next time to see if poor Cell Body #3 will ever get a chance to grow and shine, or if they will continue to be a victim of synaptic pruning!

(Students take a bow.)

THINKING LOG

INSTRUCTIONS FOR TEACHERS:

- Read the guiding question and text aloud to students, modeling appropriate pace and intonation.
- During the read-aloud, define words and phrases in context that students are unlikely to know, drawing defintions from the glossary when you can. Translations, examples, gestures, and visuals also help.
- Ask students to read the text on their own and work with a partner to answer supplementary questions.
- Ask students to use their glossary to help them with word meanings.
- Call on pairs to answer the supplementary questions.
- Discuss the guiding question(s) as a group and then have students write the answer in their student chart.

INSTRUCTIONS FOR STUDENTS:

Your teacher will ask you a guiding question that you will think about as your teacher reads the text aloud to you. As your teacher reads the text aloud, listen and follow along in your text. After the text has been read aloud, work with a partner to reread the text and answer the supplementary questions. Use your glossary to help you. Your teacher will review the answers with the class. You will then discuss the guiding question(s) with your teacher and the class. Finally, you will complete a written response to the guiding question(s).

GUIDING QUESTION: *Write the ways that the brain matures as you develop from four years old to 21.*

THE CHILD'S DEVELOPING BRAIN

Introduction

Different **areas** of the brain mature at different **rates**, which helps explain many of the **intellectual** and emotional changes seen in children, teens, and young **adults**. While no two children develop in exactly the same way, scientists have been able to **link** certain developmental **milestones** to changes in **brain tissue**, observed by MRI scans taken **repeatedly** over years. Move the slider below to see how the brain matures. Red, yellow, and orange **patterns indicate** undeveloped brain tissue, while green, blue, and purple **indicate** a maturing of the brain.

4 Years Old

Early Development

In the first few years of life, areas of the brain **devoted** to basic **functions** change at a **rapid pace.** By age 4, primary senses and **basic motor skills** are almost fully developed. The child can walk, hold a crayon, and feed himself.

Sensation
Areas responsible for **sensations** like touch are almost as developed as they ever will be.

Vision
The part of the brain governing **vision** has already matured.

6 Years Old

Language

The area of the brain governing language is immature, as indicated in orange, but continues to develop rapidly in children through age 10. The brain already has begun a "pruning" process, **eliminating redundant** neural **links**. This will accelerate in later years, one reason why learning a new language is easy for children and virtually impossible for many adults.

Reason
The dappled yellow and red areas of the prefrontal cortex indicate that this part of the brain, which affects **abstract** thinking, **reasoning** skills, and emotional maturity, has yet to develop. This lack of maturity is one reason young children can't juggle a lot of information and throw tantrums when presented with too many choices.

9 Years Old

Fine Motor Skills

While basic motor skills are well developed by age 5, children experience a burst of fine motor skill development between ages 8 and 9, helping to explain **gains** in the ability to use scissors, write neatly or in cursive, and **manipulate** models and craft projects.

Mathematics
By the age of 9, the parietal lobes are beginning to mature. Development here allows children to **acquire** math and geometry skills. The **pace** of learning at this age is fast and can be enhanced with flashcards and math drills.

13 Years Old

Judgment
The prefrontal cortex is among the last areas to mature. Until it does, children **lack** the ability to adequately judge risk or make long-term plans. Ask kids at this age what they want to be when they grow up, and the answer is likely to change often.

Emotion

Deep in the limbic system, a **capacity** for **creating** emotion increases. As yet, this capacity is **unrestrained** by the prefrontal cortex, which lags behind. That's why some teens can seem emotionally out of control.

Logic

The parietal lobes are developing rapidly at this age, as shown here in blue. The child's intelligence and analytical abilities are **expanding**.

15 Years Old

Specialization

In the teen years, an abundance of neural links continue to be **discarded**. Underused connections will die to help more active connections thrive. As a result, the child's brain will become more **specialized** and efficient.

17 Years Old

Abstract Thought

The deep blue and purple of the maturing prefrontal cortex shows why the brains of older teenagers are **capable** of dealing with far more **complexity** than younger children. This development leads to a burst of social **interactions** and emotions among older teens. Planning, risk-taking, and **self-control** become possible.

21 Years Old

Executive Functions

Although the brain appeared to be almost fully developed by the teen years, the deepening blue and purple areas here show that tremendous **gains** in emotional maturity, **impulse control** and decision making continue to occur into early adulthood.

Maturation

The 21-year-old brain is mostly mature, but the areas of green show that even at the threshold of legal adulthood, there is still room for increases in emotional maturity and decision-making skills, which will come in the next few years.

WORD BANK:

acting	emotional maturity	learn	social interactions
blue	emotions	mathematics	**specialized**
brain tissue	feed themselves	mature	sypnaptic pruning
changing	future	matured	ten
complex	green	nine	there is still room for
decision making	hold crayon	orange	thinking
efficient	**impulse control**	prefrontal cortex	use scissors

eight	in the next few years	purple	**vision**
eliminating	intellect	risky	walk
emotion	language	sensation	write neatly

SUPPLEMENTARY QUESTIONS:

Introduction

1. The introduction says, "Different areas of the brain mature (develop) at different rates." What can this statement help us understand?

This statement helps us understand that children, teens, and young adults are different intellectually (in their thinking) and emotionally (in their feelings) because their brains are changing.

2. Do all children's brains develop in exactly the same way?

No, they do not (Yes, they do/No, they do not).

3. How can scientists tell that changes in the brain are related to how children act at different ages?

Scientists use MRI scans (scans that look inside the body) to show how changes in intellect (thinking) and emotion (feelings) are related to changes in brain tissue.

4. In the graphic, you can move the slider to see images (pictures) of the brain as it matures (grows) from 4 years old to 21 years old. What color indicates (shows) undeveloped brain tissue?

The orange color indicates undeveloped brain tissue.

5. Which colors indicate, or show, that the brain is maturing?

The colors green, blue, and purple show that the brain is maturing.

4 Years Old

6. The text says that in the first few years of life, the brain changes at a rapid pace. What does this mean?

"Changing at a rapid pace" means the brain changes very fast (very slowly/very fast) during these early years.

7. What are some examples of 4-year-olds having almost fully developed primary senses (seeing, hearing, touching, tasting, and smelling) and basic motor skills (actions that use muscles)?

Four-year-olds can walk, hold a crayon, and feed themselves.

8. Which areas of the brain are almost fully mature or completely mature?
The area of sensation (touching) is almost completely mature, and the area of vision (seeing) is mature.

6 Years Old
9. Which area of the brain is immature at this age?
The immature area is language.

10. The language area will grow rapidly until what age?
It will grow fast until age ten.

11. At 6, what is the brain beginning to do? What is this process called?
The brain is eliminating (getting rid of) redundant (extra) neural links. This process is called synaptic pruning (*hint: we read about this process in the previous lesson*).

12. The author says the pruning process explains something about language. What does it explain?
The author says that synaptic pruning makes language easier to learn for children than for adults.

13. What do the yellow and red areas of the prefrontal cortex indicate?
The colors yellow and red indicate that the prefrontal cortex has not yet matured. As a result, children at this age have trouble thinking abstractly, reasoning, and controlling their emotions.

9 Years Old
14. At what ages do children develop fine motor skills, or skill at making small movements?
Children increase fine motor skills between ages eight and nine.

15. What are some examples of fine motor skills?
Examples of fine motor skills include being able to use scissors and write neatly.

16. What area of learning is developing rapidly, or fast at this age?
The ability to do mathematics is developing rapidly.

13 Years Old
*17. What can children at this age **not** do, and why?*
At 13, children cannot judge what is risky (dangerous), and they cannot make plans for the more distant future. This is because the prefrontal cortex is very immature.

18. The limbic system is becoming more capable, or able to do things. What does the limbic system do?
The limbic system creates emotions.

19. What is the result of the limbic system being more mature than the prefrontal cortex?
Some teens can seem unable to control their emotions.

15 Years Old
20. What is the result of synaptic pruning at 15 years old?
The brain becomes more specialized and efficient because of synaptic pruning.

17 Years Old
21. What do the dark blue and purple colors in the prefrontal cortex mean?
These purple and blue areas are more mature. Older teens are now able to deal with complex situations.

22. What does this development mean for seventeen-year-olds?
Seventeen-years-olds are involved in many more social interactions.

21 Years Old
23. What are examples of executive functions?
Executive functions incudes emotional maturity, impulse control, and decision making.

What is impulse control?
Impulse control is being able to stop yourself from acting before thinking.

24. Is the 21-year-old brain fully mature?
No, it is not (Yes, it is/No, it is not).

25. How can you tell from the image?
The image still has green areas.

25. What in the text tells you that the 21-year-old brain is not fully mature?
The text says, "there is still room for increases in emotional maturity and decision making, which will come in the next few years."

RESPONSE TO GUIDING QUESTION(S) – *Graphic organizer*:

Work with a partner. Use the graphic organizer to show how the brain matures as you grow from 4 years old to 21. The lefthand column states, or says, the age. In the center column, write what is mature, or developed, at that age. In the righthand column, write what is not yet mature.

WORD BANK: analytic skills, complexity, decision making, emotional maturity, fine motor skills, impulse control, intelligence, interaction, language, mathematics, motor skills, planning, primary senses, risk-taking, self-control, sensations, specialization, vision

Age	**What Is Mature?**
Age 4	primary senses basic motor skills sensations vision
Age 6	language
Age 9	fine motor skills mathematics
Age 13	intelligence analytic skills
Age 15	specialization
Age 17	dealing with complexity social interaction planning risk-taking self-control
Age 21	emotional maturity impulse control decision making

COMPARING TEXT TO MULTIMEDIA

INSTRUCTIONS FOR TEACHERS:
Review student instructions. Make sure all students have access to the multimedia feature online. Have students work with a partner to complete the graphic organizer, then as a class to answer the questions.

INSTRUCTIONS FOR STUDENTS:
Navigate, or go to, the online *Child's Developing Brain* feature with your class or with a partner. The words are the same as what you already read, but there are some differences in how it is presented, or shown.

- Play around with the slider feature and observe, or watch, what happens.
- Then, with a partner, fill out the graphic organizer to compare and contrast (show what is the same and different about) the text and the online feature.
  - Write what is *different* about the text and online feature.
  - Write what is the *same* about the text and online feature
  - Write what the *advantages*, or good things, are about each.
- Finally, answer the questions as a class.

	TEXT	**ONLINE FEATURE**
What is different *(contrast)*	The text has _____. The online feature does not have _____. You can find information in the text by _____ _____. You cannot find information in the online feature this way. Other differences I noticed: _____ _____.	The online feature has _____ and _____. You can find information in the online feature by _____ _____. Other differences I noticed: _____ _____.
What is the same (*compare*)	They both have the same _____. Other similarities I noticed: _____ _____.	They both have the same _____. Other similarities I noticed: _____ _____.
Advantages (*good things*)	The advantage of the text is _____ _____	The advantage of the online feature is _____ _____

	_____.	_____.

Questions

Use the information you wrote in your graphic organizer to answer these questions as a class.

1. What are the differences between the text and the online feature? How are they the same?

The differences between the text and the online feature are _____
_____
_____

The ways they are the same are _____
_____
_____

2. What are the advantages of the text-only version?

The advantages of the text-only version are_____
_____.

3. What are the advantages of the online feature?

The advantages of the online feature are _____
_____.

4. Remember your Thinking Log from reading just the text. What did you learn from seeing the online feature that you did not learn from reading the text?

From seeing the online feature, I learned _____
_____.

5. Think about what you learned from the text and the online feature. What other images, or pictures, could the online feature include to help you learn more?

The online feature could have pictures of _____
_____
_____.

EXIT TICKET

INSTRUCTIONS FOR TEACHERS:

- Review student instructions with the whole class.

INSTRUCTIONS FOR STUDENTS:

This graphic organizer will help you keep track of information about the brain for all of the readings. Each day you will write down new information from each reading. Today,

- Write one thing that happens in the brain at each of the ages indicated, or noted, in the chart.
- Write one thing you learned today that is new. It should be *different* from what you learned in the previous lesson.

Age 6	**Age 9**	**Age 13**	**Age 21**

One new thing I learned today is

_____

_____

_____.

Appendix A: Glossary

Word	Definition	Examples
abstract	a thought or an idea; not something concrete	The prefrontal cortex affects **abstract** thinking, reasoning skills, and emotional maturity.
acquire	learn or develop	Children **acquire** math and geometry skills at age 9.
adult (adulthood)	a grown-up; someone who is fully mature	Gains in emotional maturity, impulse control, and decision making continue to occur into early **adulthood**.
area	part	The prefrontal cortex is among the last **areas** to mature.
basic	fundamental or essential (very necessary)	Areas of the brain devoted to **basic** functions, like eating and walking, grow very fast.
brain tissue	the cells or material that form the brain	Red, yellow, and orange patterns indicate undeveloped **brain tissue**.
capable	able to do something	The brains of older teenagers are **capable** of dealing with more complexity than young children.
capacity	ability	The brain's **capacity** for creating emotion increases.
complex (complexity)	not simple	The brains of older teenagers are capable of dealing with more **complexity** than young children.
create (creating)	make	The brain's capacity for **creating** emotion increases.
devoted	set apart for a special reason or purpose	Areas of the brain **devoted** to basic functions, like eating and walking, grow very fast.
discard (discarded)	get rid of something	In the teen years, an abundance of neural links continue to be **discarded**.

Word	Definition	Examples
eliminate (eliminating, elimination)	remove or destroy	The brain is **eliminating** redundant neural links through synaptic pruning.
expand (expanding)	get bigger	The child's intelligence is **expanding**.
function	a specific activity that someone or something does	Areas of the brain devoted to basic **functions**, like eating and walking, grow very fast.
gain	get or arrive at something	**Gains** in emotional maturity, impulse control, and decision making continue to occur into early adulthood.
impulse control	ability to stop or prevent a sudden desire (want) or decision	Gains in emotional maturity, **impulse control,** and decision making continue to occur into early adulthood.
indicate	show or make known	Red, yellow, and orange patterns **indicate** undeveloped brain tissue.
intellectual	having to do with thought or thinking	Different areas of the brain mature at different rates, which helps explain many of the **intellectual** changes seen in children and teens.
interact (interaction, interacting)	communicate or talk with other people	This development leads to a burst of social **interactions** and emotions among older teens.
lack	does not have	Until the prefrontal cortex matures, children **lack** the ability to adequately judge risk.
link	something that joins or connects two things	In the teen years, an abundance of neural **links** continue to be discarded.
manipulate	handle something skillfully with your hands	Children experience a burst of fine motor skill development between ages 8 and 9, helping to explain gains in the ability to **manipulate** models and craft projects.

Word	Definition	Examples
milestone	an important event or goal	Scientists have been able to link certain developmental **milestones** to changes in brain tissue.
motor skill	ability to control body movements, especially complicated body movements that use several muscles	Children experience a burst of fine **motor skill** development between ages 8 and 9.
pace	how fast something moves, grows, or changes	In the first few years of life, areas of the brain devoted to basic functions change at a rapid **pace**.
pattern	design	Red, yellow, and orange **patterns** indicate undeveloped brain tissue.
rapid	very fast	In the first few years of life, areas of the brain devoted to basic functions change at a **rapid** pace.
rate	how fast something happens	Different areas of the brain mature at different **rates**, which helps explain many of the intellectual changes seen in children and teens.
reasoning	logic or rational thinking	The prefrontal cortex affects abstract thinking, **reasoning** skills, and emotional maturity.
redundant	extra or repetitive	The brain is eliminating **redundant** neural links through synaptic pruning.
repeated (repeatedly)	over and over again	Scientists have been able to link certain developmental milestones to changes in brain tissue, observed by MRI scans taken **repeatedly** over years.
restrain (unrestrained)	hold something back	As the capacity for creating emotion increases, it is **unrestrained** by the prefrontal cortex, which lags behind.
self-control	holding back or containing strong emotions and reactions	As the brain matures, planning, risk-taking, and **self-control** become possible.

Word	Definition	Examples
sensations	physical feelings	Areas responsible for **sensations** like touch are almost as developed as they ever will be.
specialize (specialization, specialized)	focus on a specific thing, or on getting better at a specific thing	Underused connections will die to help more active connections thrive. As a result, the child's brain will become more **specialized** and efficient.
vision	sight	The part of the brain governing **vision** has already matured by age 4.

Italicized words are from the Academic Word List.