KANSAS CORN STEM

KANSAS CORN :
Structurally Speaking

This lab is made possible with the support and content contributions of the Kansas Corn Commission.

KANSAS CORN COMMISSION

Kansas Corn: Structurally Speaking
Grade Level: 4

Unit Overview

This unit, which focuses on plant structures and functions, is spread over several weeks in order to grow corn plants in the classroom to be used in the last lesson. In the first lesson, students plant corn seeds in order to sprout plants to be used three weeks later. They also set up their science notebooks to record ongoing observations. In the second lesson, which involves observations over 3-5 days, students investigate how a seed germinates, with structures and functions of seeds being emphasized. The third lesson culminates in students observing and drawing a full corn plant, identifying structures and functions of the plant. These lessons can be modified so that instead of growing the plants in the classroom, full corn stalks are brought into the classroom for the final lesson.

Kansas College and Career Ready Standards

Science

- **4-LS1-1.** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Language Arts

- **W.4.2.** Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
- **SL.4.1.** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.

Learning Objectives

- Students will propose ideas about how a seed sprouts and a plant grows.
- Students will plant seeds and water them over the course of three weeks.
- Students will observe the plantings and record their findings by drawing and writing over the course of three weeks.
- Students will plan and conduct an investigation to determine the best germinating conditions for corn seeds.
- Students will analyze their recorded data, labeling structures they observe, and indicating functions for them.
- Students will observe carefully and record their observations of a corn plant by drawing and labeling what they observe.
- Students will construct an explanation based on evidence that plants have structures that function to support survival, growth, behavior, and reproduction.

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Materials
- Pretest (pg. S13 and online)
- Science notebook with seed growth journal (pg.S14-16, S20-25, & S29 and more options available for print online)
- Corn seeds
- Soil
- Planting containers
- Water and spray bottles
- Zip close sandwich baggies
- A variety of liquids such as orange juice, soda, energy drink, vinegar, oil, milk, baking soda water mixture
- Sharpies for labeling
- Corn seed germination diagram with labeled structures (pg. S17-19 and online)
- White paper
- Colored pencils
- Magnifying glasses
- Flash cards of plant structure names (printable version online and 4x6 index cards included in the kit)
- Diagram of corn plant with structures labeled (pg. S26-28 and online)
- Content video on structures and functions (available online)
- Post-test (options available on pg. S30-34 and online)

Safety Considerations
Be aware of student allergies or seeds treated with chemicals. Remind students to not put seeds in their mouths, ears, or nose.

Lesson 1: Planting
(30 minutes, to be done 3 weeks prior to the rest of the unit; then ongoing observations for next 3 weeks to document plant growth)

Key question
How does a plant grow?

Learning Objectives
- Students will propose ideas about how a seed sprouts and a plant grows.
- Students will plant seeds and water them over the course of three weeks.
- Students will observe the plantings and record their findings by drawing and writing over the course of three weeks.

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Materials

- Pretest (pg. S13)
- Science notebook with seed growth journal (pg. S20-22)
- Corn seeds (1-3 for each student)
- Soil
- Planting containers (one for each student)
- Water and spray bottles

Procedures for Instruction

1. Pre-lesson preparation: If your students utilize science notebooks, print out the notebook pages and have students cut and paste the pages into their notebooks. If your class does not use specific science notebooks feel free to copy and staple together the science notebook pages and hand out to your students. Different versions of these are available online at kansascornstem.com to meet the needs of diverse classrooms.

2. Assess students for prior understanding: Have students fill out the pretest included in their science journal packet to assess their understanding of the parts that help the plant grow. Collect the pretests, and then on their first journal page, give them 5 minutes to draw and/or write in their science jouirnals about how they think a plant grows.

3. Introduce project and engage students:
   - "We just recorded our thoughts on how seeds grow. How many of you have grown seeds before?"
   - Pass out corn seeds, and ask, "What are these?" "Where do you think they came from?"
   - Guide them to recognize them as corn seed that came from a corn cob, and that we eat corn seeds when we eat corn.
   - "Today we are going to plant these corn seeds to grow our own plants!"

4. Plant seeds:
   - Distribute materials to students.
   - Have students label the containers with their name.
   - Use a push pin to make 4 drainage holes in the bottom of the container. Fill the container ¾ full with potting soil. Place the seed 1 inch down from the soil's surface. Water seed until soil is damp, approx. 2 tablespoons. Monitor dampness daily; water as needed.

Note: Optimum planting depth of corn kernel is 1-2 inches deep. Emergence of leaf above the soil will take approximately 5-7 days.

5. Document their thinking:
    - In their science journals, have students draw a picture of what their container looks like now, and what they imagine it will look like in 3 weeks.

6. Observe and record results over 3 weeks:
    - Have students water the soil as appropriate with spray bottles over the next 3 weeks to keep soil damp.
    - Provide brief (3-5 minute) observation times every few days for students to observe (draw) and record (describe) in their science journals the progress (or lack thereof) of their plants.

NOTE: Determine how many times you want students to observe their plants and be sure to provide enough data sheets in their journals.

Assessments

- Formative Assessments
    - Assess prior learning using the pretest.
    - Assess contributions in discussions for prior understanding and adjust instruction if needed. Do students have experience with growing plants? Do they understand what seeds are in general, and what a corn seed is specifically? Are they aware that many seeds provide important food sources? Are they also aware that some seeds can be poisonous to eat? Crops such as corn, wheat, and soybeans are grown because those seeds are good as a food source.

Lesson 2: Seed Germination

(45 minutes, with follow-up observations for 3-5 days, and 45 minutes on final day)

Key question

How does a seed germinate?

Learning Objectives

- Students will plan and conduct an investigation to determine the best germinating conditions for corn seeds.
- Students will observe and record data (drawings and descriptions) while seeds are germinating.
- Students will analyze their recorded data, labeling structures they observe and indicating functions for them.

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Materials

- Corn seeds in 2 plastic baggies, prepared a day or two in advance with one having a little water added, and the other that is dry.
- Additional dry seeds
- Baggies for students
- Water and a variety of other liquids such as orange juice, soda, energy drink, vinegar, oil, milk, baking soda water mixture
- Sharpies for labeling
- Science notebooks with seed growth journal (pg. S20-25)
- Colored pencils
- Magnifying glasses
- Corn seed germination diagram with labeled structures (pg. S17-19)

Procedures for Instruction

DAY 1 (45 minutes):

1. Introduce the topic and assess prior understanding:
   - Present the 2 bags of seeds to students, one that had a little water added a day or two ago, and one that is dry.
   - Tell students that you aren't sure what happened to the seeds: "Look what I found! Here are 2 bags of seeds. They look like they're left over from when we planted our seeds three weeks ago!"
   - Don't tell the students that one has water in it – let them discover this on their own. Pass the bags around.
   - "What do you see?"
   - "What do you think happened?"
   - "They look different – I wonder why?"

2. Record their thinking in their science notebook, and discuss as a class to assess their thinking. Do not signal right or wrong answers. Just let them discuss their ideas, and guide the flow with such prompts as:
   - "Can you say more about that?"
   - "Why do you think that?"
   - "Who agrees/disagrees with this idea and why?"
   - "Does anyone have a different idea?"
   - "Would this be true all the time?"

3. Develop an investigation as a whole class or in small groups based on the question, "How does a seed germinate?" Hand out corn seeds and baggies, letting students figure out that they will be placing a few seeds in each baggie, and seeing if they will germinate in different conditions. Have a variety of liquids setting out. Guide the development of the investigation with such questions as:
    - "What does a seed need to germinate?" (Based on the introductory activity, they should realize it needs water. If not, guide them to reflect on the introductory activity to understand this.)
    - "Does it have to be water, or can it be any liquid? Does it have to be a liquid?"
    - "Which liquid will work best? Why?"
    - "Should the bag be opened or closed? Why?"

4. Focus the elements of their investigations:
    - "What is our research question or questions?" Have students generate their own questions about the seeds, and possibly set up different observation stations around the room for different questions. Write the questions on the board or anchor chart.
    - "What kind of data do we need to collect to show what we know?" (Introduce seed germination journal pages, and how they will observe, draw, and write in their science notebooks.)
    - "What are the different conditions (variables) you want to test?" Let the students pick the different kinds of liquids they would like to test.
    - "Should we have something to compare to? Would the seeds just have germinated anyway? Should we set up comparison baggies (controls) using no water, and just water?"
    - "What do you think will happen and why in each condition?" Have them record this as a prediction or hypothesis.

5. Instruct students to set up the investigation.
    - Guide students to prepare their baggies and seeds according to their own questions.
    - Using sharpies, have them label their baggies with their name and conditions.
    - Have them record the set-up of their investigation, including research question(s), type of data they will need to collect, different conditions (variables), what they will compare the experimental conditions to (controls), and predictions/hypotheses.

DAYS 2-5:

1. Record their observations in their science notebooks by drawing and writing. Use colored pencils and magnifying glasses.
    - Each day for 3-5 days, have students observe the progress of the germinating seeds and record their data. Be sure they draw and write in their science notebooks what they see happening with the corn seeds in their baggies.

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FINAL DAY (45 minutes):

1. Discuss their findings by having students share results. You can do this as a large group, making note of their findings on an anchor chart or on the board, OR you can split them into small groups to compare their findings and report out. Lead the discussion with such questions as:
    - "The corn seeds germinated best in which conditions?"
    - "How did the various liquids compare to our control conditions (water and dry)?"
    - "Why do you think you got the results you did?"
    - "Were there any contradictory results?"
    - "What new questions do you have based on your findings?"
    - "Based on your evidence, how do you think a corn seed germinates?"
    - "Do you think this is true of all seeds? How could we find out?"

2. Explore seed and sprouting seed structures by asking students to examine their drawings from the different days again, and
    - Label the different structures they drew or wrote about. Do not give them the "proper" terms for the structures – let them use their own descriptive words.
    - Then have them suggest functions for each structure – again, do not signal if they are correct or not, but have them justify why they think that. Encourage their thinking.
    - Discuss these structures in a large group with having students share their labeled structures and proposed functions.

3. Explain how their discoveries are very much like those of scientists' discoveries.
    - "You planned and conducted an investigation to determine how corn seeds germinate, and you have formed conclusions based on very convincing evidence! You are budding scientists!"
    - "You observed carefully and identified parts of the seeds, and proposed functions for them. You are certainly budding scientists, because that's what many plant scientists do – they observe carefully and identify structures on plants that many people never even knew were there! If those structures have no names, they have to name them. They also observe very carefully over time to see what functions those structures have."
    - "Let's look at what scientists have named the structures you identified, and what they have found are their functions."

4. Show a diagram (model) of corn seed germination, with major structures labeled.
    - Distribute copies of diagrams to students and have them label the structures as you guide them.
    - Have them compare their terms for each structure to the term scientists use.
    - If they have room, they can label their own drawings with the scientific terms.
        - Discuss the function of each structure.

5. Conclude:
    - "Were you surprised to discover so much going on in the seed as you observed them germinating?"
    - "What do you wonder about now?" (Guide them to connect the seed germination they have observed to the seed germination that occurred in the soil of the plants growing in the classroom, AND the plants growing in corn fields throughout the world. In fact, all seeds of plants germinate in similar ways – this is happening underground all over the world!)
    - Show the time lapse video of corn growth called, "Time lapse fast growing corn, roots and leaves growing" found on YouTube at https://youtu.be/iFCdAgeMGOA

Assessments

- Formative assessments:
    - Assess contributions in discussions for prior understanding and adjust instruction if needed.
    - Assess their observation and recording skills as they draw and write in their science notebooks. If needed, encourage them to look closer, to notice things with the magnifying glasses that are slightly hidden (are they seeing all the root hairs, for instance?).
- Summative assessments:
    - Science Notebook observations
    - Corn Seed Germination diagram, labeled with structures and functions

Extra Information for the Teacher

A seed is the house for a future plant, outfitted to furnish what a baby plant needs to start to grow and succeed in life. A seed is wrapped in a tough outer coating (seed coat) that prevents the future plant from damage. Inside, there is a food supply and the beginnings of a new plant. In the world of flowering plants, there are monocots and dicots. A monocot seed has an embryo that contains one cotyledon, the part of the plant that becomes its first leaf-like structures. A dicot seed has an embryo with two cotyledons. The cotyledons help provide and absorb nutrients for the plant until the plant is ready to make its own food through photosynthesis. Corn kernels are monocots, and beans are dicots.

Inside a corn kernel (seed), there is a cotyledon near the bottom, pointy part of the kernel, where the new plant begins to grow. It is surrounded by the endosperm, which is starchy food for the baby plant. When the seed begins to grow, its protective covering breaks open in two places. The top breaks open to reveal the coleoptile and eventually the plumule, the future shoot of the plant. The bottom breaks open to reveal the coleorhiza and eventually the radicle, the future root of the plant.

Like the corn seed, the bean seed has places where the root and the leaves emerge. However, since bean seeds are dicots, when you open one up, you'll see it has two cotyledons that look like reverse copies of each other.

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Instead of having a separate baby plant and food supply, inside the bean plant the cotyledons contain the endosperm (the food supply).

As the root grows, tiny little root hairs extend out to form a net-like mass to absorb water at a microscopic level. Guide students to look for these and all the structures using magnifying lenses.

Lesson 3: Corn Plant Observations
(45 minutes)

Key Questions
What structures does a corn plant have? What functions do the plant structures serve?

Learning Objectives
- Students will observe carefully and record their observations of a corn plant by drawing and labeling what they observe.
- Students will construct an explanation based on evidence that plants have structures that function to support survival, growth, behavior, and reproduction.

Materials
- 3-week old corn plants OR full grown corn stalks
- White paper
- Colored pencils
- Magnifying glasses
- Flash cards of plant structure names (printable version online and 4x6 index cards included in the kit)
- Diagram of corn plant with structures labeled (pg. S26-28 and online)
- Content video on structures and functions (available online)
- Post-test (options available on pg. S30-34 and online)

Procedures for Instruction
1. Introduce the topic and engage students:
   - Give students a corn plant (or one plant for 3-4 students), and distribute paper, colored pencils, and magnifying glasses.
   - Instruct students to observe carefully and draw what they see.
   - Instruct them to label the parts (structures) – they can make up words for any structures they don't know.
     - The technical terms do not matter now, but rather the goal is for them to observe and draw the important structures of the plant.
   - Instruct them to write what they propose the function is for each structure.

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For at least 20 minutes, students should be completely quiet during the drawing and labeling of the plant parts. Guide them to look closely and use magnifying glasses for things that might be hidden to most people!

2. Share out loud with the class or small group what they noticed, and what they predict the function for each part is with questions such as:
   - "What did you notice? Did you all notice that?"
   - "Did you know its name, or did you give it your own name?"
   - "Why do you think that plant has that part? What do you think it's used for (function)?"
   - "Why do you think that? What is it about that shape or that structure that makes you think that?
   - "Can you say more about that?"
   - "Who can say what you think _____ is saying?" (this helps them listen to each other's ideas)
   - Do not indicate right or wrong – just collect their observations and thoughts.

3. Learn the science terms for structures and their functions.
   - Hand out the flash cards with the plant structure names.
   - Have the students place the flash card next to the structure that they think corresponds with that name.
   - Hand out or project the plant diagram with the structures labeled.
   - Ask them to revise any placement of their flash cards.

4. Show the content video about the functions of the different structures.
   (found online at kansascornstem.com/education)

5. Revise their drawings
   - Have students go back to their drawings and revise their labels.
   - Add the terms that scientists use for the structures (don't encourage students to cross theirs out since their own terms were not "wrong" – just add the scientific terms).
   - Add the functions of each part according to scientists.

6. Write an explanation
   - Instruct students to write 7-10 sentences to go along with their drawing to explain that corn plants have structures with specific purposes that help the plant. Be sure they use evidence based on their observations or other information they found.

7. Conclude
   - Hang their drawings up and have a gallery walk
   - Discuss that they worked as scientists, because they:
   - Observed carefully

- Recorded what they observed
- Proposed names for structures and functions
- Revised the names for structures and functions based on what other scientists have learned
- Worked together and communicated with each other!

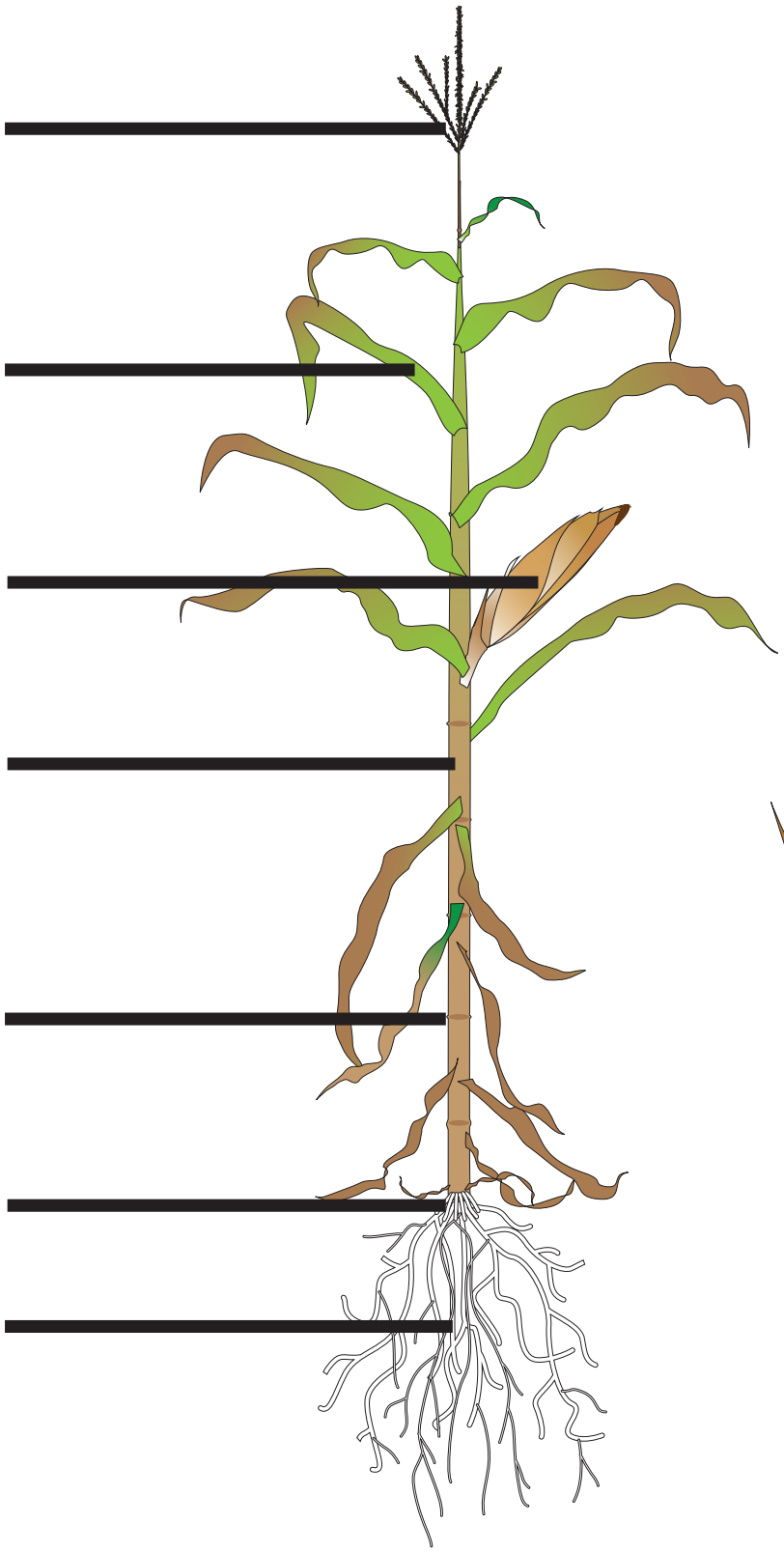
8. Assess using post-test: Three different post-test options are available on pg. S30-34 and online. Each ranges in degrees of difficulty. They could also be used as practice worksheets to help students learn the corn plant structures and their functions.

Assessments

- Formative assessments:
  - Assess students' abilities to observe in detail and record them by their drawings.
  - If they are "done" early, tell them there are parts that may need magnifying glasses to see and to look very carefully.
  - Assess students' understandings of how structures serve functions for the plant in discussions.
- Summative assessments:
  - Assess students' understanding of structures and functions by their final revised drawings.
  - Assess overall learning throughout the unit by comparing pretest with post-test.

Do You Know the Parts of a Corn Plant?

In the blanks below, label the parts of the corn plant.



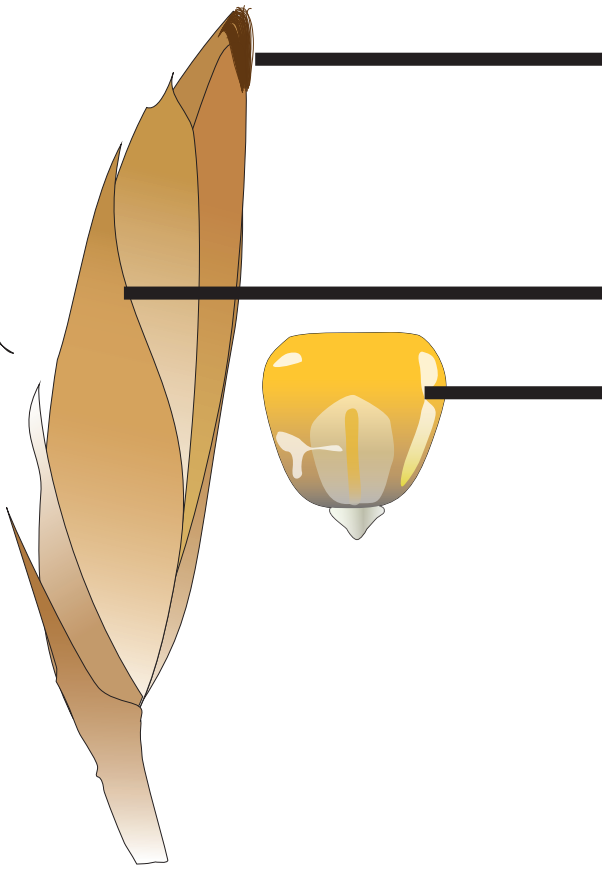


Image provided by K-STATE Research and Extension KSU CROPS Crop Production Team

Record Your Thinking

How does a plant grow? Show by drawing or writing, or both.

CORN: Structurally Speaking
Lesson 1: Planting

Today's Date:

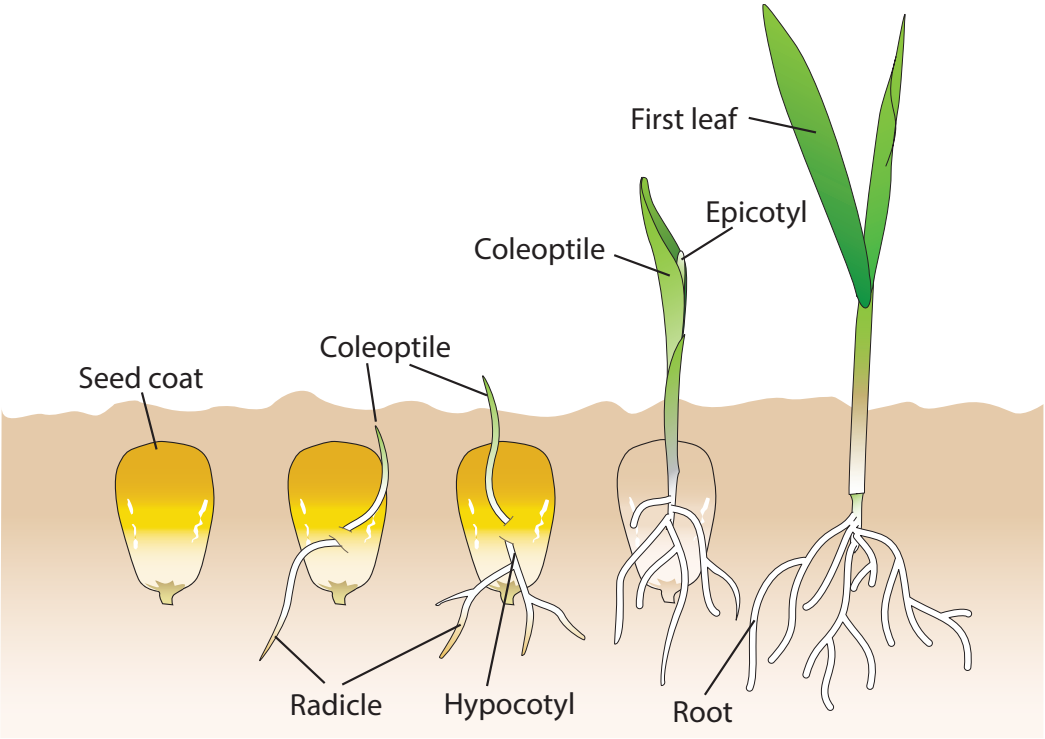
Draw a picture of what your container looks like today	Draw a picture of what you think your container will look like in 3 weeks.

My Plants Progress

Date:	
Date:	
Date:	

Lesson 2: Where is the Corn Seed?

Emerging Corn Plant Structures and Functions



Seed coat: protects the starch and embryo from insects and diseases: both at planting and in storage

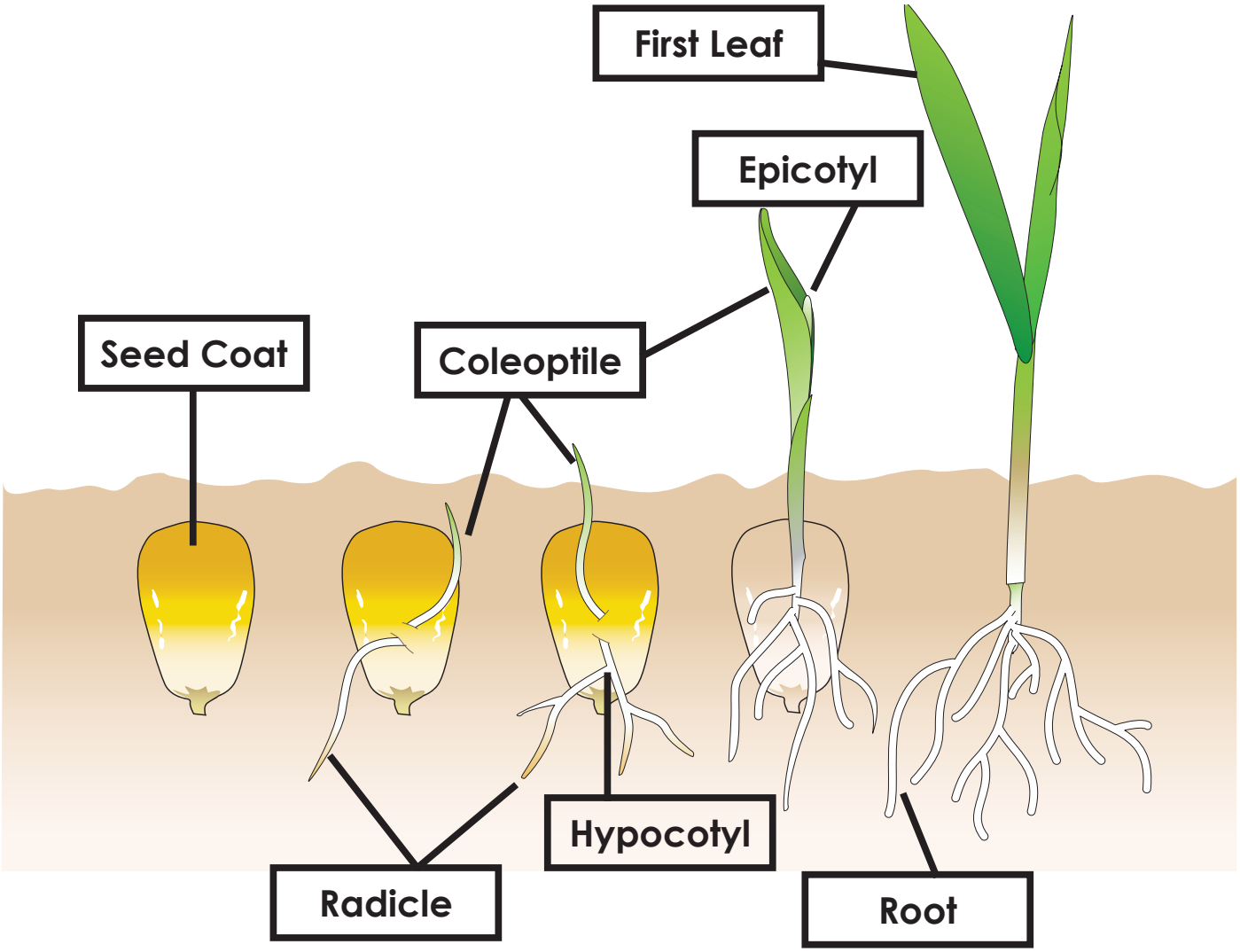
Corn seed radicle: first part of a growing plant embryo that emerges from the seed during germination. The radicle is the first root of the plant and grows downward in the soil

Corn seed coleoptile: a pointed protective sheath covering the emerging shoot (epicotyl) that pushes above the ground for the first leaves to appear

Corn seed hypocotyl: region between the radicle and the coleoptile and forms more roots

Corn seed epicotyl: region inside the coleoptile that forms the leaves and stems

First leaf: the true first leaf comes from the inside of the coleoptile and is distinguished by have a rounded tip. All other future leaves have a pointed tip. This first leaf will fall off as the plant is growing and the stem is enlarging. By six leaves the first leaf is hard to find.



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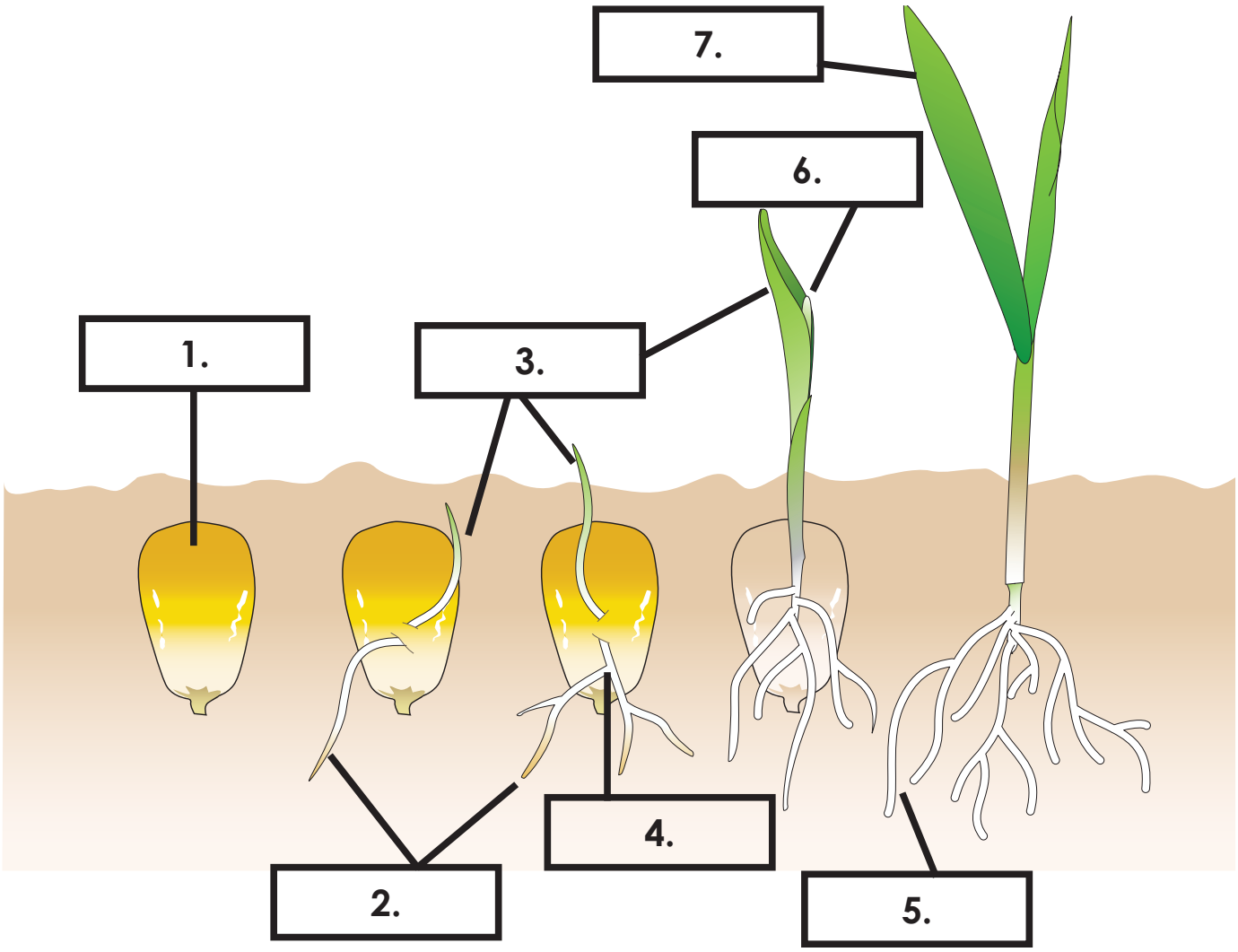


1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

Image provided by K-STATE Research and Extension KSUCROPS Crop Production Team

Record Your Thinking

What do you think happend? Why?

Seed Germination Investigation

Today's Date:

Research Questions:

Type of Data:

Variables:

Control:

Prediction/Hypothesis:

My Seed's Progress

Date:	**CONTROL:**
Date:	**CONTROL:**
Date:	**CONTROL:**

My Seed's Progress

Date:	**CONTROL:**
Date:	**CONTROL:**
Date:	**CONTROL:**

My Seed's Progress

Date:	**VARIABLE:**
Date:	**VARIABLE:**
Date:	**VARIABLE:**

My Seed's Progress

Date:	**VARIABLE:**
Date:	**VARIABLE:**
Date:	**VARIABLE:**

Corn Plant Structures and Functions

Tassel: the male part of the corn plant that contains the pollen. The tassel is on top of the corn plant.

Leaf: a full grown corn plant has 16-19 leaves although 5 leaves fall off by the time the plant tassels. The leaf provides the surface area where light is intercepted and photosynthesis takes place.

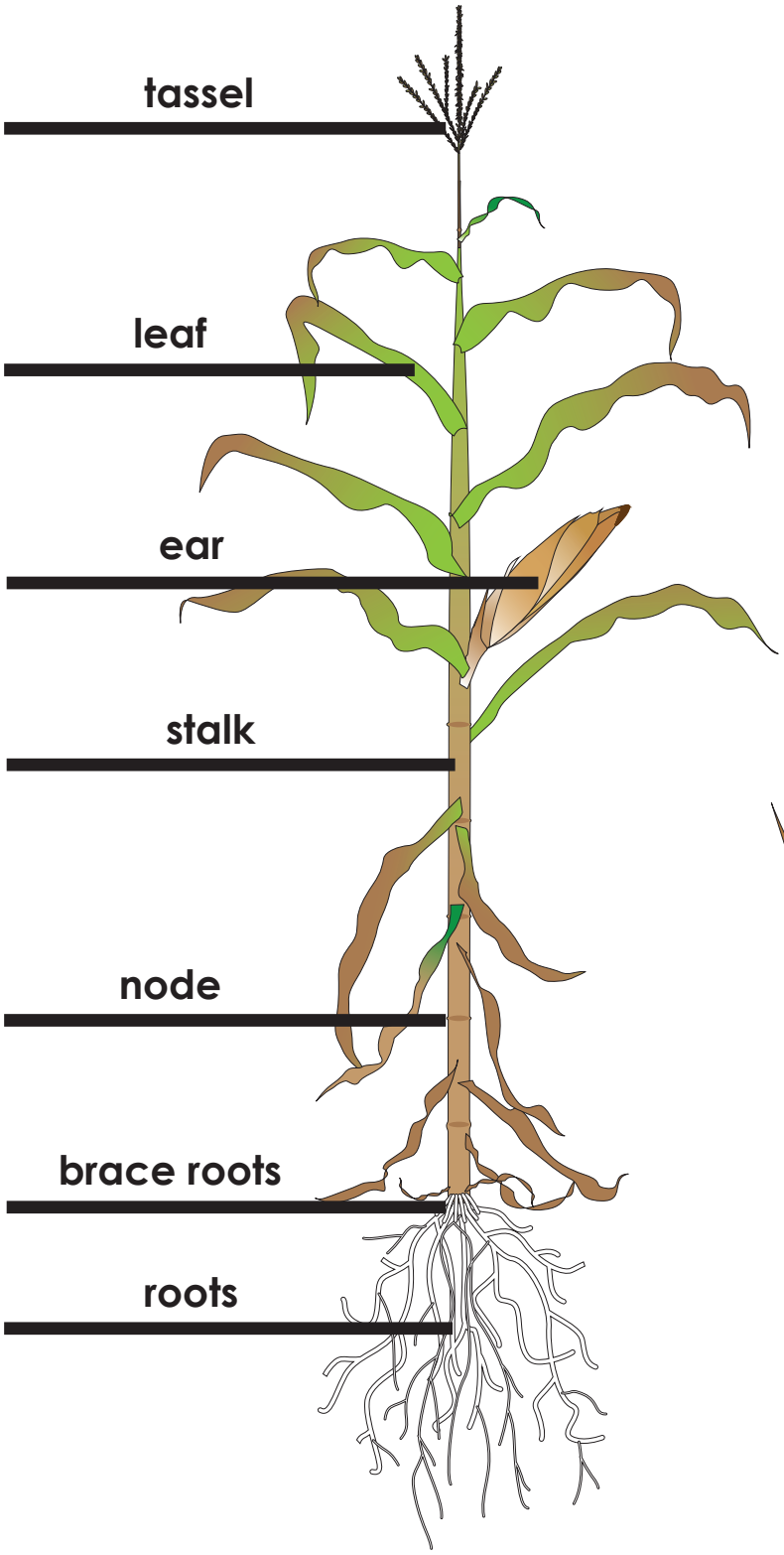
Silk: a hollow tube that comes from the female part (ovary) on the ear. The silk grows outside of the husk until the pollen lands on the silk and then moves down silk tube to fertilize the ovary to form the seed. Each ear has one silk strand for each kernel on the ear.
Husk: leaf like structure that wraps around the ear for protection.

Ear: the structure that contains the kernels that are forming after fertilization. The female part of the corn plant.
Kernel: it is the corn seed with one main function; to make another corn plant.

Node: a place on the stem where growth occurs. Leaves, roots, ears, and tassels form from nodes.
Stalk: the main body (stem) of the corn plant. Stalks have to be sturdy to support the weight of the corn ears and provide pathways for the nutrients to move up and down the plant.

Brace root: roots that form above ground one the sixth node (the first five nodes are below ground where other roots are formed) Grow from the node and then down to the soil and keep the plant standing upright.

Roots: grow underground and bring water and nutrients to the rest of the plant.



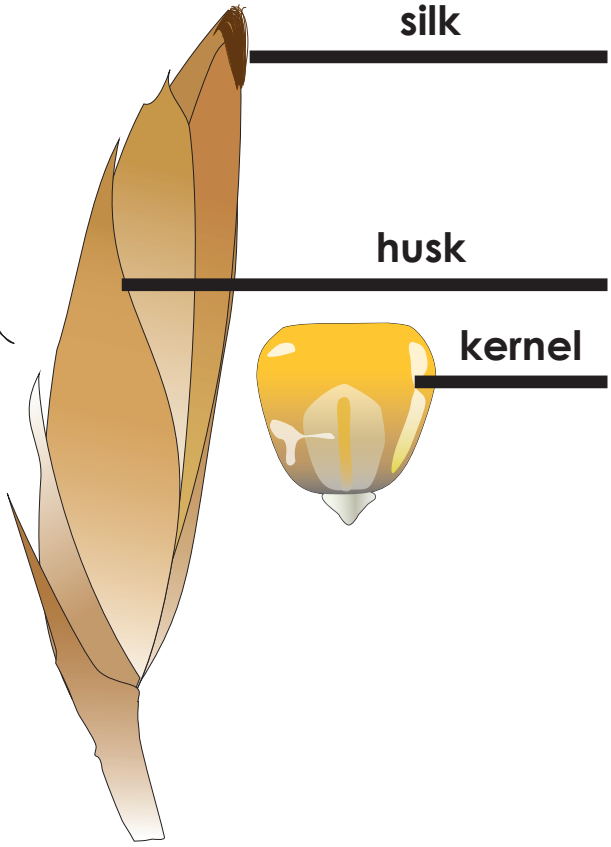


Image provided by K-STATE Research and Extension KSUCROPS

Image provided by K-STATE Research and Extension KSU CROPS Crop Production Team

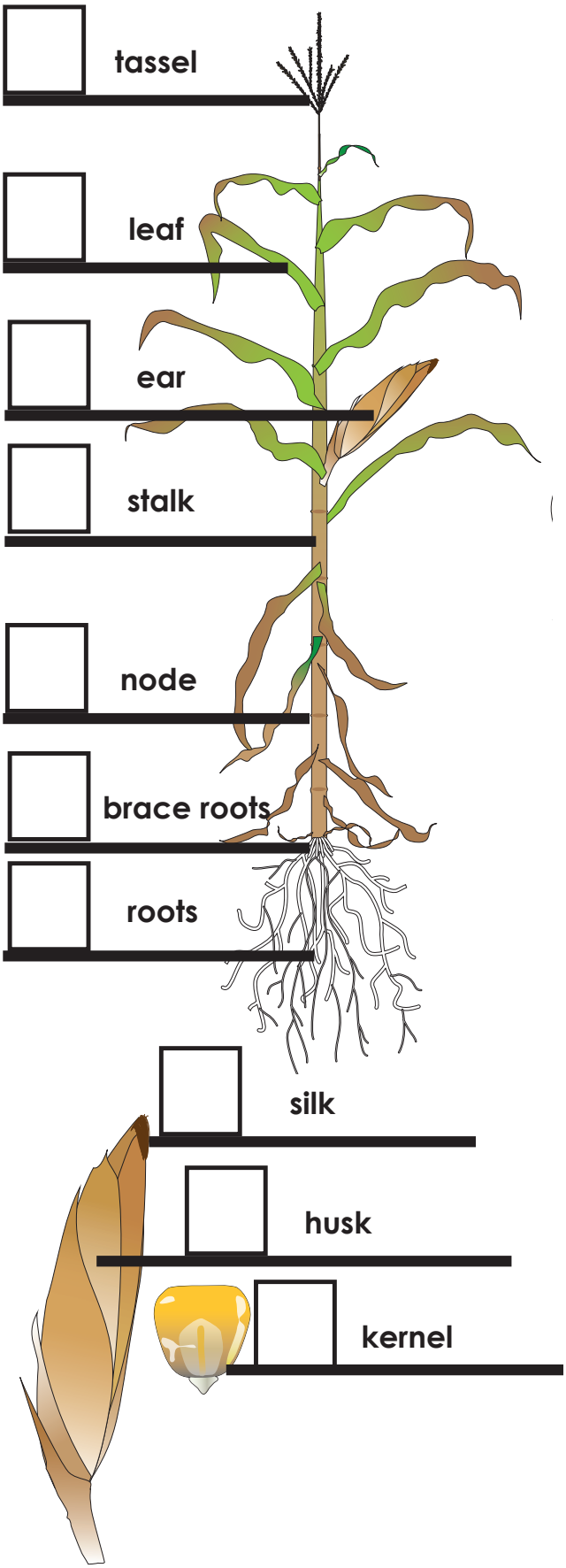
Explain Your Drawing

Write 7-10 sentences explaining the corn structures and how their specific purposes help the plants grow and survive

Test What You Learned

In the blanks below, label the parts of the corn plant.

Image provided by K-STATE Research and Extension KSU CROPS



Test What You Learned

Match the functions with their plant structures.

A. it is the corn's seed with one main function; to make another corn plant.

B. the male part of the corn plant that contains the pollen.

C. roots that form above ground to keep the plant standing upright.

D. provides the surface area where light is intercepted and photosynthesis takes place.

E. collects pollen and carries it inside to the female part of the plant to grow a seed.

F. a place on the stem where growth occurs.

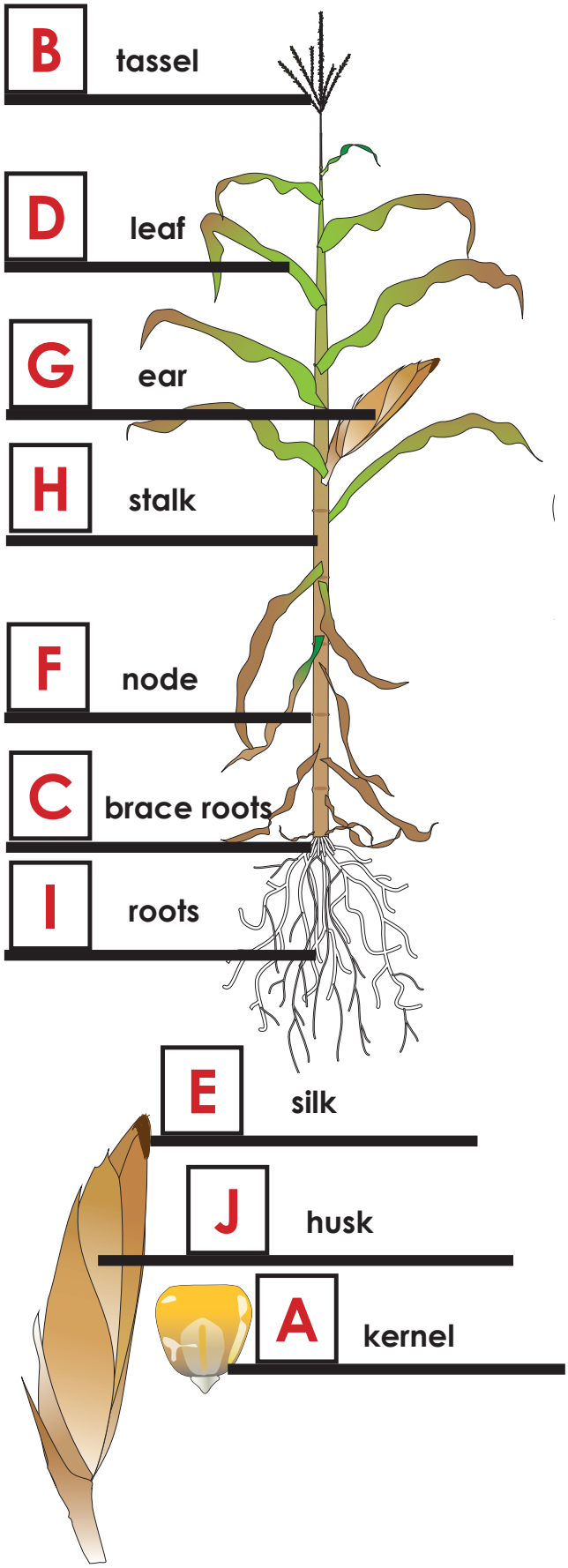
G. the female part of the plant that contains the kernels that are forming after fertilization.

H. the main body (stem) of the corn plant.

I. grow underground and bring water and nutrients to the rest of the plant.

J. leaf like structure that wraps around the ear for protection.

Image provided by K-STATE Research and Extension KSUCROPS



Test What You Learned

Match the functions with their plant structures.

A. it is the corn's seed with one main function; to make another corn plant.

B. the male part of the corn plant that contains the pollen.

C. roots that form above ground to keep the plant standing upright.

D. provides the surface area where light is intercepted and photosynthesis takes place.

E. collects pollen and carries it inside to the female part of the plant to grow a seed.

F. a place on the stem where growth occurs.

G. the female part of the plant that contains the kernels that are forming after fertilization.

H. the main body (stem) of the corn plant.

I. grow underground and bring water and nutrients to the rest of the plant.

J. leaf like structure that wraps around the ear for protection.

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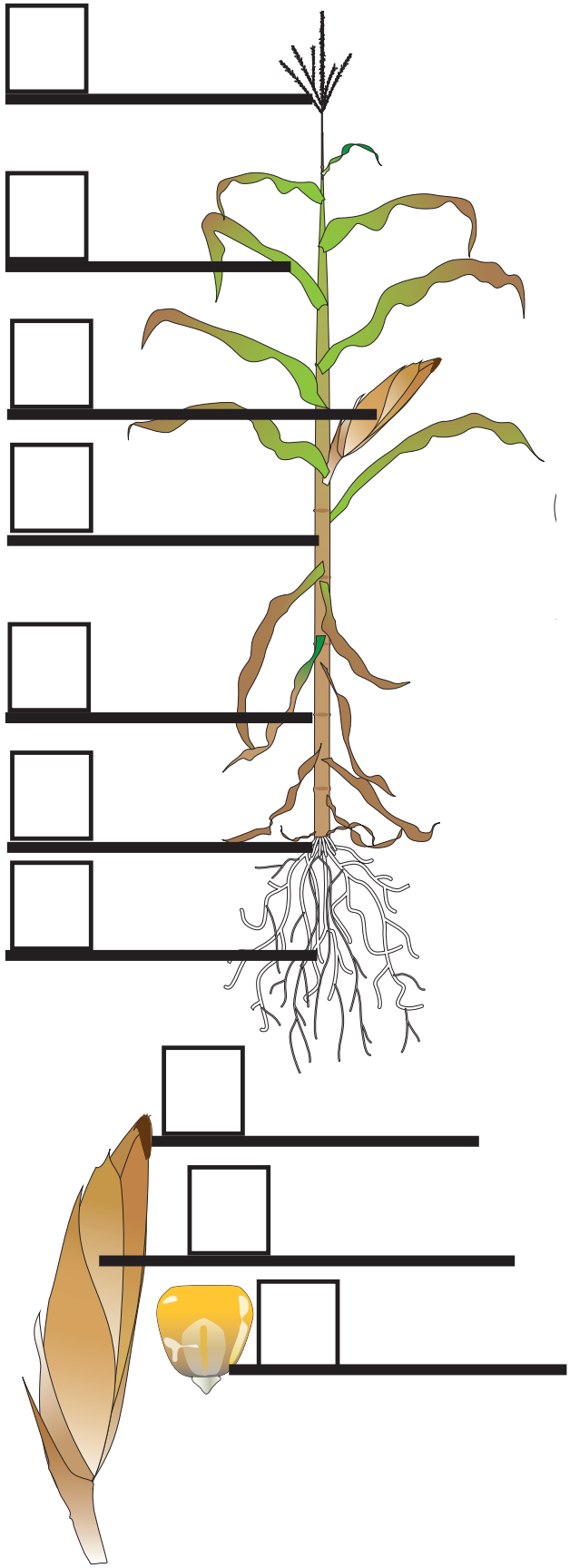


Test What You Learned

Match the structures and their functions to the correct place on the corn plant.

A. Kernel: it is the corn seed with one main function; to make another corn plant.

B. Tassel: the male part of the corn plant that contains the pollen.

C. Brace root: roots that form above ground to keep the plant standing upright.

D. Leaf: provides the surface area where light is intercepted and photosynthesis takes place.

E. Silk: collects pollen and carries it inside to the female part of the plant to grow a seed.

F. Node: a place on the stem where growth occurs.

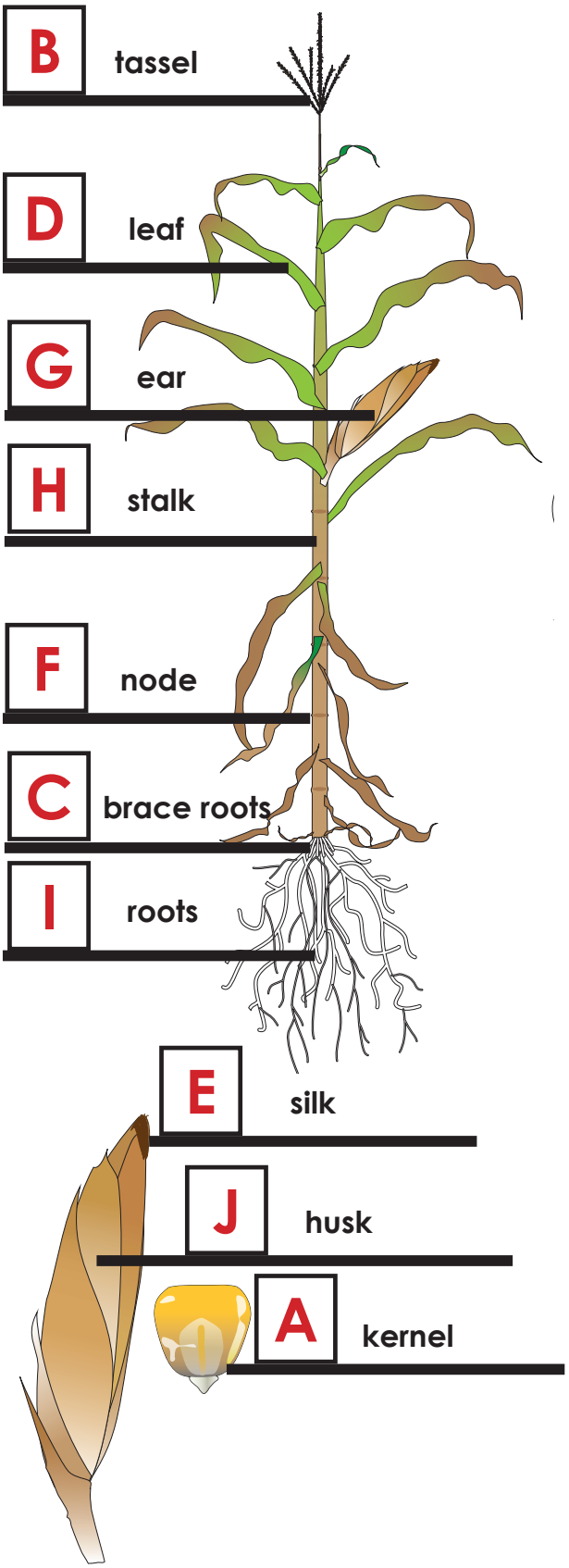
G. Ear: the female part of the plant that contains the kernels that are forming after fertilization.

H. Stalk: the main body (stem) of the corn plant.

I. Roots: grow underground and bring water and nutrients to the rest of the plant.

J. Husk: leaf like structure that wraps around the ear for protection.

Image provided by K-STATE Research and Extension KSU CROPS



Test What You Learned

Match the functions with their plant structures.

A. it is the corn's seed with one main function; to make another corn plant.

B. the male part of the corn plant that contains the pollen.

C. roots that form above ground to keep the plant standing upright.

D. provides the surface area where light is intercepted and photosynthesis takes place.

E. collects pollen and carries it inside to the female part of the plant to grow a seed.

F. a place on the stem where growth occurs.

G. the female part of the plant that contains the kernels that are forming after fertilization.

H. the main body (stem) of the corn plant.

I. grow underground and bring water and nutrients to the rest of the plant.

J. leaf like structure that wraps around the ear for protection.

Image provided by K-STATE Research and Extension KSUCROPS Crop Production Team