



Kansas Corn-ucopia

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Grade Level: Middle School / High School

Overview

Corn is a vital part of the Kansas economy and landscape. Understanding how corn is planted, grown, and harvested helps students comprehend the importance of this crop to the Midwest. As cities have grown, many people move away from an agricultural understanding, even though it is essential to their lives. In this activity, students will learn about the origins and types of corn. They will gain knowledge about its growth and development, where it is grown, and products made from it. Students will also get the chance to apply math concepts, interpret graphs and data, and dissect a corn plant.

Kansas College and Career Ready Standards

Science

- **LS1-5.** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- **LS 3-2.** Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
- **ESS3-2.** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

Language Arts

- **RI.3.1.** Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.
- **RI.3.7.** Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur).
- **W.3.2.** Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
- **SL.3.1.** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on Grade 3 topics and texts, building on others' ideas and expressing their own clearly.

Mathematics

- **HSN.Q.A.1.** Use units as a way to understand problems and to guide the solution of multi-step problems.
- **HSN.Q.A.2.** Define appropriate quantities for the purpose of descriptive modeling.
- **HSN.Q.A.3.** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

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Learning Objectives

- Students will understand the history and origins of corn and its present-day applications.
- Students will understand and identify the eight main types of corn.
- Students will recognize and be able to identify corn in various stages of growth.
- Students will understand how corn goes from vegetative to reproductive stages.
- Students will be able to classify and label the major parts of the corn plant.
- Students will be able to determine the number of kernels in a bushel of corn, the number of corn plants in an acre, and even the equivalent of how many corn kernels make up the human body through quantitative measurements.
- Students will know how to interpret graphs, tables, infographics, and data involving all aspects of the corn industry.
- Students will learn how to determine the growth stage of a corn plant through dissection.
- Students will understand the process of planting corn and its stages until harvest.

Table of Contents

The introduction to this unit begins with the class reading the Explore Corn article that gives a brief introduction to corn, its history, its properties, and how it is planted. The unit is then broken down into sections that can be completed either sequentially or broken down into stations that students can, in any order, rotate around. The teacher can pick-and-choose and mix-and-match those lessons that best fit their curriculum and time frame.

This unit is broken up into the following sections.

- Introduction to Corn: Background Information
 - Introduction to Corn article
 - Introduction to Corn Kahoot!
- Section 1: The History of Corn
 - A Brief History of Corn Article with Quizizz
 - TED-Ed: The History of the World According to Corn Edpuzzle
 - Video: Is Corn a Fruit, Vegetable or Grain?
 - HHMI Biointeractive: Popped Secret: The Mysterious Origin of Corn Video with Activity and Other Resources
 - How Stuff Works: Corn Video
- Section 2: Types of Corn
 - Corn Types Quizlet
 - Corn Types Card Sort
 - Corn Types KERNEL Card Game
- Section 3: Corn Growth and Development
 - Pioneer Growth Stages WebQuest with Worksheets

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- Corn Growth and Development Flipbook with K-State Poster
- 3D Corn Plant Paper Model – Staging Version
- Section 4: Corn Plant Anatomy
 - Corn Plant Structures and Functions
 - Corn Structures and Functions Image Match – Purpose Games
 - Corn Structure and Function Interactive Notebook – Color and Label
 - 3D Corn Plant Paper Model – Individual Version
 - Corn Felting Lab
- Section 5: Mathematics with Corn
 - Corn Kernel Math with Ear of Corn Dissection
- Section 6: Corn in Everyday Products
 - Everything is Corny Crossword Puzzles
 - Alternative: Corn-Based Consumer Products Research
- Section 7: Corn Data – Where is Corn Grown?
 - Corn Graphs and Math Activity – World of Corn 2020
- Section 8: Corn Plant Dissection
 - Leaf Collar Dissection Method
- Section 9: Planting Corn – this section coming soon!
 - Fertilizers, Pesticides, Herbicide, and Fungicides
 - Nitrogen, Carbon, and Water Cycles
 - Grow Your Own Corn Lab!
- Section 10: Kansas Corn Video Series – this section coming soon!
 - Mini Videos – From Planting to Harvesting
 - 360°/VR Photos and Videos of Corn Fields

Materials

General Materials

- Corn-ucopia PowerPoint (available online at kansascornstem.com)
- Computer and internet access
- Calculators
- Colored markers, highlighters, or pencils

Materials for Introduction to Corn

- Article: Student copies of Introduction to Corn (pg. S1, or available online at kansascornstem.com)
- Butcher paper for each group
- Kahoot: Explore Corn: Introduction to Corn <https://tinyurl.com/CornIntroKahoot>
 - Students will need computers or mobile devices

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Materials for Section 1: The History of Corn

- Article: A Brief History of Corn (S2-6or available at kansascornstem.com)
- Quizizz: A Brief History of Corn: <https://tinyurl.com/CornBriefHistory>
 - Students will need computers or mobile devices
- Edpuzzle: TEDEd The History of Corn: <https://tinyurl.com/TedEdCornHistory>
 - Students will need computers or mobile devices or can do it together as a class
- Video: Is Corn a Fruit, Vegetable, or Grain provided by Popular Science <https://tinyurl.com/CornFruitVegetableOrGrain>
- Video: Popped Secret provided by hhmi BioInteractive, <https://tinyurl.com/PoppedSecretVideo>
- Student Worksheet: Popped Secret, provided by hhmi BioInteractive, <https://tinyurl.com/PoppedSecretActivity>
- Video: How Stuff Works – Corn, provided by Manu John, <https://tinyurl.com/CornHowStuffWorks>

Materials for Section 2: Types of Corn

- Article: Eight Types of Corn Biosheet (pg. S11-12 or available online at kansascornstem.com)
- Quizlet: <https://tinyurl.com/CornTypesQuizlet>
 - Students will need computers or mobile devices
- Card Set: Corn Type Cards (pg. S9 or available online at kansascornstem.com)
- Card Set: Corn Description Cards (pg. S10-15 or available online at kansascornstem.com)
- Card Set: Kernel Card Game – Coming Soon!

Materials for Section 3: Corn Growth and Development

- Pioneer Website Resource: <https://tinyurl.com/PioneerCornVegetativeStages>
- Pioneer Website Resource: <https://tinyurl.com/PioneerCornReproductiveStages>
- Student Worksheet: Corn Staging (pg. S24-26 or available online at kansascornstem.com)
- K-State Website: <https://tinyurl.com/KStateCornGrowthStages>
- K-State Poster: <https://tinyurl.com/CornStagesPoster>
- Flipbook: Kansas Corn – Paper Version (available online at kansascornstem.com)
 - Stapler, colored markers or pencils
- Flipbook: Kansas Corn – Electronic Version (available online at kansascornstem.com)
- Instruction Sheet: 3D Paper Model Corn Plants - Coming Soon!
 - Colored paper, tape, glue, white thread, yarn, and green pipe cleaners

Materials for Section 4: Corn Plant Anatomy

- Info and Student Worksheets: Corn Plant Structures and Functions (pg. S27, or available online at kansascornstem.com)
- Card Set: Corn Structures and Functions Cards (pg. S37-40 or available online at kansascornstem.com)
- Website: <https://www.purposegames.com/game/parts-of-an-emerging-corn-plant>

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- Website: <https://www.purposegames.com/game/parts-of-an-emerging-corn-plant-function-version>
- Website: <https://www.purposegames.com/game/kansas-corn-plant-anatomy>
- Website: <https://www.purposegames.com/game/kansas-corn-plant-anatomy-functions>
- Handout: Corn Structure-Function INB (pg. S41-44, or available online at kansascornstem.com)
 - Colored paper, scissors, and glue
- Instruction Sheet - Coming Soon!
 - Colored paper, tape, glue, white thread, yarn, and green pipe cleaners
- Lab: Needle Felting Corn Lab (available online at kansascornstem.com)
 - Felting needle, white wool roving, and green, yellow, and light brown wool

Materials for Section 5: Mathematics with Corn

- Labsheet: Corn Kernel Math with Ear of Corn Dissection (pg. S46-48, or available online at kansascornstem.com)
 - At least six ears of corn, scale that reads to at least two decimal places, at least 50 kernels, see-through container with enough kernels to fill that container, long strips of masking tape, colored markers to mark seeds, and ruler or tape measure.
- Website and iBook: Abnormal Ears of Corn: <https://www.agronomy.k-state.edu/extension/crop-production/corn/>

Materials for Section 6: Corn in Everyday Products

- Poster/PDF: National Corn Growers Association: The Many Uses of Corn (pg. S50, or available online at kansascornstem.com)
- Handout: Kansas Corn: Common Items Containing Corn (pg. S51-52, or available online at kansascornstem.com)
- Crossword Puzzle: Everything is Corny (pg. S53-57, available online at kansascornstem.com)
- Alternative: Find actual common household products that contain corn or ingredients derived from corn

Materials for Section 7: Corn Data – Where is Corn Grown?

- Infographic: National Corn Growers Association World of Corn 2020 (available at kansascornstem.com)
- Worksheet: Corn Graphs and Math (pg. S58-61, or available online at kansascornstem.com)

Materials for Section 8: Corn Plant Dissection

- Worksheet: Leaf Collar Dissection Method (pg. S62-63, or available online at kansascornstem.com)
 - For each group: corn at any stage, preferably greater than V5, scalpels or box knives, butcher paper to cover table, cutting board, and a bin or trash can to collect soil and plants when finished.
- Video: <https://tinyurl.com/FarmBasicsCornGrowthStages>
- Video: <https://tinyurl.com/GrowthStagingCorn>

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Materials for Section 9: Planting Corn

- Activities coming soon!

Materials for Section 10: Kansas Corn Video Series

- Short videos from planting to harvest – coming soon!
- 360°/VR photos and videos of fields – coming soon!

Safety Considerations

Students will be using a cutting utensil with a sharp edge to dissect corn. Show proper handling of the cutting utensil.

Procedures for Instruction

Introduction to Corn

Procedure for “Introduction to Corn Article” Lesson (45 minutes)

Begin by using these classroom discussion questions to find out what students already know (or think they know) about corn and where it is grown. This discussion can be done with the entire class, small groups, or as bellwork:

- Where is corn grown? Why is it grown there?
- How is corn grown?
- Are there specific stages that corn goes through when it grows?
- When can you harvest corn?
- How many ears of corn are there on one stalk?
- How many kernels of corn are found on each ear?
- How many corn plants can be grown on an acre of land?
- What types of corn are there?
- What products are made from corn?

Introduction to Corn

Why is corn such a valuable crop? How does corn grow, pollinate, and produce kernels? What farming techniques are important to increase corn yield?

Corn is a grass, native to the Americas. Evidence in central Mexico suggests corn was used there about 9,000 years ago. Various Native American tribes shared their knowledge of corn, known as maize, with early European settlers, saving many from starvation. Early American colonists ground dried corn as meal for flour to use in porridge, cake, and bread. Sweet corn, served as “corn on the cob,” was not developed until the 1700s.

Along with wheat and rice, corn is one of the world’s major grain crops. It is the largest grain crop grown in the United States. About 9 percent of all the corn is used to produce food for humans: corn meal, cooking oils,

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margarine, corn syrups, and sweeteners (fructose). About 64 percent of all corn is used for livestock feed.

Corn is harvested for either grain or silage, with most of the grain going to dairies, animal feeding operations, and poultry operations. Corncobs have been used in the manufacturing of nylon fibers as well as being a source for producing biodegradable plastics. Ethanol, made from corn, is a renewable fuel used in today's cars.

Corn is pollinated by wind and is typically planted in 30-inch rows. A single seed, or kernel, of corn may produce a plant that yields more than 600 kernels of corn per ear. Approximately 22,000 to 35,000 individual plants may be grown on an acre of land. Hybrid corn is developed to produce from one to two ears per plant. More than 80 million acres of the heartland are planted in corn each year. That's almost as big as 60 million football fields!

After corn is harvested, farmers begin to prepare the soil for the next season by mixing in nutrients, such as potassium and phosphorus, with some form of tillage (breaking up soil) to incorporate them. In the spring, farmers will do a light tillage pass to create smooth bedding for planting. When the ground temperature is ready (50°F and expected to rise), farmers will plant the corn seeds. Farmers will then add fertilizer, two inches deep and two inches to the side of the kernels to help the seeds get a healthy start. After the seed is planted, most farmers will spray a pre-emergent herbicide to prohibit weed growth. When seedlings emerge and grow, farmers will inject the soil with some form of nitrogen fertilizer before the V8 (eighth leaf development) stage. This spring fertilizer will allow for the plant to "green-up" and establish good photosynthetic activity through harvest.

Farmers will continue to scout the crop through maturity for any additional pests. Farmers will harvest the crop when it is ripe in the fall.

Once the discussion is finished, hand each student the Introduction to Corn article (pg. S1, or available online at kscorn.com) and instruct them to read it.

- Encourage students to highlight, in a specific color, important concepts they would like to further explore. Also, have students highlight, in a different color, important facts or take-a-ways from the world of corn.
- Then, have students get together in groups. Hand each group a big sheet of butcher paper and a box of colored markers or pencils.
- Ask each student within the group to draw a picture that represents a piece of information they took away from the article. No words!
- After given enough time to complete this activity (about 15 minutes), ask each group to present their drawings to the class and talk about information from one of the pictures. Once a piece of information has been used, groups afterwards cannot repeat that information.

Procedure for "Introduction: Explore Corn Kahoot" Lesson

(15 minutes)

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The class can then come together and play a game of Kahoot! to review the material. It can also be played the next class period as a warm-up to refresh what was learned the previous day.

- Kahoot! Link: Introduction to Corn – <https://tinyurl.com/CornIntroKahoot>

Reflection and Conclusion Questions (Answers in printed teacher packet)

By the end of this section, students should be able to answer the following:

- What are three uses for corn?
•
- How long has corn been around? Where did it originate?
•
- How many kernels are on an ear of corn? How many plants can grow on one acre?
•
- What percentage of corn is used for human consumption?
•
- What should the ground temperature reach before planting corn?
•

Section 1: The History of Corn

Procedure for “A Brief History of Corn” Lesson

(30 minutes)

- Make copies of the A Brief History of Corn article.
- Students will read the article individually or, if in groups, each student can become an “expert” on that topic by reading one of the pages. Be sure that they are actively reading by highlighting key points. After each student is done reading their page, they will then explain what they have read to the group.
- Each student can follow the link to the Quizizz that contains 10 review questions. This can be assigned individually and at the student’s pace, or this can be done as a whole class.
 - A Brief History of Corn Quizizz: <https://tinyurl.com/CornBriefHistory>
 - As a class: Click on the play live button. Choose either: Team, Classic, or Test. Click the continue button. Have students enter the game code. When all players have entered, click the start button to begin the game.
 - For self-paced individuals: Click on the “Assign HW” button. Enter how long you want the Quizizz to be open as well as any customizations found under the advanced settings. Click the continue button. You can copy the link and give that to your students or give them the join code.

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Procedure for “TED-Ed: The History of the World According to Corn” Lesson

(20 minutes)

- Have students access the TED-Ed: The History of the World According to Corn video through Edpuzzle by the following link:
 - <https://tinyurl.com/TedEdCornHistory>
- There are 14 multiple-choice questions that pop up throughout the video.
- This can be done together as a class or assigned to the individual student.
- To track student progress, the teacher will want to create an Edpuzzle account. It’s free.
 - www.edpuzzle.com
 - Create a class and give the class code to each of your students.
 - Find this video, either through the search function or the link above.
 - Click the assign button to the right and select the class you want to assign it to.
 - You can customize the features and the due date.

Procedure for “Is Corn a Fruit, Vegetable or Grain?” Lesson

(20 minutes)

- Ask students if corn is a vegetable, fruit, or a grain.
- Then, have the students breakout into three different groups based on what they believe. Put each group in a different part of the room – like the room’s corners.
- Give each group 3-5 minutes to discuss why they chose their answer amongst themselves.
- Then, have each group make their case to the class.
- Give a few minutes for students from each group to counterargue their case and to try to bring other students to their side of the room.
 - Be sure to give students a chance to move to a different group if they change their view.
- Afterward, count how many students were in each group: fruit, vegetable, or grain.
- Have the students return to their seats to watch the video, Is Corn a Fruit, Vegetable, or Grain?: <https://tinyurl.com/CornFruitVegetableOrGrain>
- As a review, ask if the video helped to change anyone’s mind.

Procedure for “HHMI Biointeractive – Popped Secret: The Mysterious Origins of Corn” Lesson

(60-75 minutes)

- This film and its activity worksheet explore how scientists used genetic and archaeological evidence to determine when, where, and how corn was domesticated from the Mexican grass teosinte.
- Access the Popped Secret video (18 minutes) from the following link:
 - <https://tinyurl.com/PoppedSecretVideo>
- The student handout reinforces the concepts found in the video and can be downloaded using this link:
 - <https://tinyurl.com/PoppedSecretHandout>
- Have students watch the video in its entirety before working on the student handout.
- Educator materials are also available in the link above.

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Procedure for “How Stuff Works: Corn” Lesson

(45 minutes)

- This is a great video that introduces a person to the world of corn: from how it is planted, harvested, and used for feed and industry. The video covers how it is used as an ingredient in many household products.
- This can be a video for students to watch as a class or as a reference for the educator to get a nice overview on the versatile role corn plays in our everyday life.
- Here is the YouTube link to the video: <https://tinyurl.com/CornHowStuffWorks>.

Reflection and Conclusion Questions (Answers in printed teacher packet)

By the end of this section, students should be able to answer the following.

- When and where corn was first domesticated?
•
- What is another name for corn?
•
- What was the earliest ancestor of modern-day corn?
•
- What type of corn is the most widely used?
•
- What common products can we find corn in?
•

Section 2: Types of Corn

Procedure for “Corn Types Quizlet” Lesson

(30 minutes)

- The teacher can hand out the Eight Types of Corn Biosheet (pg. S7-8, or available online at www.kscorn.com) for students to actively read.
- Have students highlight and compare the major differences between each type of corn.
- A digital card set has been created in Quizlet. It contains the eight types of corn that are being studied in this unit along with their descriptions and characteristics. Students can access this card set and use it to study. The teacher can use it as a review after reading the Eight Types of Corn Biosheet.
- Open Quizlet (www.quizlet.com) and find the Explore Corn – Corn Types or click the link:
 - <https://tinyurl.com/CornTypesQuizlet>
- There are many options to choose for studying this material such as:
 - Learn, Flashcards, Write, Spell, Match, Gravity, Test, and Live.
 - Choose the Live option.
- Choose whether you want your students to compete as Individuals or in Teams.
- You can then select how the questions will be worded: the definitions as the questions with possible terms as the answers or the term as the questions with possible definitions as the answers.

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- Students will be given the link: www.quizlet.live and a code to join the live game. A URL link and a QR Code are also provided as a way for people to join.
- You can choose to assign students randomly to a team or specifically assign them to teams.
- If specifically assigning to teams, tell each student the team number you want them to join.
- Click the start button to begin the game. The first team to get 12 consecutive answers correct wins! Be careful though, as one wrong answer drops you back to zero!
- Repeat as many times as you would like. The students start to learn after three games.
- The following are different ways of playing Quizlet Live.
 - Randomly switch teams after each game.
 - Have students stand with their backs toward each other facing outward. They are not allowed to turn and look at each other. They must communicate verbally only.
 - Another version is to have students only communicate in funny enunciations picked by you, like a French accent or an Arnold Schwarzenegger impersonation.
 - Have one student in the group be the one that has to answer the question. There is no talking. The student that has the correct answer has to hand the designated student their device in order for them to select the correct answer. You can have that designated student sit further away, so students must run to them like a relay race.
 - For further adaptations to playing Quizlet Live, check out the following links.
 - <https://quizlet.com/blog/5-fun-easy-ways-to-adapt-quizlet-live>
 - <https://ditchthattextbook.com/6-new-ways-to-play-a-quizlet-live-game/>

Procedure for “Corn Types Card Sort” Lesson

(30 minutes)

- This is a fun reinforcement activity after reading the Eight Types of Corn Biosheet. There are eight corn type cards that all have description cards that give the characteristics of each type of corn. These cards can be printed in as many sets as your classroom needs and can also be found at kansascornstem.com. Students will match the description cards with the correct corn type card.
- Card set: Corn Types (S9 or available at kansascornstem.com)
- Each group will get a set of eight Corn Cards that contain the following corn types:
 - Dent, Flint, Pod, Popcorn, Flour, Sweet, Blue, and Amylomaize.
- Card set: Description Cards (S10-15 or available at kansascornstem.com) This is enough for only one group. Print group copies of these pages so that there is one set of Description Cards for each group.
 - There are 50 Description Cards in total.
- For maximized repeatability, have the cards laminated.
- Shuffle the Description Cards.
- Have students break out into groups of two to five.
- Each group gets a set of Corn Cards and a set of Description Cards.
- Have the group put each corn card in a designated spot on their table.
- Students will place the Description Cards around each Corn Card.

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- After students have completed the card game, post the answers.
- Have each group count the number of correct matches.
- The group with the most matches wins!
- Alternatively:
 - Groups can be timed how long it takes to complete the game. When finished, every wrong answer gets 10 seconds added to their time. The group with the quickest time wins!
 - The teacher can pass out the corn type cards and the description cards along with the Eight Types of Corn Biosheet. Students can spread out the different corn cards. As they read the sheet, they can place the description cards with the proper corn card. The teacher can check to see how well they were able to grab information from the text.
 - Have all the description cards placed around the room. Give each group one type of corn card. They must find all the description cards for that type of corn and then they share afterwards.

Procedure for “Corn Types KERNEL Card Game” Lesson

(45 minutes)

- This card game uses the corn type cards, description cards, and action cards to play a game that is similar to the style of the UNO card game. This can best be used as a review of the types of corn and their characteristics. The KERNEL cards and directions can be found at kansascornstem.com. The directions for the game are below.
- Coming soon!

Reflection and Conclusion Questions (Answers in printed teacher packet)

By the end of this section, students should be able to answer the following.

- What are the eight main types of corn?
 -
- Which corn type is the most abundant?
 -
- Describe each corn type?
 -

Section 3: Corn Growth and Development

Procedure for “Pioneer Growth Stages WebQuest” Lesson

(60 minutes)

- This activity has each student going to the DuPont Pioneer website to complete the Pioneer Corn Staging Student Worksheet. The students will learn the major growth and development stages corn undergoes as it emerges from the ground to being harvested.
- Pass out the Pioneer Corn Staging Student Worksheet found in the (pg. S24-26, or available online at kansascornstem.com) to each student.

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- Have students access the Pioneer Reproductive and Vegetative Growth Stages links to read and explore the different stages of corn growth.
 - <https://tinyurl.com/PioneerCornReproductiveStages>
 - <https://tinyurl.com/PioneerCornVegetativeStages>
- This also makes a great emergency sub plan activity.

Procedure for “Corn Growth and Development Flipbook” Lesson

(45 minutes)

- This is a fun modification to the Pioneer Growth Stages WebQuest that uses Kansas State University’s Department of Agronomy website and its accompanying poster. Students will use these resources to identify and describe the major growth and development stages corn goes through from emerging through the soil to when it is harvested.
- Hand out a copy of the Kansas Corn Flipbook – Paper Version.
- Students will use the following resources to summarize the main features and characteristics of each major stage of corn growth and development.
 - K-State website: <https://tinyurl.com/KStateCornGrowthStages>
 - K-State poster: <https://tinyurl.com/CornStagesPoster>
- Students will write the summaries of the corn stages on the flip cards, to the left of each corn picture.
- They will then cut out each card individually and stack them in order from VE on top to R6 on bottom with the purple title card on the very top.
- Staple the top left and bottom left edges of the stack.
- You now have a flipbook by placing your thumb on the right edge of the stack and allowing each card to slip past your thumb.
- Alternatively, students can do this assignment using the included Kansas Corn Flipbook – Electronic Version, available at kansascornstem.com, instead of the paper version. They can type in the characteristics of each growth and development stage and then set a build transition to alternate through the slides at a pace of 0.2–0.4 seconds to show the corn plant growing throughout each stage.

Procedure for “3D Corn Plant Paper Model – Staging Version” Lesson

(120 minutes)

- This activity has students creating three-dimensional corn plants using simple craft supplies found at any retail store. Students can be broken up into groups of two. Each group can craft a 3D paper model at a different growth and development stage. These paper models can then be arranged in order around the room for a visual representation of corn’s growth and development stages.
- Step-by-step directions with pictures, templates and video can be found at kansascornstem.com. Coming soon!

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Reflection and Conclusion Questions (Answers in printed teacher packet)

By the end of this section, students should be able to answer the following:

- What are the main vegetative stages of corn plant growth and development, and what is happening at those key stages?
 -
 -
 -
 -
 -
 -
- What are the main reproductive stages of corn plant growth and development and what is happening at those key stages?
 -
 -
 -
 -
 -
 -

Section 4: Corn Plant Anatomy

Procedure for “Corn Plant Structures and Functions” Lesson

(60 minutes)

- This packet contains the structures and functions of the major parts of the corn plant and its seed. Students are given these information sheets along with worksheets, pg. S27-29 or available online at kansascornstem.com, that have them match and label the structures along with their functions.
- To make this an introductory activity, do the following:
- Print out the Corn Structures and Functions Cards (S37-40 or at www.kscorn.com) Then, cut across so that the structure and the function are on the same slip of paper. If there are more than 17 students in your class, you will want to make two copies of the Corn Structures and Functions Cards.
- Print out the Emerging Corn Plant structures and functions worksheet and one version of the Parts of an Emerging Corn Plant worksheet. Each student gets both worksheets.
- Shuffle the slips of paper and pass them out, one for each student.
- Have students get up and walk around the room in a disordered fashion. You can play music if you want.
- When you say, “grow,” then have the students meet up with one, and only one, other student.
- This pair will use their slips of paper to figure out and fill out their worksheet with those two structures and functions.
- Once they feel like they figured out what structure and function matches the worksheet, they will exchange their slips of paper, part ways, and find another partner.

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- They will continue this procedure until they are able to complete their worksheet.
- They may run into someone with a structure/function slip of paper that they already encountered. They should check their work and correct it if necessary.
- Make sure that they only pair up with one other person at all times.
- After the meet-and-greet, you can hand out the Emerging Corn Plant Structures and Functions information sheet with the Corn Plant Structures and Functions information sheet (pg. S29, or available online at www.kscorn.com) and have them check their answers.
- Alternatively, the teacher can take all the corn function cards and tape them up all around the room, in a scavenger hunt-like fashion. Students can then get up and walk around to match the functions to their respective structures, then write them down on their worksheets.

Procedure for “Corn Structures and Functions Image Match – Purpose Games” Lesson

(30 minutes)

- The above worksheets were used to create an interactive image matching game. There is a Parts of an Emerging Corn Plant Terms and Functions version as well as a Kansas Corn Plant Anatomy Terms and Functions version.
- Have students go to the Purpose Games website, <https://www.purposegames.com/>, and create a free account. They do not have to do this, only if they want their name shown on the game scoreboard. They can then find the games using the search function.
- You can also provide them with the direct link:
 - <https://www.purposegames.com/game/parts-of-an-emerging-corn-plant>
 - <https://www.purposegames.com/game/parts-of-an-emerging-corn-plant-function-version>
 - <https://www.purposegames.com/game/kansas-corn-plant-anatomy>
 - <https://www.purposegames.com/game/kansas-corn-plant-anatomy-functions>
- Have students compete for the fastest, most accurate score. Those that make the top leaderboard can get extra credit or recognition.
- You can give students a goal such as 100% percent accuracy in under 15 seconds to get credit. This will enforce them to try many times in order to reach the goal. Have students take a screenshot of their final score.

Procedure for “Corn Structure and Function Interactive Notebook” Lesson

(60 minutes)

- Students will use the Emerging Corn Plant Structures and Functions and the Corn Plant Structures and Functions handouts to create an interactive notebook page that contains corn plant and seed pictures with seventeen structure nametags. Students will then write the function of the structure inside the name tag.
- Each student will get a copy of the corn plant and corn seed pictures from the Corn Structure-Function INB handout. They can paste these pictures into their notebooks, or they can paste them on a colored 8.5” x 11” sheet of paper.

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- Each student will get a copy of the 17 name cards, which are also located on the Corn Structure-Function INB handout, and needs to cut them out individually.
- Each name card will be folded in half with the name on the outside. The white backside will be pasted into the notebook next to the line that identifies the structure.
- Students will then flip up the name card and write its function on the inside.
- There are some blank name cards if you want to add any more structures.
- Have students color the pictures as well as the structure name tags. The more colorful the better!
- There is a picture available at the end of the Corn Structure-Function INB handout to see what it can look like.

Procedure for “3D Corn Plant Paper Model – Individual Version” Lesson

(120 minutes)

- This activity has students creating three-dimensional corn plants using simple craft supplies found at any retail store. Students can be broken up into groups of two to create a mature corn plant in one of the reproductive stages.
- Students will then tag and label each of the major parts of the corn plant.
- These labels will contain the functions of the structure, written by the student.
- Step-by-step directions with pictures, templates, and video can be found at kansascornstem.com. Coming soon!

Procedure for “Corn Felting” Lesson

(120 minutes)

- Students will be using the needle felting craft technique to create an ear of corn.
- See if students can’t create a mini corn plant replica made from felt as well.
- Download the Needle Felting Corn Lab found at kansascornstem.com for the complete instructions.

Reflection and Conclusion Questions (Answers in printed teacher packet)

By the end of this section, students should be able to answer the following.

- What are the seven major structures and their functions of an emerging corn plant?
 -
- What are the ten major structures and their functions of a mature corn plant?
 -

Section 5: Mathematics with Corn

Procedure for “Corn Kernel Math with Ear of Corn Dissection” Lesson

(120 minutes)

- This lab activity will have students explore ears of corn while incorporating math concepts involving averages, conversions, accuracy, percent error, and quantity estimation. Students will use the mass of

Kansas Corn-ucopia

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objects to determine quantity without counting individual objects.

- The following are sections contained in this Corn Kernel Math with Ear Dissection lab.
 - Counting the average number of rows and corn kernels on an ear of corn.
 - Using quantity estimation to determine the number of kernels in a container.
 - Applying the law of large numbers to determine accuracy.
 - Determining the number of kernels in a bushel of corn.
 - Estimating corn yield per acre.
 - Determine how many kernels and bushels of corn make up the human body.
- Handout the Corn Kernel Math with Ear of Corn Dissection lab sheet each student.
- Each group or station will need anywhere from three to six ears of corn, at least 50 loose corn kernels, and scales for getting the mass of the kernels.
- The teacher will need to determine the mass of a clear container, then fill it up with as many corn kernels as it can hold. The number of kernels in that container will need to be hand-counted.
- The teacher may want to think of a small prize for the student(s) or group that gets closest to the actual number of kernels in the container.
- When determining the number of corn plants per acre in Part 4, the teacher can use tape any length longer than 17.5 feet.
- The teacher will then use a colored marker to create a dot on the tape to represent a planted corn seed.
- The distance of the “seeds” can be anywhere from 6-12 inches apart. The teacher may make the following changes:
 - Alternatively, the teacher can place a piece of tape on the floor that is exactly 17.5 feet and the students can count how many steps it takes to walk that distance.
 - In addition, the teacher can place multiple lengths of tape with different seed spacing, ranging from 6-12 inches.
- K-State has published a PDF and an iBook (for iPads only). The title is Abnormal Ears of Corn and can be found under Publications with the following link.
 - <https://www.agronomy.k-state.edu/extension/crop-production/corn/>

Reflection and Conclusion Questions (Answers in printed teacher packet)

By the end of this section, students should be able to answer the following.

- What is the average number of kernels on an ear of corn?
 -
- What is the average mass of an individual corn kernel?
 -
- How many rows of kernels are on an individual ear of corn
 -
- How many pounds is a bushel of corn?
 -
- Explain how farmers determine the number of corn plants in an acre with 30-inch rows.

Kansas Corn-ucopia

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Section 6: Corn in Everyday Products

Procedure for “Everything’s Corny” Lesson

(60 minutes)

- Corn is found in many everyday products either as a main component or as a starting point for other ingredients. It is even useful in many manufacturing processes. Students will use the National Corn Growers Association’s The Many Uses of Corn poster as well as Kansas Corn’s Common Items Containing Corn handout to identify the different forms corn can take in our everyday products. They will then use this information to complete a crossword puzzle.
- Handout the two resources mentioned above along with an Everything is Corny crossword puzzle for the student to fill out. There are five versions of the crossword puzzle that can be used.
- Alternatively,
 - The teacher can find many household products and place them all together on a table. The product samples can be numbered or lettered. The students can then find how corn was used in that product by looking at the ingredient list and doing some research. They can then write down the corn ingredient on a sheet of paper next to the letter or number of the product sample.
 - The teacher can create a matching worksheet that has the names, letters, or numbers of the product samples on one side and the corn ingredients on the other.

Reflection and Conclusion Questions (Answers in printed teacher packet)

By the end of this section, students should be able to answer the following.

- What are some products that you didn’t expect to have corn as an ingredient?
•
- What common items found in your bathroom have corn as an ingredient?
•
- Ask another question like the above; in food, home, industry, etc.
- What are some ingredients that are derived from corn that have scientific names?
•

Section 7: Corn Data – Where is Corn Grown?

Procedure for “Corn Graphs and Math” Lesson

(120 minutes)

- This activity uses the World of Corn 2020 infographic provided by the National Corn Growers Association. Students will complete a worksheet that has them read and analyze data provided in different types of graphs and tables.

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- Each student or pair of students gets a copy of the World of Corn 2020 infographic, available at kansascornstem.com.
 - Due to its colorful nature, it would be best to push this out to your students electronically.
- Pass out the Corn Graphs and Math activity worksheet (pg. S58-61 or available online at kansascornstem.com) to each student or pair of students.
- Helpful math formulas are found on the last page as a reference guide.

Reflection and Conclusion Questions (Answers in printed teacher packet)

By the end of this section, students should be able to answer the following:

- What is the average number of bushels of corn harvested in the U.S. in 2019?
 -
- What are the components and their percentages of yellow dent #2 corn?
 -
- What are the three largest corn producers in the world?
 -
- How does most of our corn get used?
 -
- What are the four main animals that feed off corn as a main part of their diet?
 -
- Which states are the top 3 producers of ethanol?
 -

Section 8: Corn Plant Dissection

Procedure for “Leaf Collar Dissection Method” Lesson

(45 minutes)

- Students will break out into groups of three to five students
- Students will be working with cutting utensils for this portion.
- Hand out the Leaf Collar Method Student worksheet (pg. S62-63, or available online at kansascornstem.com).
- Give the students 5-10 minutes to read the background information and directions.
- Show the following two YouTube videos that cover the determination of corn growth stages.
 - <https://tinyurl.com/FarmBasicsCornGrowthStages>
 - <https://tinyurl.com/GrowthStagingCorn>
- Students will use a knife and cutting board to carefully split the stalk of a corn plant in half, vertically, and down to the roots.
- Remember, the first four nodes are often indistinguishable within the crown.
- Count the number of nodes to determine the vegetative stage that the corn plant is in.
- Compare the nodes counted within the stalk to the number of leaf collars found on the outside of the

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plant.

- Have students complete the reflections section individually or as a group before coming together as a class to discuss.

Reflection and Conclusion Questions (Answers in printed teacher packet)

By the end of this section, students should be able to answer the following.

- How do we know when we have a fully developed leaf stage?
 -
- Why is it important for a farmer to know the development stages their corn plants are in?
 -
 -
- What is so important about a corn plant being at the V2-V3 stage?
 -
- Why do we have to split the stalks instead of using the collar method?
 -

Section 9: Planting Corn

- This section will discuss how corn is planted and harvested. It will also talk about fertilizers (N-P-K), pesticides, herbicides, fungicides, and Bt Corn.
- We will also show videos on how to plant your own corn in the classroom, all while undertaking the scientific method.
- This section will also contain physical science lessons involving the nitrogen, carbon and water cycles.
- All of this is coming soon!

Section 10: Kansas Corn Video Series

Procedure for “Kansas Corn Video Series” Lesson

- Short videos will be produced over the growing season, taking students from the planting of corn to being harvested and everything in between.
- Resources will be available to accompany these videos.

360-degree/VR photos and videos are in the works, too!

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Science and Agriculture Careers

- Crop adjuster
- Data processor
- Extension agent
- Grain buyer
- Geospatial analytics specialist
- Precision agriculture specialist
- Climate change analyst
- Ecologist
- Environmental engineer
- Environmental scientist
- Nutrient manager
- Pest control advisor
- Produce inspector
- Irrigation specialist
- Aerial applicator
- Agronomist
- Crop advisor
- Crop scout
- Crop systems specialist
- Entomologist
- Horticulturist
- Microbiologist
- Plant biologist
- Plant breeder
- Plant geneticist
- Plant pathologist
- Field agronomist
- Soil scientist
- Weed scientist

To learn more about agriculture careers, visit agexplorer.com. You can also find career profiles at kscorn.com.

Sources

- Resources adapted with permission from Ohio Corn and Wheat, <http://ohiocorneducation.org/>
- Introduction to Corn Article, <http://ohiocorneducation.org/curriculum/growing-ohio>

Any educator electing to perform demonstrations is expected to follow *NSTA Minimum Safety Practices and Regulations for Demonstrations, Experiments, and Workshops*, which are available at <http://static.nsta.org/pdfs/MinimumSafetyPracticesAndRegulations.pdf>, as well as all school policies and rules and all state and federal laws, regulations, codes and professional standards. Educators are under a duty of care to make laboratories and demonstrations in and out of the classroom as safe as possible. If in doubt, do not perform the demonstrations.

Introduction to Corn

Why is corn such a valuable crop? How does corn grow, pollinate, and produce kernels? What farming techniques are important to increase corn yield?

Corn is a grass, native to the Americas. Evidence in central Mexico suggests corn was used there about 9,000 years ago. Various Native American tribes shared their knowledge of corn, known as maize, with early European settlers, saving many from starvation. Early American colonists ground dried corn as meal for flour to use in porridge, cake, and bread. Sweet corn, served as “corn on the cob,” was not developed until the 1700s.

Along with wheat and rice, corn is one of the world’s major grain crops. It is the largest grain crop grown in the United States. About 9 percent of all the corn is used to produce food for humans: corn meal, cooking oils, margarine, corn syrups, and sweeteners (fructose). About 64 percent of all corn is used for livestock feed.

Corn is harvested for either grain or silage, with most of the grain going to dairies, animal feeding operations, and poultry operations. Corncobs have been used in the manufacturing of nylon fibers as well as being a source for producing biodegradable plastics. Ethanol, made from corn, is a renewable fuel used in today’s cars.

Corn is pollinated by wind and is typically planted in 30-inch rows. A single seed, or kernel, of corn may produce a plant that yields more than 600 kernels of corn per ear. Approximately 22,000 to 35,000 individual plants may be grown on an acre of land. Hybrid corn is developed to produce from one to two ears per plant. More than 80 million acres of the heartland are planted in corn each year. That’s almost as big as 60 million football fields!

After corn is harvested, farmers begin to prepare the soil for the next season by mixing in nutrients, such as potassium and phosphorus, with some form of tillage (breaking up soil) to incorporate them. In the spring, farmers will do a light tillage pass to create smooth bedding for planting. When the ground temperature is ready (50°F and expected to rise), farmers will plant the corn seeds. Farmers will then add fertilizer, two inches deep and two inches to the side of the kernels to help the seeds get a healthy start. After the seed is planted, most farmers will spray a pre-emergent herbicide to prohibit weed growth. When seedlings emerge and grow, farmers will inject the soil with some form of nitrogen fertilizer before the V8 (eighth leaf development) stage. This spring fertilizer will allow for the plant to “green-up” and establish good photosynthetic activity through harvest.

Farmers will continue to scout the crop through maturity for any additional pests. Farmers will harvest the crop when it is ripe in the fall.



A Brief History of Corn



Teosinte

Corn was first domesticated in Mesoamerica around 10,000 years ago. Its earliest ancestor is a grassy plant called teosinte. This wild grass is a far cry from modern-day corn. Teosinte is characterized as being approximately three inches tall and has between five and twelve “tooth-crackingly” hard kernels. Compared to modern day corn, which can have 600-800 kernels, it’s no wonder botanists originally didn’t believe the two were related! Over many generations, early Mesoamericans selectively bred for longer ears and softer kernels, thus giving us the soft, golden ears of corn we know today.

Photo courtesy of Matt Lavin
https://www.flickr.com/photos/plant_diversity/4055517697

Implications of Early Agriculture



Agriculture meant laying down roots! The planting of crops and raising cattle is known as domestication. It was an end to the hunter-gatherer lifestyle and a beginning to sedentary life.



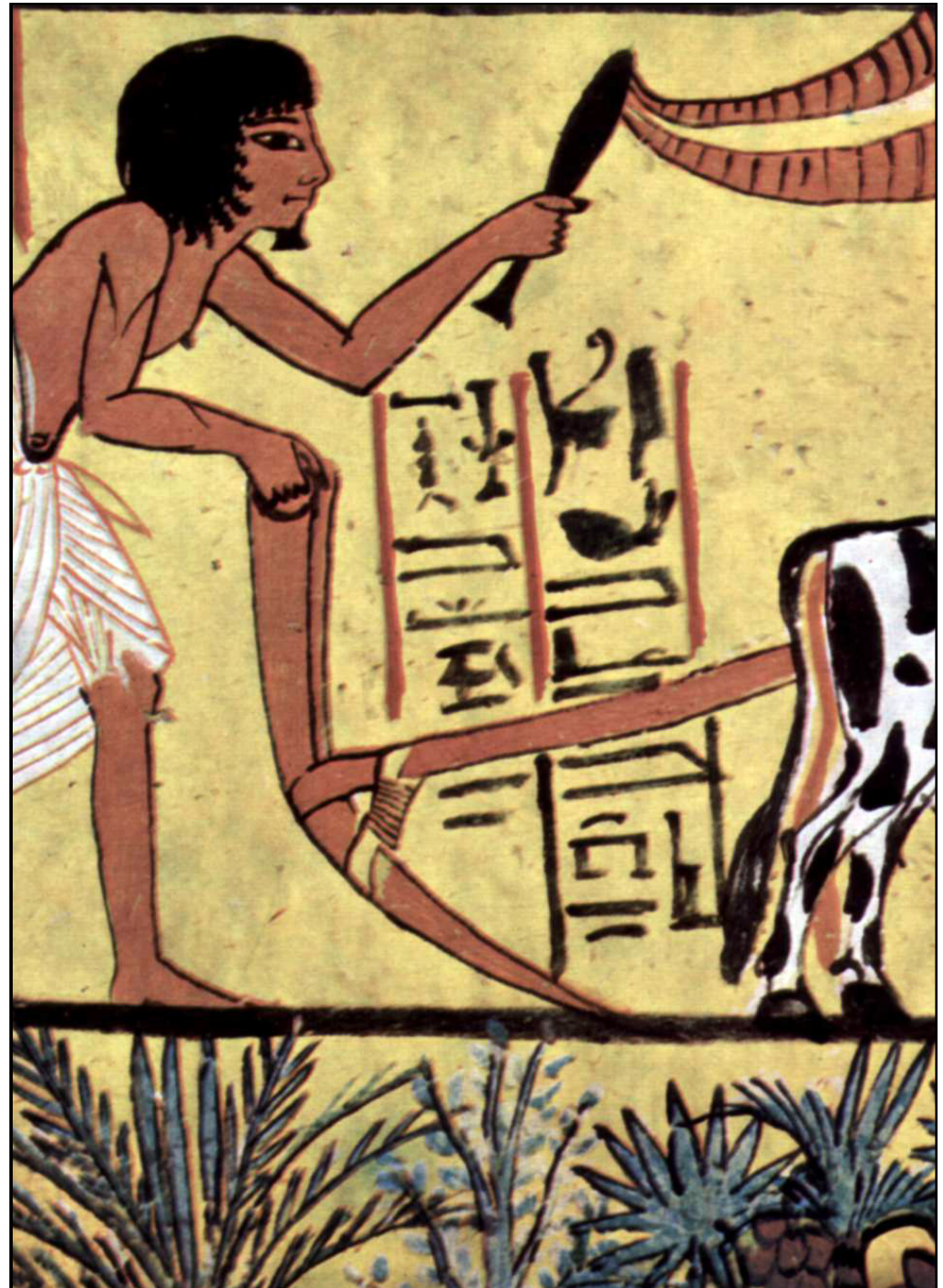
Native communities had to stay in one place to plant, grow, and harvest crops. They began to build permanent dwellings and form villages.



By settling in permanent areas, this led to the idea of “personal property.” People were willing to defend this property from attacks by those who wanted to take it.



What are other consequences of early agriculture and domestication?

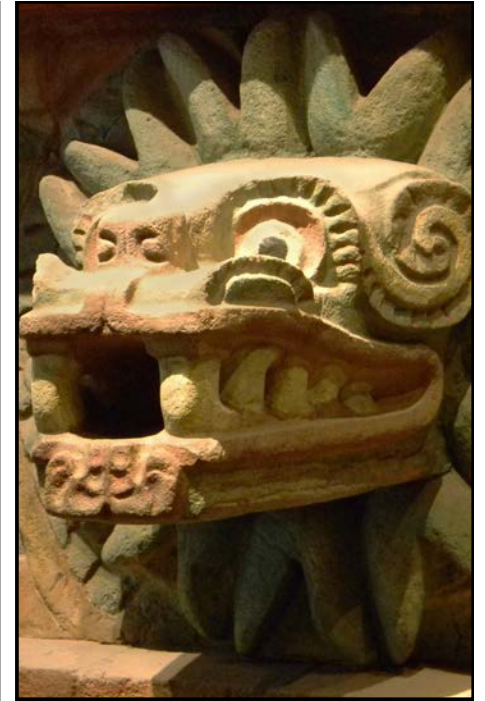


Blood and Corn

One of the most important civilizations in Mesoamerica, the Mayans, were very dependent on corn.

Based on isotopic analysis of skeletal remains, 70% of their diet was corn-based!

In fact, according to the Mayan creation legend, the Gods formed the Mayans from a dough made of corn and blood.



Corn Goes Global!

From Mesoamerica, corn was brought north to present-day America. In fact, the Southwest was the first place where corn agriculture began in America. This was in present-day Arizona and New Mexico.

From there, corn was brought through America by the Native Americans. When European colonists arrived, the Native Americans taught them how to grow corn, an act that was vital to successful colonization efforts.

After learning how to grow corn, Christopher Columbus and other explorers introduced corn to Europe. Because of this, corn plants mature somewhere in the world nearly every month of the year and corn has become the most important crop in the United States!



5 "John Smith trying to get more food for the settlers." Photo courtesy of National Park Service
<https://www.nps.gov/jame/learn/historyculture/pocahontas-her-life-and-legend.htm>



"Interview of Samoset with the Pilgrims." Book Engraving. 1853.
 {{PD-US-Expired}}

Dent

This corn is named for having a small indentation on the top of each of its kernels and has the scientific name of *Zea mays indentata*. It is a type of field corn that has a high, starch content that is soft enough to make into cornmeal flour for cornbread, corn chips, tortilla shells and taco shells. Though, it is mainly used for animal feed, cooking oil and the production of ethanol, a biofuel. Its starch can also be used to create plastics, such as water bottles and disposable kitchen utensils as well as high fructose corn syrup which is a sweetener for many foods. It can even be used to create paper and food-grade starch to thicken your gravy! It is grown more than any other crop on the planet and was developed by an Illinois farmer by the name of James Reid which won him the blue ribbon at the 1893 World's Fair.



Flint

This corn goes by the scientific name of *Zea mays indurata* but is also known as Indian or Calico corn due to its many different colors of kernels. Because of its coloration, it is used as decoration for the holidays which give it another name, ornamental corn. Though, its official name is flint corn because its kernels have a hard outer layer that protects its soft inner endosperm. Other than decorations, you may have come across it as hominy and perhaps eaten it as grits or popcorn which is a specific variety of flint corn. It is famous for being the only crop to survive New England's "Year without summer" in 1816. This was because it has very low water content in the kernel that makes it more resistant to freezing.



Pod

Zea mays tunicata is one crazy looking variety of corn! There are leaves growing around each kernel which is why it is also known as wild maize. This is a mutant variety of corn and not an ancestor of the maize family.



Popcorn

This is a special variety of flint corn with remnants being dated all the back to 3600 BC. *Zea mays everta* has the strongest hull and contains a hard, starchy endosperm with a moisture content between 13.5 and 14 percent. This moisture is what heats up and turns to steam creating an inside pressure of up to 135 psi! The steam gelatinizes the starch when it finally "pops" breaking through the hull and immediately expands into an airy foam. This creates two types of popcorn "flakes:" the butterflies or snowflakes that are irregularly shaped with a number of protruding wings, and the mushrooms which are ball-shaped. Those poor kernels that do not pop are called "old maids." During the Great Depression in the 1930s and World War II in the 1940s, popcorn became one the most popular snacks around. It wasn't until 1981, when General Mills patented the very first microwaveable bag for us to enjoy in a jiffy!



Flour

What can be said about *Zea mays amyloperla*? As its common name suggests; it is mainly used to make corn flour, which can be found as an ingredient in many food products. It is easy to ground into flour due to its soft, starchy endosperm within a thin pericarp.

Sweet

Now this is the one corn type that makes it to the dinner table, especially during the summer grilling season! *Zea mays rugosa* was first recorded by European settlers in 1779 when it was introduced by the Iroquois, which was not all that long ago.

It has a high sugar content due to a natural recessive mutation. It is harvested very quickly, when the kernels are in the immature milk stage. It is then cooled down by putting it on ice to stop the sugars converting into starch, keeping them from losing their sweetness. This lack of starch causes sweetcorn to not store very well which is why you find it many times in the refrigerated section in the produce aisle. In Latin America, it is eaten with beans in order to balance out the abundance and deficiency of essential amino acids contained in each.

Blue

What kind of tortilla chips do you think are made from this corn type? Yep, it's blue tortilla chips! It's the different kinds of anthocyanin pigments that give this corn its unique color. This is another variety of flint corn that has roots that go deeper into the soil, making it more drought tolerant, but has an overall shorter height at only 4-5 feet tall. That is short for corn! It packs a bit more protein, 7.8 percent, versus yellow corn's puny 5.7 percent. It was originally developed by the Pueblo Indians of the Rio Grande, known as the Hopi.

Amylomaize

This is a new kind of corn that was developed to have a very high amylose content. Amylose is a polysaccharide sugar and this type of corn contains 50 percent greater amylose than other corn types. Some have even reached 94 percent! This makes it great for industrial wet milling processes such as the production of ethanol and biodegradable plastics.

Dent



Pod



Flour



Flint



Popcorn



Sweet



Amylomaize



Blue



Field corn with a high, soft starch content



Named for having a small indentation on the top of each kernel



Developed by an Illinois Farmer by the name of James L. Reid



Won the blue ribbon at the World's Fair in 1893



Most corn grown today is of this variety



Used to make cornmeal flour for cornbread, corn chips, tortillas and taco shells



It's starch can be used to create plastics and high fructose corn syrup



Primarily used for animal feed, cooking oils and production of ethanol



Used to create food-grade starch and paper



Also known as Indian Corn or Calico Corn



Named for having a hard outer layer to protect the soft endosperm



Has a very low water content which makes it more resistant to freezing



The only crop to survive New England's "Year without Summer" in 1816



Most of this type is multi-colored



Popcorn is a variant of this type of corn



Used to make hominy



Is also named ornamental because of its use during the holidays due to its multiple colorations



Also known as wild maize



It is a mutant - not an ancestor of the maize family



Leaves are formed around each kernel in this type



Has the strongest hull that contains a hard, starchy endosperm



Has a moisture content between 13.5-14%



Is a variety of flint corn



Remnants of this type have been found all the way back to 3600 BC



Was a very popular snack during the Great Depression and WWII



General Mills in 1981 patented the first microwaveable bag for this type



Pressurized steam gelatinizes the starch inside and breaks through the hull at 135 psi, expanding the starch into an airy foam



Unpopped kernels are called "Old Maids" whereas popped kernels are called "Flakes"



There are two types of Flakes - Butterflies or Snowflakes that are irregular with a number of expanded wings and Mushrooms which are ball-shaped



Has a soft, starchy endosperm and a thin pericarp



Used to make corn flour



Has a high sugar content due to a naturally occurring recessive mutation



Harvested when kernels are immature - in the milk stage



Stores poorly due to lack of starch



First recorded by European settlers in 1779 when given by the Iroquois



Eaten with beans in Latin America because each is deficient in certain amino acids that are abundant in the other



Is a variety of flint corn



Originally developed by the Hopi - the Pueblo Indians of the Rio Grande



This type is more drought tolerant, deeper rooted and shorter (4-5 ft)



For each 100g, it has a protein content of 7.8% versus 5.7% in yellow corn



Contains different types of anthocyanins that corn its unique color



Used to make blue tortilla chips



Has an amylose content of 50% or greater - up to 94%



Used primarily for wet milling like in the production of ethanol and biodegradable plastics



Zea mays indurata



Zea mays tunicata



Zea mays everta



Zea mays amylacea



Zea mays rugosa



Zea mays indentata



AMYLOMAIZE



AMYLOMAIZE



DENT



DENT



DENT



DENT



DENT



DENT



DENT



DENT



POPCORN



POPCORN



POPCORN



POPCORN



POPCORN



POPCORN



POPCORN



POPCORN



FLINT



FLINT



FLINT



FLINT



FLINT



FLINT



FLINT



FLINT



SWEET



SWEET



SWEET



SWEET



SWEET



SWEET



BLUE



BLUE



BLUE



BLUE



BLUE



BLUE



POD



POD



FLOUR



FLOUR



+2

+2

+2

+2

REVERSE

REVERSE

REVERSE

REVERSE

SKIP



SKIP



SKIP



SKIP



**DENT, FLINT, SWEET,
POP, POD, FLOUR,
BLUE, AMYLOMAIZE**



**DENT, FLINT, SWEET,
POP, POD, FLOUR,
BLUE, AMYLOMAIZE**



**DENT, FLINT, SWEET,
POP, POD**

+4

**FLOUR, BLUE,
AMYLOMAIZE**



**DENT, FLINT, SWEET,
POP, POD**

+4

**FLOUR, BLUE,
AMYLOMAIZE**



Corn Staging Student Worksheet

Name: _____

Group: _____

How does corn go from the vegetative to reproductive stage?

- From under the ground (germination) to the first stage (VE), as shown in the picture below.

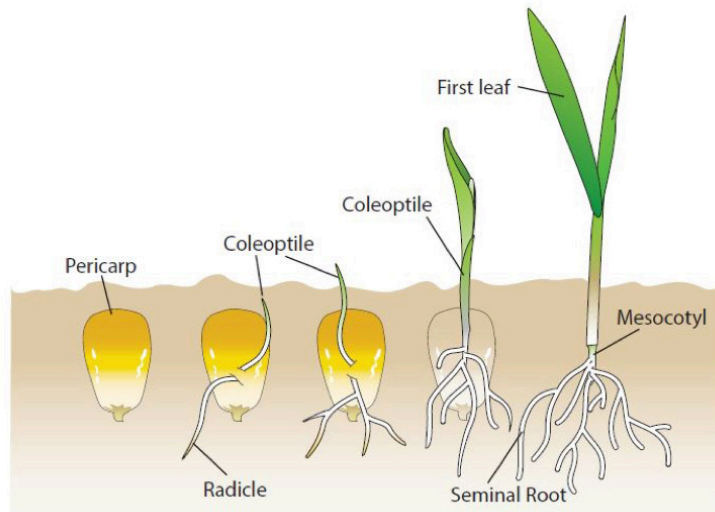


Photo provided by Dr. Ciampitti, KSUCROPS Team, K-State Agronomy and Bob Holcombe, K-State Communications

Corn Staging:

Visit the DuPont Pioneer website (tinyurl.com/cornstages). Fill in the grid describing the vegetative and reproductive stages. If link does not work visit kansascornstem.com for updated link.

VE		R1	
V1		R2	
V2		R3	
V3		R4	
V(n)		R5	
VT		R6	

Corn Staging Student Worksheet (Continued)

Stages of Development (Vegetative):

Visit the DuPont Pioneer website (tinyurl.com/PioneerCornVegetativeStages). Write why each stage is important (significance) and draw a picture showing how the plant would look in that stage. If link does not work visit kansascornstem.com for updated link.

Stage	Significance	Picture
VE-V1		
V3		
V6		
V9		
VT		

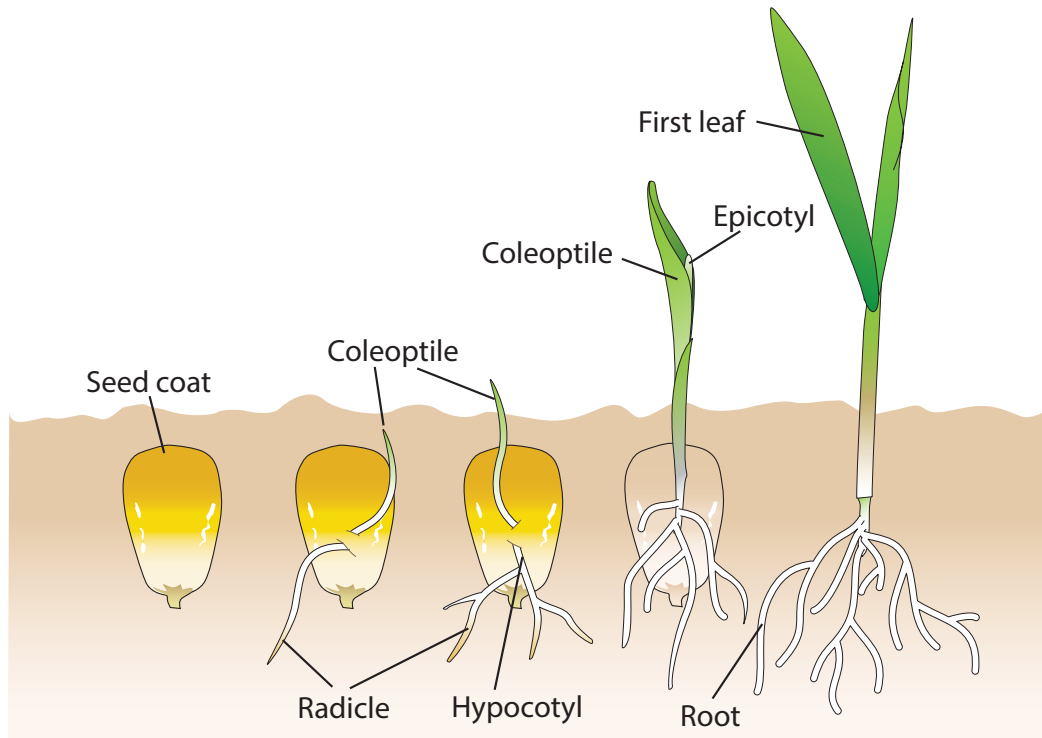
Corn Staging Student Worksheet (Continued)

Stages of Development (Reproductive):

Visit the DuPont Pioneer website (tinyurl.com/PioneerCornVegetativeStages). Write why each stage is important (significance) and draw a picture showing how the plant would look in that stage. If link does not work visit kansascornstem.com for updated link.

Stage	Significance	Picture	GDUs
R1			
R2			
R3			
R4			
R5			
R6			

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

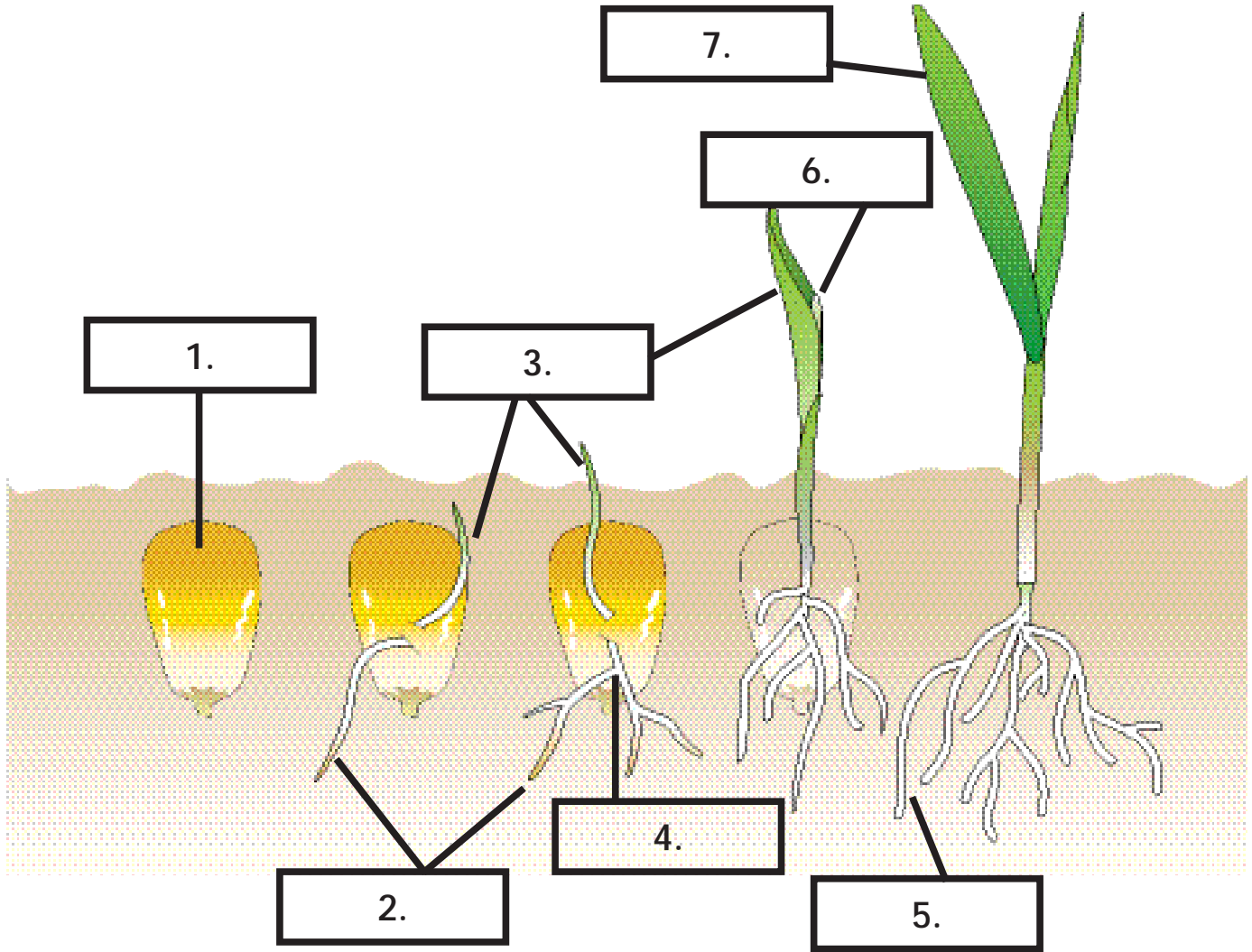
Corn seed coleoptile: a pointed protective sheath covering the emerging shoot (epicotyl) that pushes above the ground for the first leaves to appear

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.

Parts of an Emerging Corn Plant



1.

2.

3.

4.

5.

6.

7.

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.

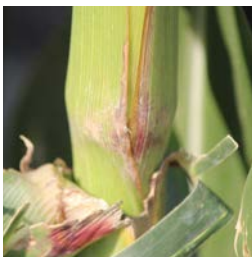


Silk: a hollow tube that comes from the female part (ovary) on the ear. The silk grows outside of the husk until the pollen lands on the silk and then moves down silk tube to fertilize the ovary to form the seed. Each ear has one silk strand for each kernel on the ear.

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.

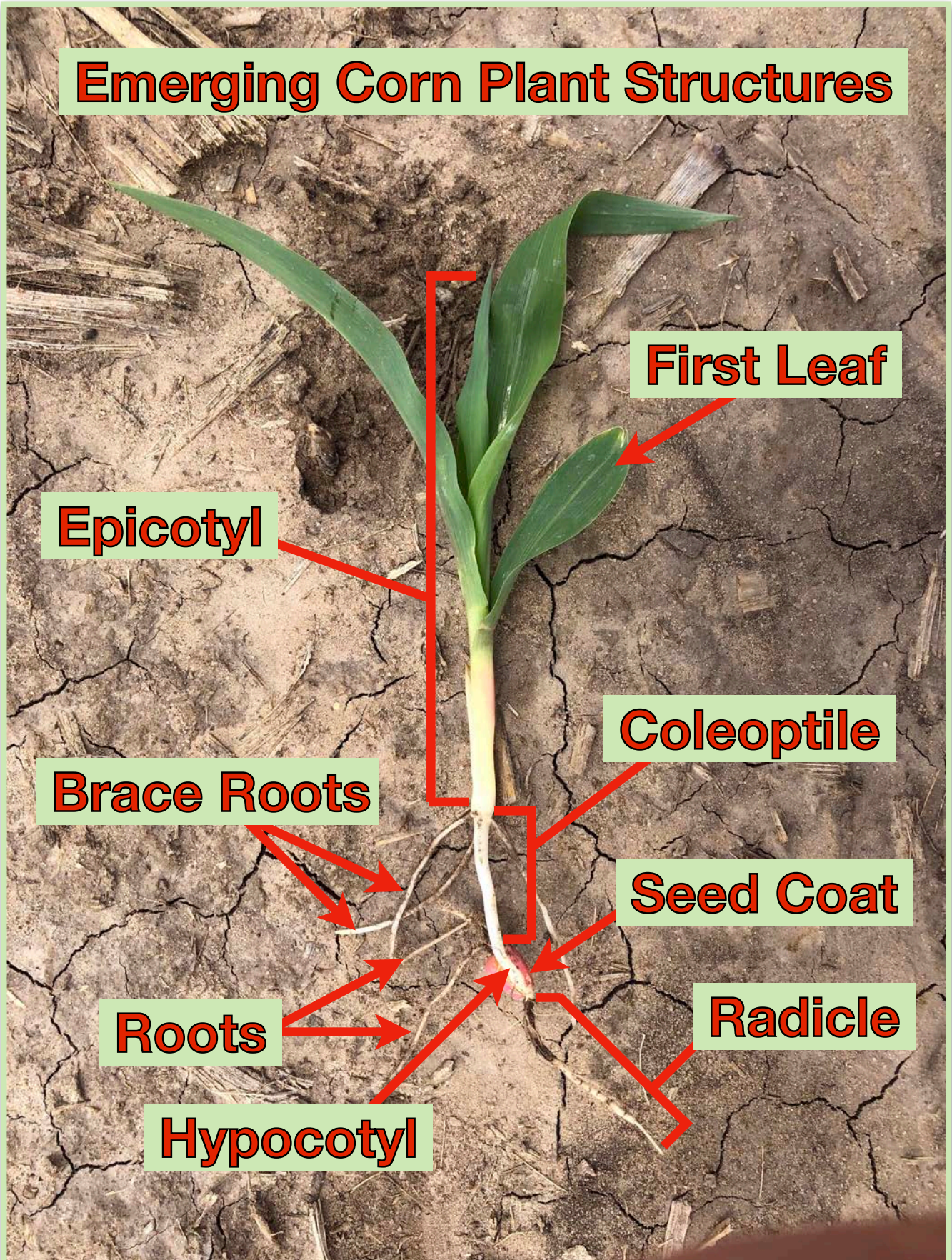
Stalk: the main body (stem) of the corn plant. Stalks have to be sturdy to support the weight of the corn ears and provide pathways for the nutrients to move up and down the plant.

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.

Emerging Corn Plant Structures



Parts of a Corn Plant

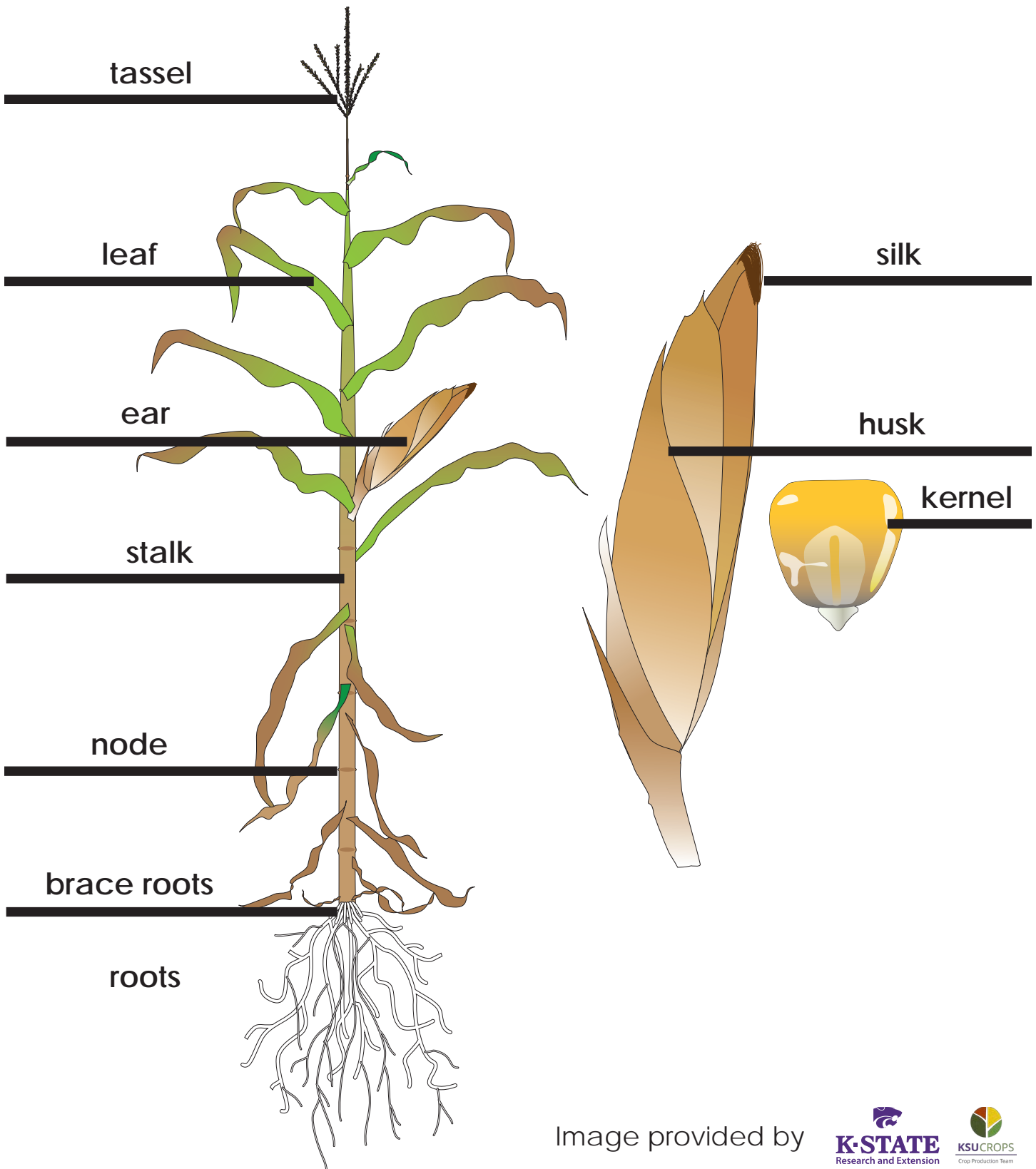


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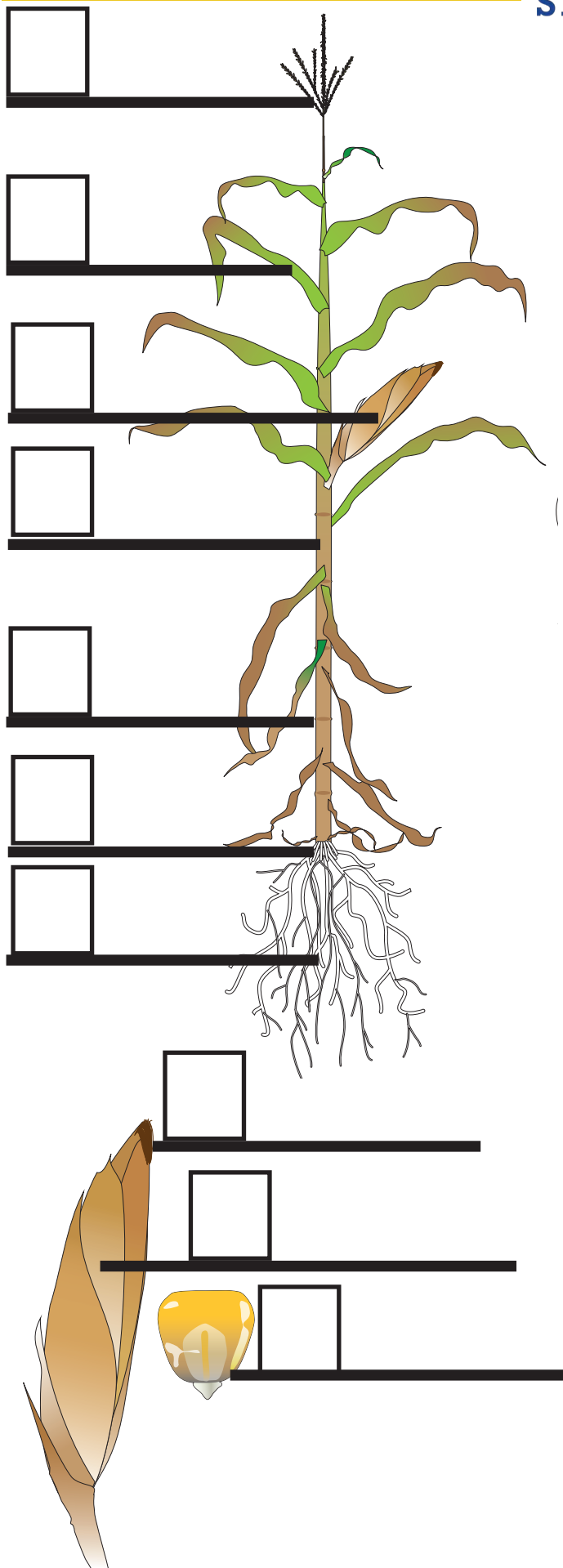
Parts of a Corn Plant



Image provided by

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.

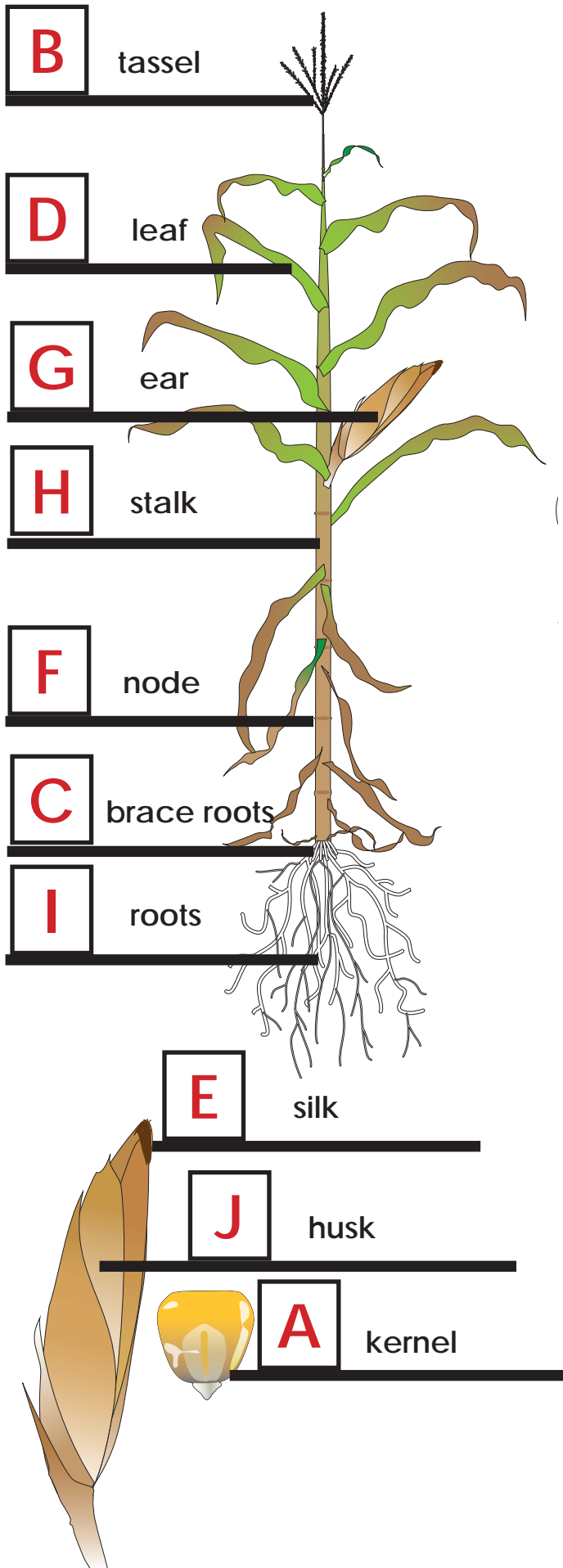
F. Node: a place on the stem where growth occurs.

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.

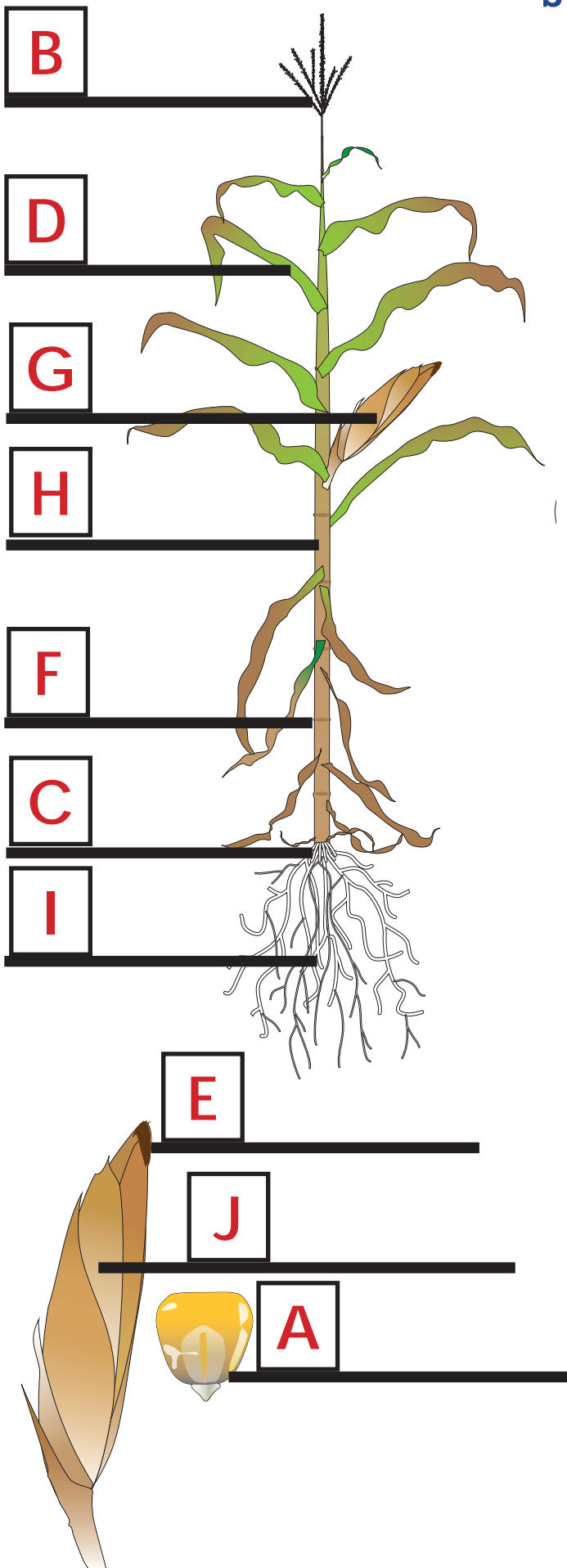
J. Husk: leaf like structure that wraps around the ear for protection.



Test What You Learned

Match the functions with their plant structures.

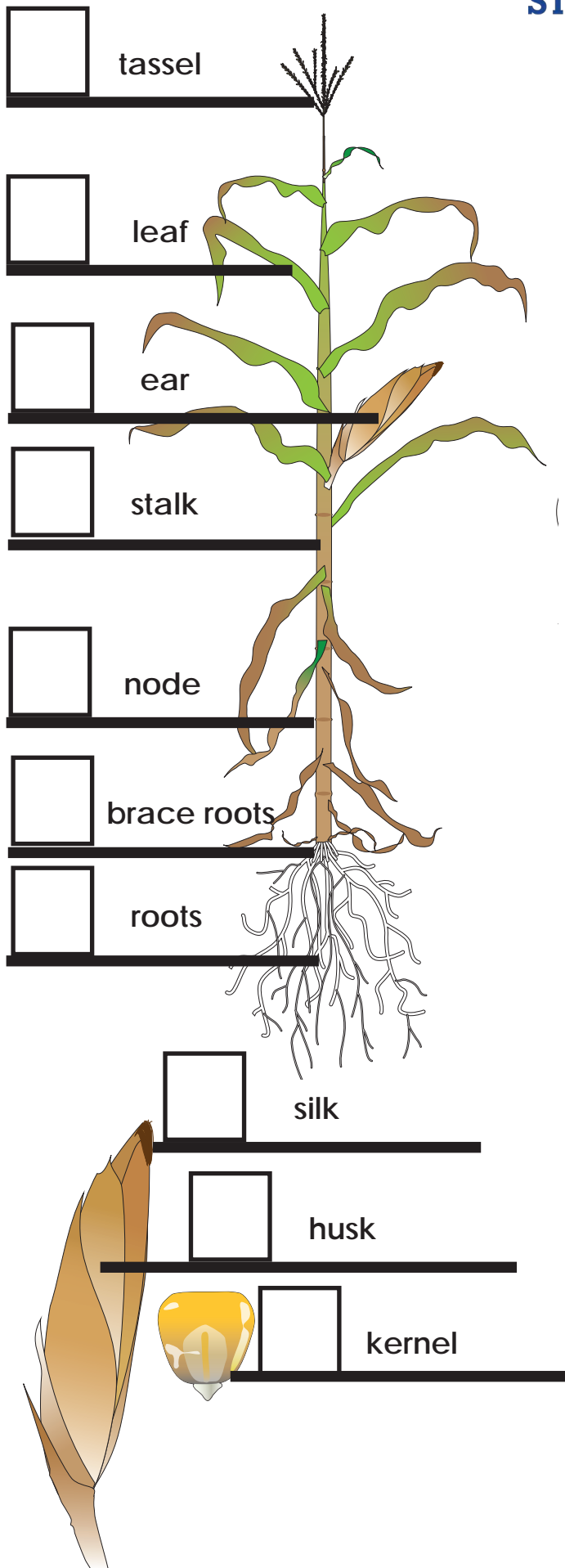
- A.** it is the corn's seed with one main function; to make another corn plant.
- B.** the male part of the corn plant that contains the pollen.
- C.** roots that form above ground to keep the plant standing upright.
- D.** provides the surface area where light is intercepted and photosynthesis takes 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.



Test What You Learned

Match the functions with their plant structures.

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Test What You Learned

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- 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.

Corn 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. It 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

The region between the radicle and the coleoptile and forms more roots.



Corn Seed Epicotyl

The region inside the coleoptile that forms the leaves and stems

First Leaf

Has a rounded tip and comes from the inside of the coleoptile. Will fall off as the plant grows

Tassel

The male part of the corn plant that contains the pollen. Located on top of the corn plant

Leaf

Provides the surface area that collects sunlight for photosynthesis

Silk

Each kernel has one of these hollow tubes that act as a pathway for pollen to the ovary

Husk

Leaf-like structure that wraps around the ear for protection

Ear

The female part of the corn plant and contains the kernels

Kernel

The seed of the corn plant with the one goal - create another corn plant

Node

A place on the stem where growth occurs. Leaves, roots, ears and tassels form from this

Stalk

The main body of the corn plant that supports the ear and provides pathways for nutrients to to move up and down

Brace Root

Forms above the ground and helps keep the corn plant anchored into the soil

Root

Grow underground and bring water and nutrients to the rest of the plant

Directions:

1. Each student gets a copy of the corn plant and corn seed pictures. They can paste these pictures into their notebook.
2. Each student gets a copy of the seventeen name cards.
3. They can cut these out, fold them in half with the name on the outside and then paste the white backside to the notebook next to the line that identifies the structure.
4. Students can then flip up the name card and write its function on the inside.

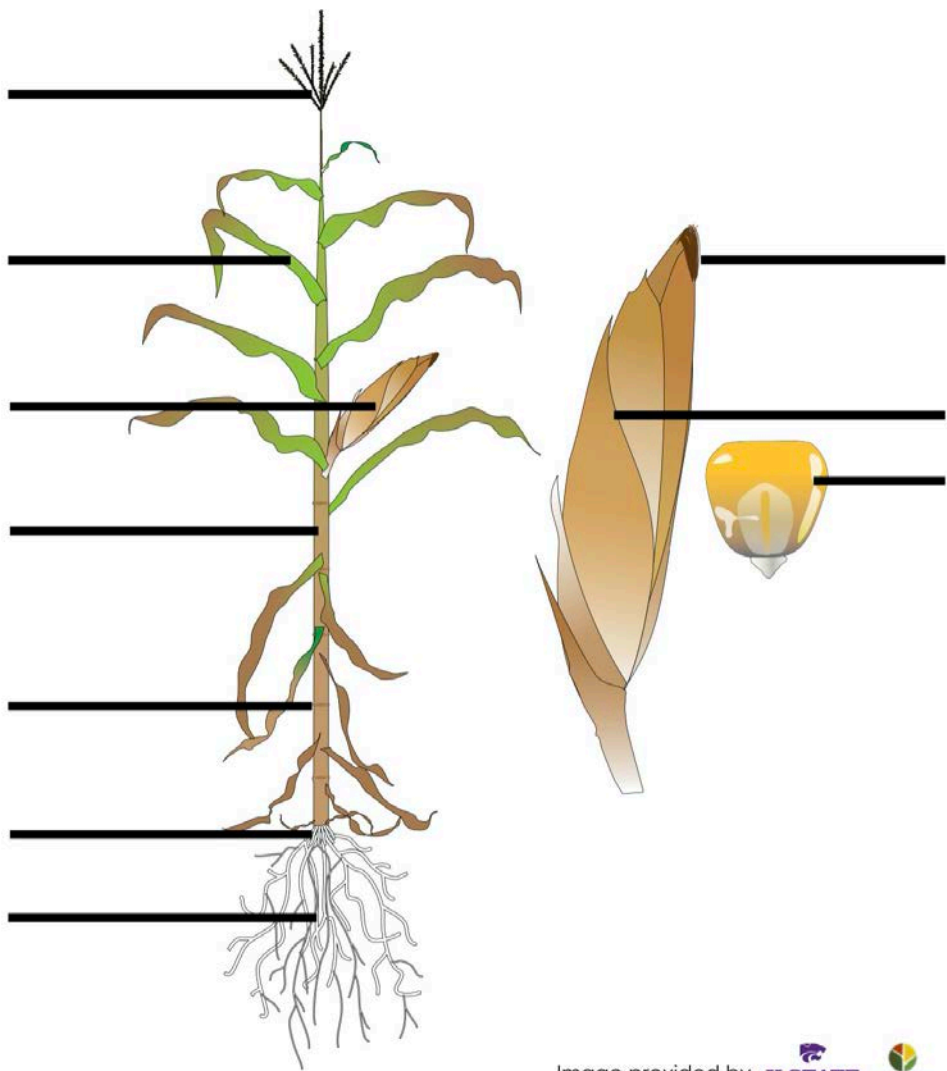


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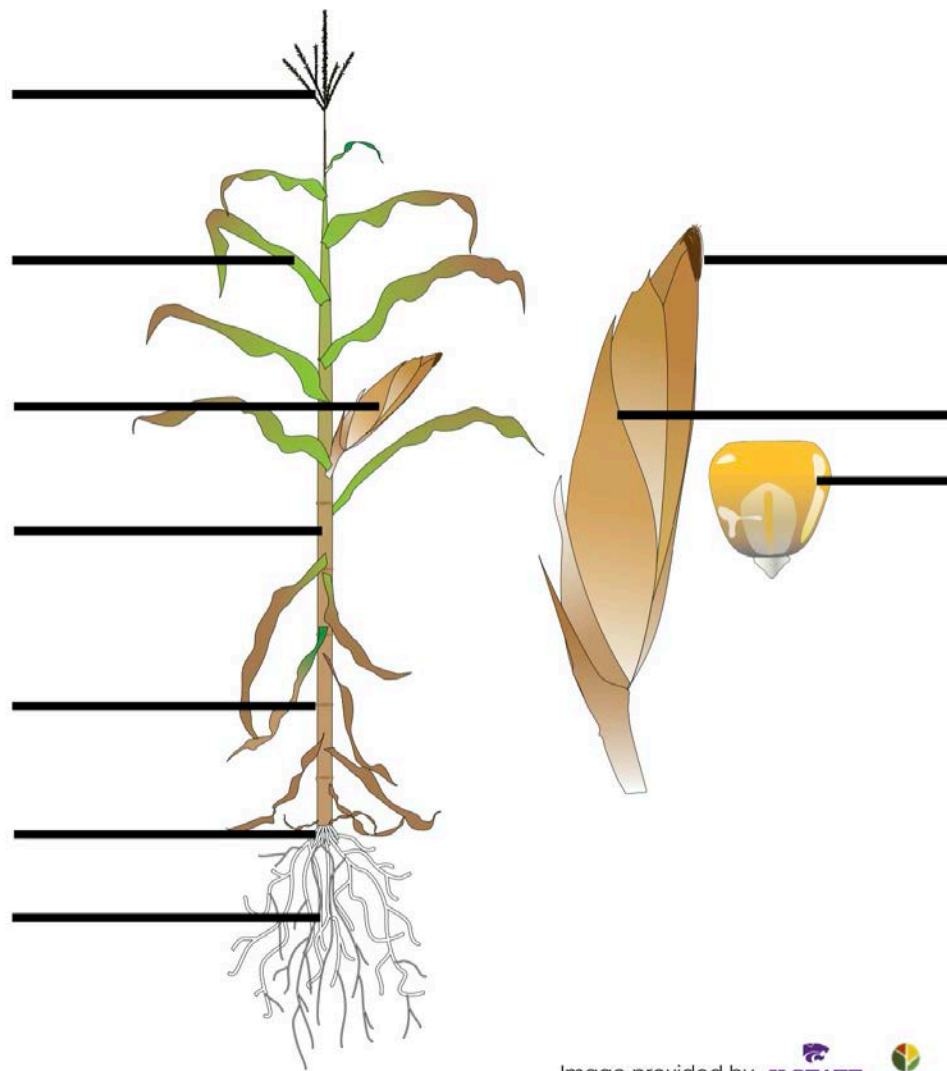
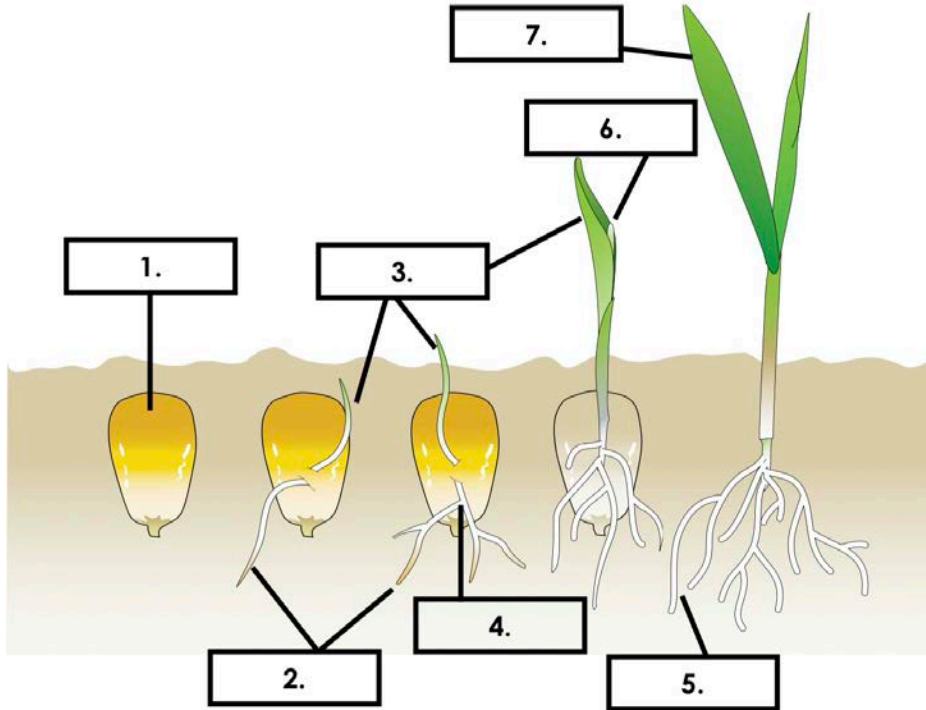
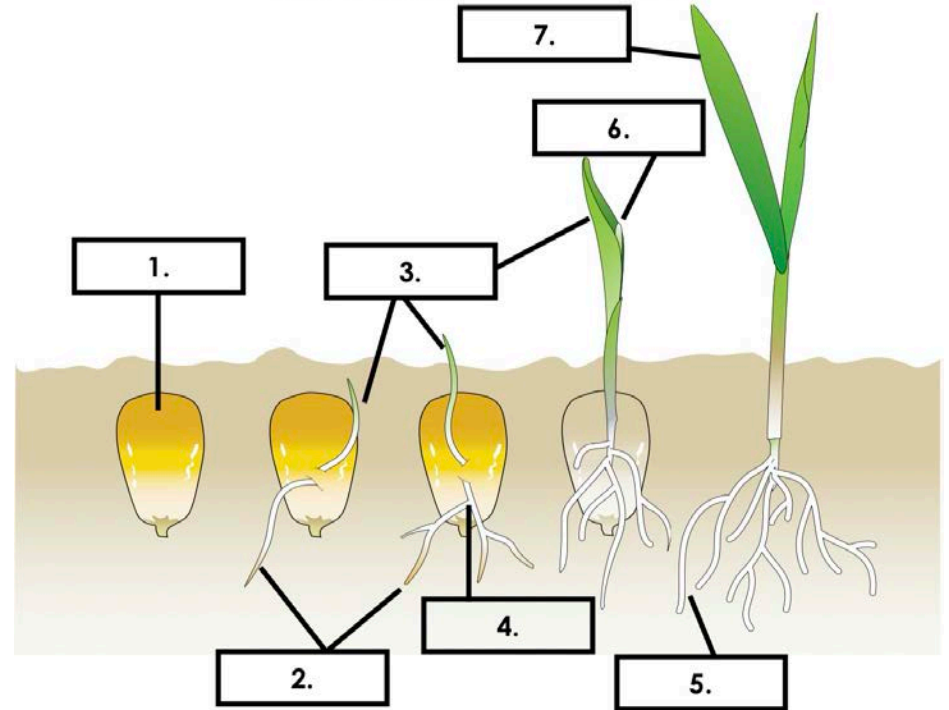


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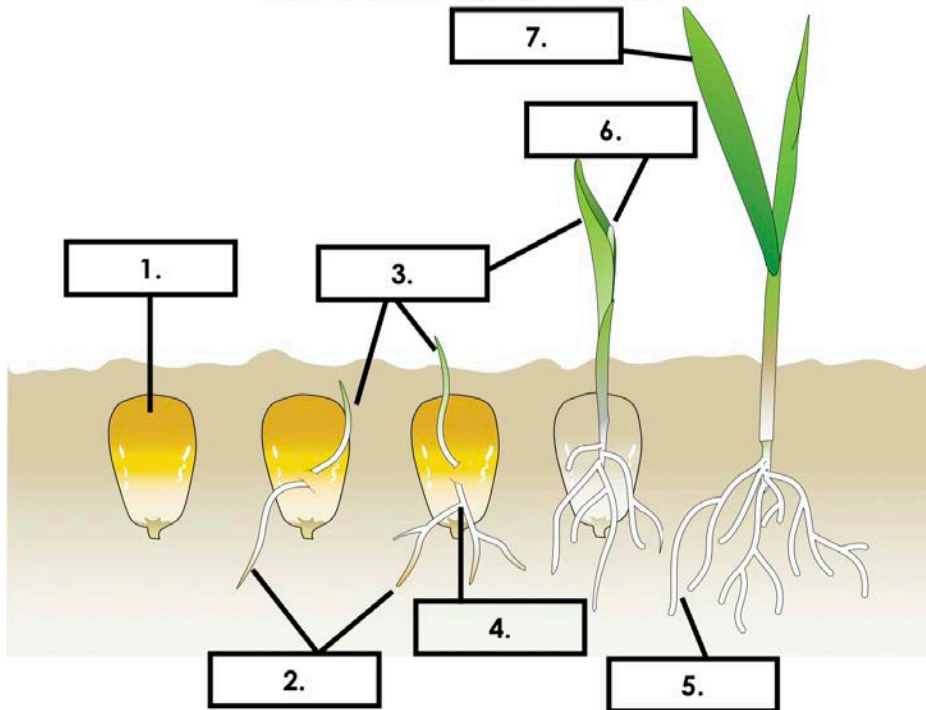
Parts of an Emerging Corn Plant



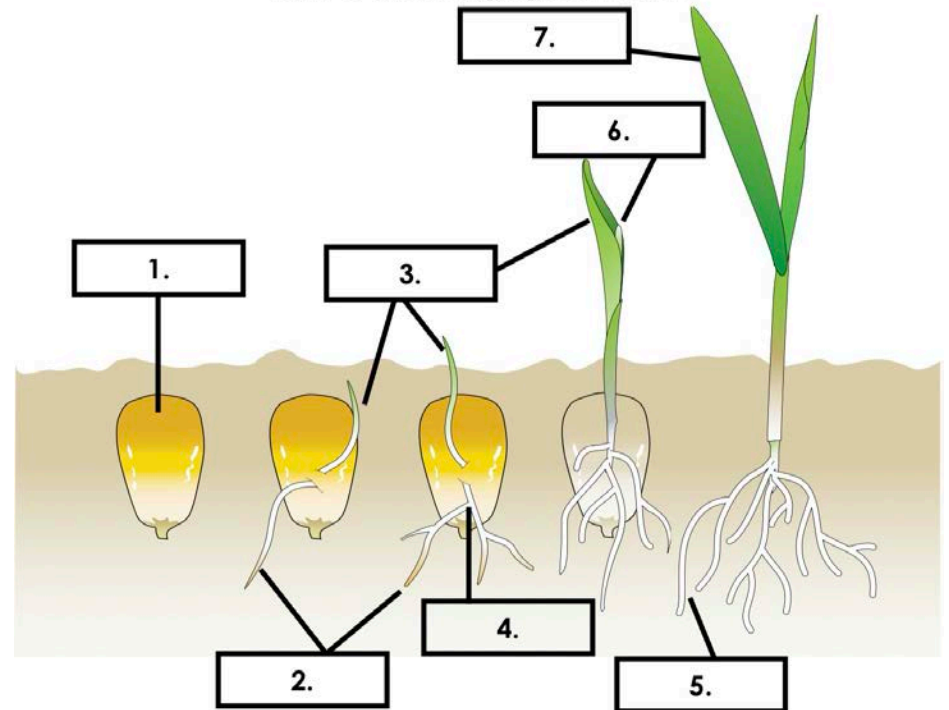
Parts of an Emerging Corn Plant

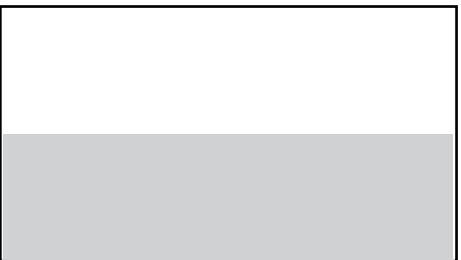
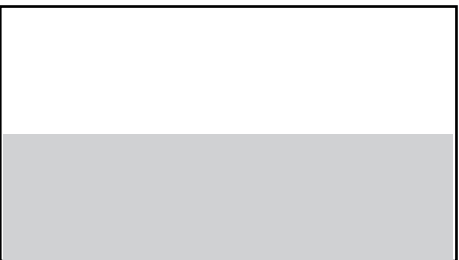
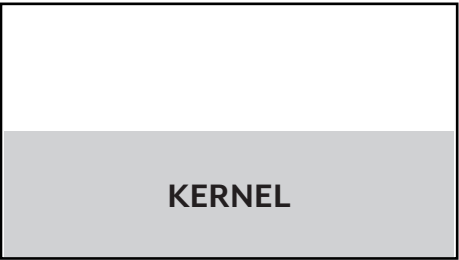
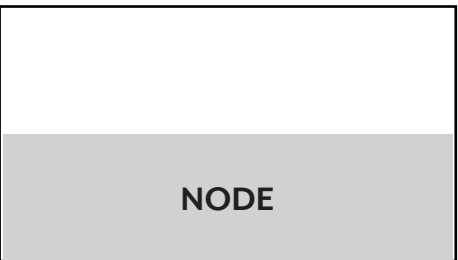
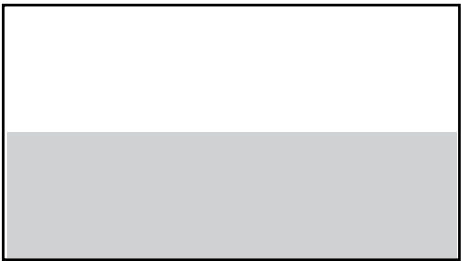
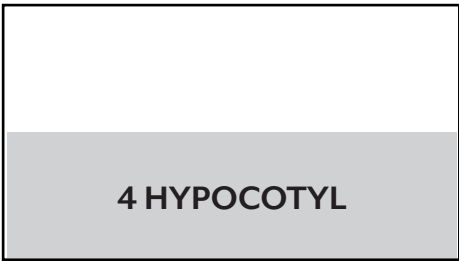
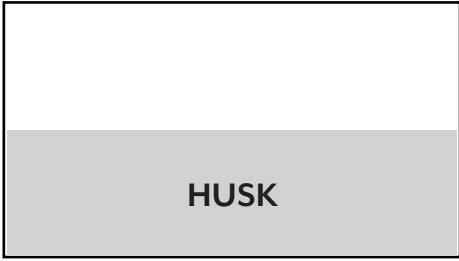
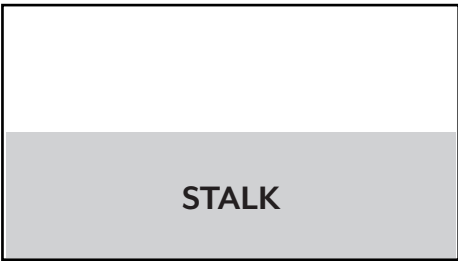
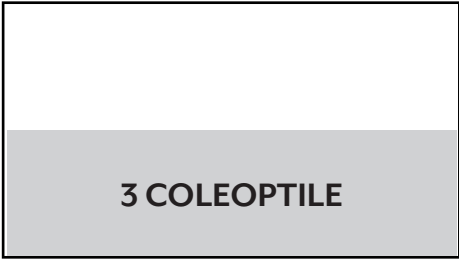
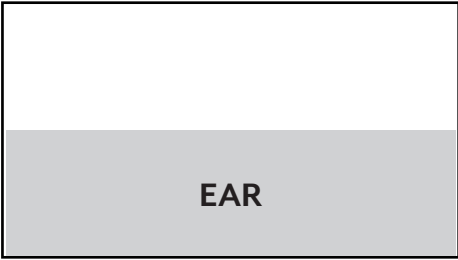
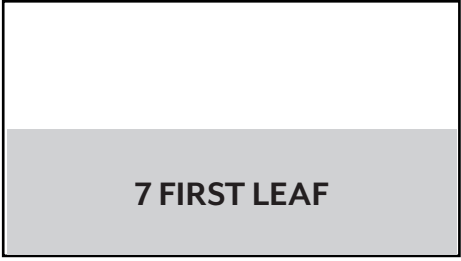
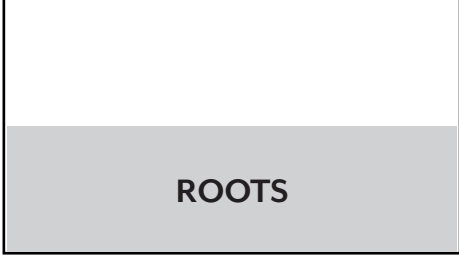
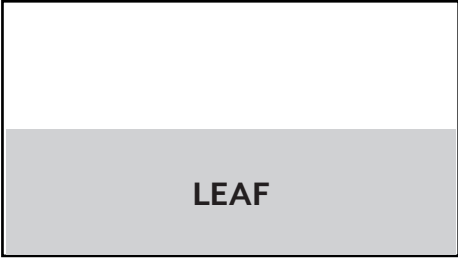
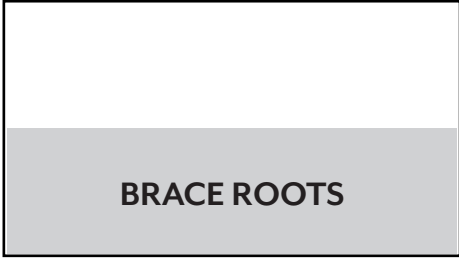
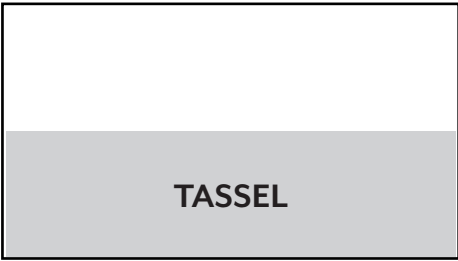


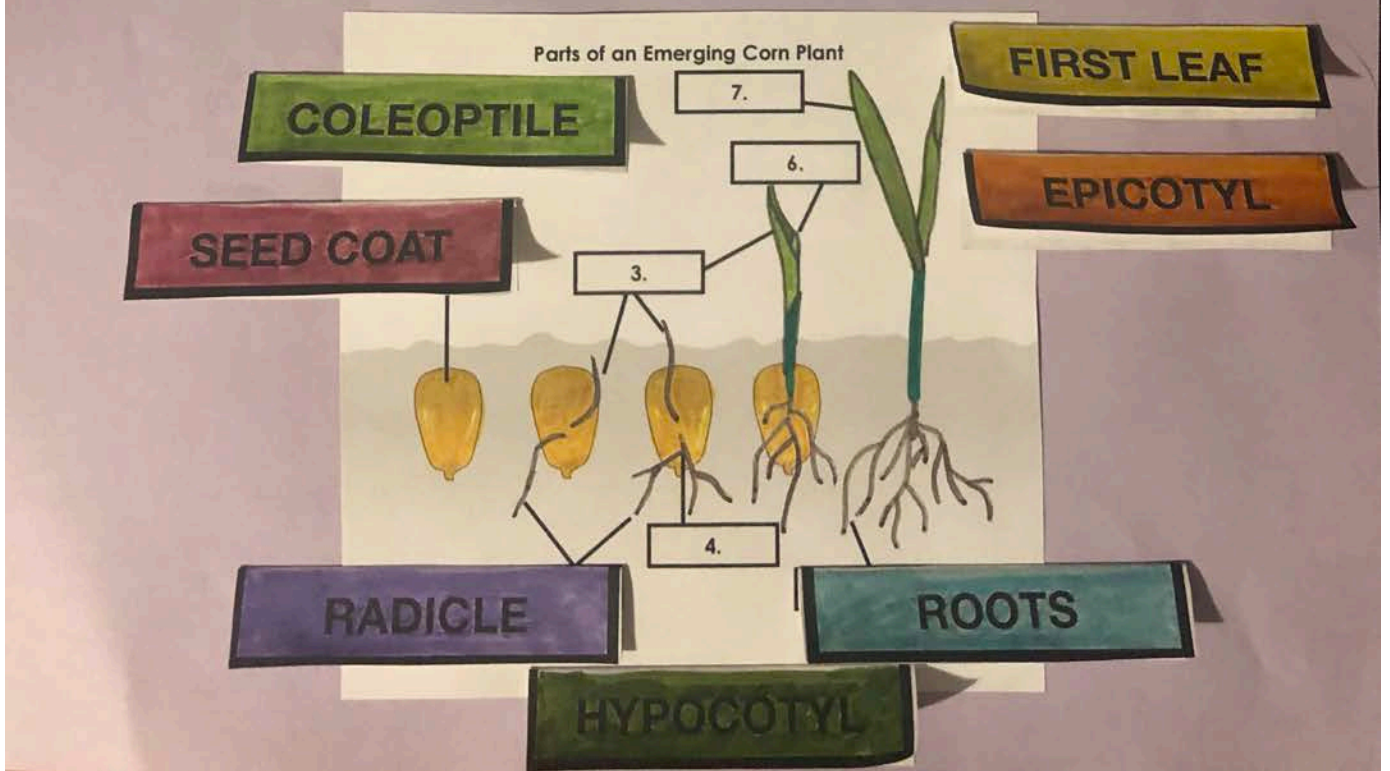
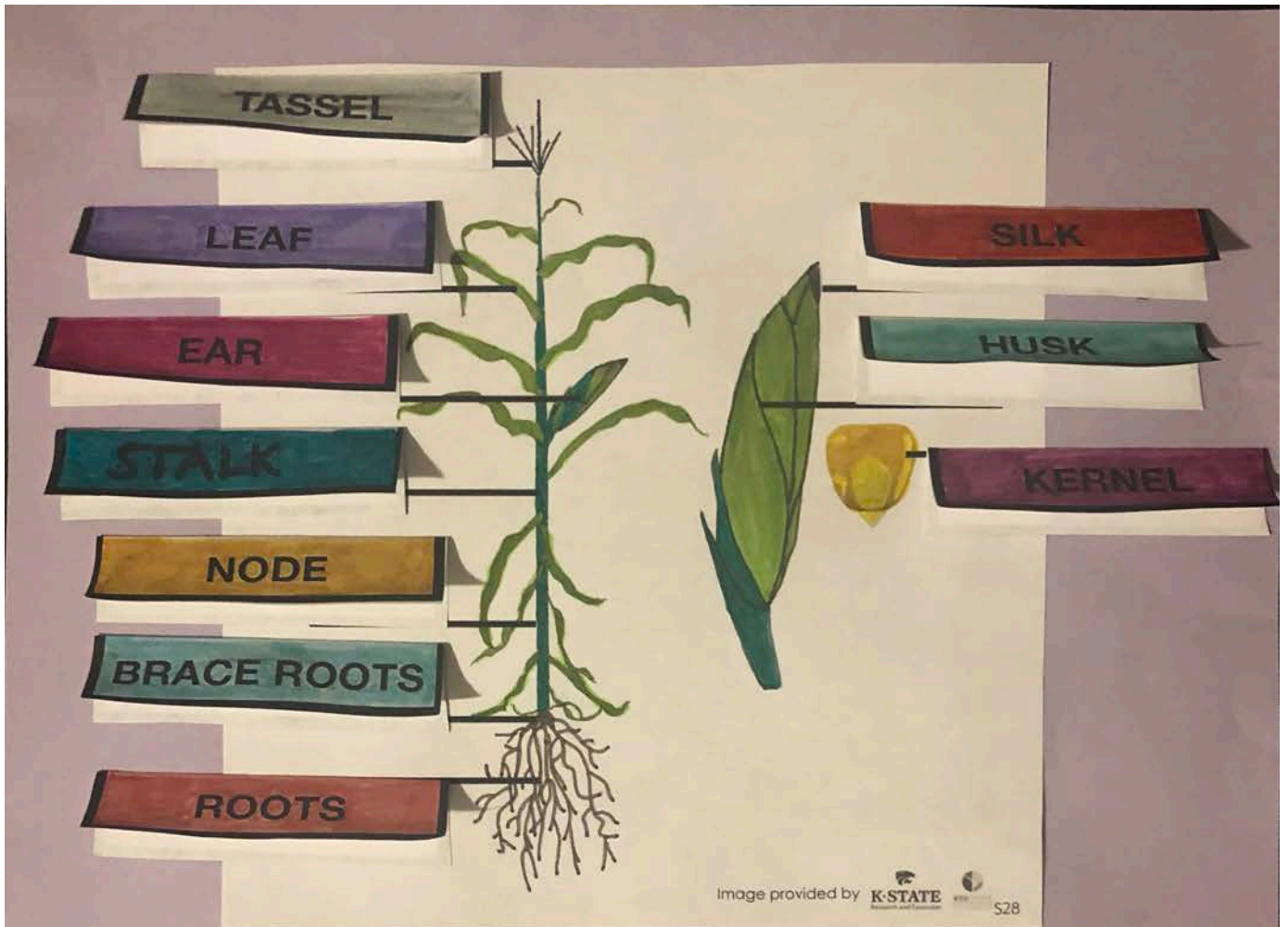
Parts of an Emerging Corn Plant



Parts of an Emerging Corn Plant







Corn Kernel Math with Ear of Corn Dissection

Directions: In this assignment, you will explore multiple ears of corn. From them, you will count the number of rows and kernels found on each ear of corn. You will then use the average mass of a kernel to determine how many kernels are in a container - without having to count every single one! Lastly, you will then find out how many kernels of corn are in a bushel. The weight of a bushel of corn can be found on the internet or somewhere on these pages.

Part 1: Explore an Ear of Corn

- You have multiple ears of corn at your station.
- For each ear of corn, **count the number of rows** and record them below:

Ear 1: _____

Ear 3: _____

Ear 5: _____

Ear 2: _____

Ear 4: _____

Ear 6: _____

a. Do they have the same number of rows? _____

b. Is it an even or an odd number of rows? _____

1 lb = 453.592 g

- Find the **total number of kernels** in each ear of corn by doing the following calculation: **count how many kernels are in one row and then multiply by the number of rows**. Show your work in the spaces provided.

Ear 1:	Ear 4:
Ear 2:	Ear 5:
Ear 3:	Ear 6:

- Find the **average number of kernels** for an ear of corn – this will be called **Multiplied Kernels**:

$$\text{average number of kernels} = \frac{\text{Total \# of Kernels}}{\text{\# of Ears of Corn}} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

- Then, actually **count the total number of kernels** on the ear of corn – this will be called **Actual Kernels**:

$$\text{actual average number of kernels} = \frac{\text{Actual \# of Kernels}}{\text{\# of Ears of Corn}} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

- Determine the **percent error** between **Multiplied Kernels (from #4)** and **Actual Kernels (from #5)**.

$$\% \text{ Error} = \frac{(\text{Actual \# of Kernels}) - (\text{\# of Multiplied Kernels})}{(\text{Actual \# of Kernels})} \times 100\% = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

Part 2: How Many Kernels are in a Container?

- Your teacher has a container filled with corn kernels. You and your group are to **determine how many kernels are in the container without counting**. You will be using mass to determine the number of kernels.
- Your teacher has the **mass of the empty container**. Find the **total mass of the kernels and the container** by placing it on a scale. Use this mass and subtract out the mass of the empty container to find the **mass of the kernels inside the container**. Show your work inside the table.

Mass of Kernels and Container	Mass of Empty Container	Total Mass of Kernels in Container

- Determine **how many kernels of corn are in the container** by finding the **average mass of a corn kernel** and dividing that average kernel mass into the **total mass of the kernels in the container**.
 - Find the **total mass of each number of the kernel(s)** – 1, 5, 10, 20 and 50 kernels. 56 lbs
 - Calculate the **average mass of a kernel for each set** = $\frac{\text{Total mass of Kernels}}{\# \text{ of Kernels}}$
 - Take the **average mass of the kernel found in 10(b)** and divide it into the **Total Mass of the Kernels in the Container** $\frac{\text{Total mass of kernels in container}}{\text{Average mass of a kernel}}$ this equals the **number of kernels in the container**.
 - Get the **actual number of kernels in the container** from your teacher.
 - Calculate the **percent error** for each kernel number $\frac{(\text{Actual \# of Kernels}) - (\text{Exp \# of Kernels})}{(\text{Actual \# of Kernels})} \times 100\%$

# of Kernels	1	5	10	20	50
Total Mass of Kernel(s)					
Average Mass per Kernel					
Total Mass of Kernels in Container					
Number of Kernels in Container					
Actual Number of Kernels in the Container (From Teacher)					
Percent Error					

Part 3: How Many Kernels of Corn are in a Bushel?

- Using the table above, find the **Average Mass per Kernel** that has the **smallest Percent Error**.

Place that value in the table below.

12 in. = 1 foot

2. Use the internet to find **how many grams are in a pound**.
3. Multiply the **number of grams in a pound** by the **number of pounds in a bushel**.
This is the number of **grams in a bushel**.
4. To find out how many **kernels are in a bushel**, divide the **number of grams in a bushel** by the **average mass per kernel**.

Average Mass per Kernel in grams	Grams in 1 Pound	Grams in a Bushel	Number of Kernels in a Bushel

Part 4: Estimating the Number of Corn Plants per Acre of Land (6-12th)

1. You will be estimating the number of corn plants in an acre of land based on the planting of 30-inch rows.
2. The teacher has placed multiple strips of tape down on the ground with spaced-out colored dots. These colored dots represent where a corn seed has been planted.
3. You will be counting the number of seeds for a distance of 17.5 feet. You will not be using a meter or yard stick for this distance. You will be using your feet.
4. Determine the number of inches in 17.5 feet by multiplying it by the number of inches in one foot. This conversion can be found somewhere on this paper or on the internet. Enter that number in the table below.
5. Using a ruler, determine the length of your foot in inches with your shoes on. We don't want smelly feet. Place that number in the table below.
6. Then determine how many of your feet equal 17.5 feet by dividing the Number of Inches in 17.5 Feet (#4) by the Your Foot in Inches (#5).
7. This is how many steps you will take along the taped seed row. Make sure to place one step directly in front of the other as you walk down the length of the seed row.
8. Determine the number of Corn Kernels in 17.5 Feet.
9. Calculate the number of corn seeds per acre by multiplying the Number of Corn Kernels in 17.5 Feet (#8) by 1,000.

Inches in 17.5 Feet	Your Foot in inches	How Many of Your Feet in 17.5 Feet	Number of Corn Kernels in 17.5 Feet	Number of Corn Seeds per Acre (x 1,000)

Questions

1. Which number of kernels (1, 5, 10, 20, 50) came the closest to the Actual Number of Kernels? _____
2. Which number of kernels had the highest percent error? _____
Explain why that number of kernels would give you the greatest error.

3. Using the internet, what is the average number of kernels for an ear of corn? _____
How does the average number of kernels you calculated compare to what you found?

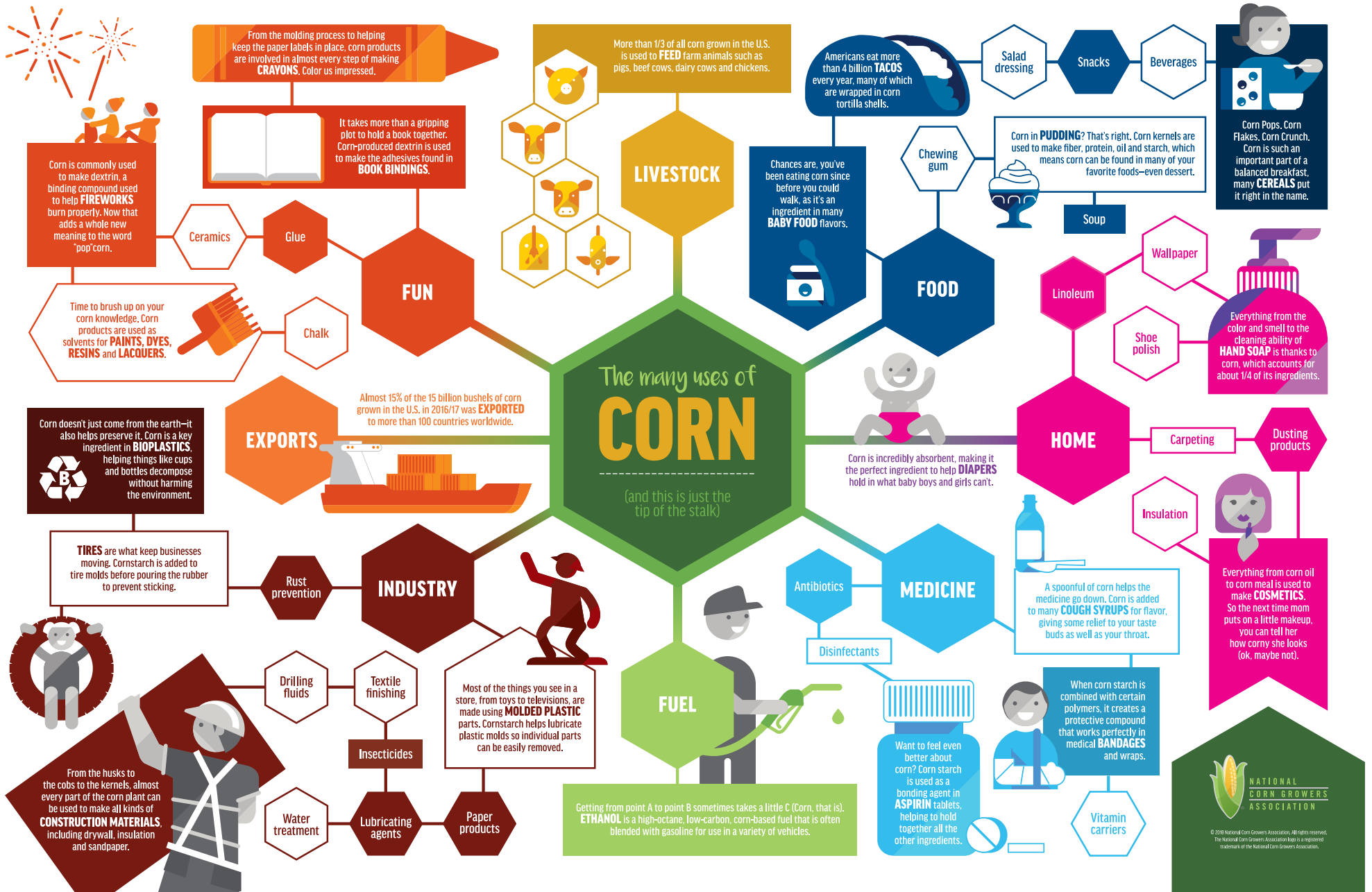
4. The average number of bushels per acre of corn in America is 176.4. How many kernels of corn are in the average American acre? Show your work below.

5. Using the number of corn plants you found in Part 4, how many kernels of corn will be in that acre? Show your work below.

6. The average human body contains 18% carbon. From that amount, the average percentage of carbon that comes from corn is 70% due to the many products that are derived from corn in our diet. We will find out how much carbon in your body comes from corn and then determine how many corn kernels you are!
 - a. How much do you or the average student weigh (in pounds): _____ lbs
 - b. Convert that into grams (remember 1 lb = 453.592 g): _____ g
 - c. Multiply your weight in grams by 0.18. This is how much carbon is in your body: _____ g
 - d. Multiply the carbon in your body by 0.70. The weight of carbon that comes from corn: _____ g
 - e. Divide the amount of carbon that comes from corn by your most accurate average mass per kernel found in Part 2 from above. This is the number of corn kernels that make up your body!

You are made up of _____ kernels of corn!

How many bushels of corn are you? _____ bushels of corn!



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Common Items Containing Corn

Toothpaste: Sorbitol is an ingredient in toothpaste derived from corn. It helps create toothpaste's flavoring and texture.

Yogurt: Uses high-fructose corn syrup as a sweetener; the cows that make the milk also eat corn in their daily meals.

Gum: Uses high fructose corn syrup and maltitol as sweeteners and sorbitol for flavoring.

Cosmetics: Blush and eye shadow often contain zeaxanthin, which is another name for corn.

Shampoo: Citric acid is a common ingredient in shampoos and conditioners and is derived from corn.

Diapers: Corn starch is used to soak up moisture in diapers.

Envelopes: Corn is used to make nitrocellulose glue, which holds envelopes closed so they can be mailed.

Corn Bread: The main ingredient is corn meal, which gives corn bread its gritty texture compared to other types of bread.

Handsoap: For many different purposes, at least 25% of the ingredients in some hand soaps contain or were derived from corn.

Windex: This glass cleaner contains at least 5 different ingredients derived from corn.

Jellybeans and Licorice: These candies not only include corn syrup of some form to give them their texture but also, powdered corn starch is used to coat their molds and allows manufacturers to more easily pop them out after they're finished being molded.

Corn Flakes: If you are someone who enjoys a hearty bowl of flakes for breakfast, you're eating the corn grit that has been steamed and flaked.

Paper, Recycled Paper and Cardboard: Industrial corn starch is used during the paper-making process.

Crayons and Chalk: Utilize industrial corn starch to get them out of their molds and corn products also help the paper labels adhere to the crayons.

Running Shoes- Currently, most shoes are made with oil-based plastics, but Reebok has announced that it will begin to make the sole of their new sustainable shoe with petroleum-free, non-toxic, industrial-grown corn.

Common Items Containing Corn

Spark Plugs: Spark plugs in your car are made from metal and ceramics. When the crystalline structures of cornstarch are heated to very high temperatures, they harden and it becomes a type of ceramic. The ceramic is able to withstand high temperatures and also withstands the corrosive properties of some specific acids.

Rubber Tires: Instead of using oil-based rubber, Goodyear and their research partner Genencor are using cornstarch to chemically bind the ingredients of its new kind of tire.

Fireworks: Some of the compounds in fireworks require a “binder” in order to burn properly. A common binder is dextrin, a light carbohydrate most commonly made from corn.

Popcorn: Popcorn is its own type of corn. There are three common types of corn; sweet corn, popcorn and field corn. The two we eat in their natural form are sweet corn and popcorn.

Pet Food: Pet food is regulated to the same level of safety as human food. Corn is used in pet food to create a balanced diet for all kinds of pets including dogs, cats and even fish.

Batteries: Corn starch is often used as an electrical conductor in batteries.

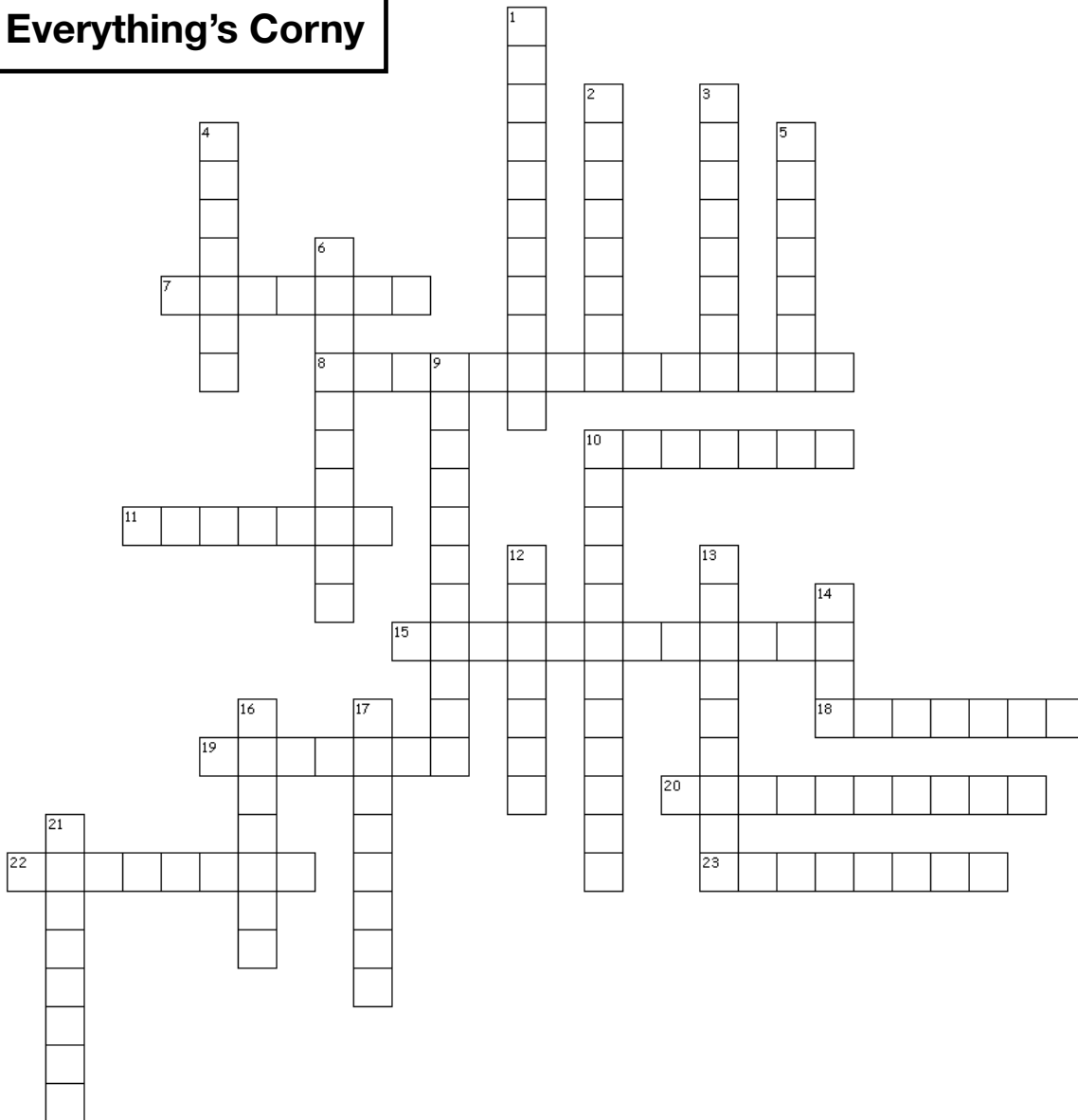
Deodorant: Uses corn starch because of its absorbent nature.

Hand Sanitizer: Contains ethanol which typically is made by fermenting corn.

Carpet and Other Textile Products: Corn-based textile products are often preferred to the petroleum based products because they are more environmentally friendly.

Plastic Products: While it’s not a widespread use like the other products, bioplastic is being used in many different products such as bags, containers and cups. Corn-based plastics are biodegradable and use up to 68% less fossil fuels during production than traditional plastics and are estimated to emit 55% less greenhouse gases.

Everything's Corny



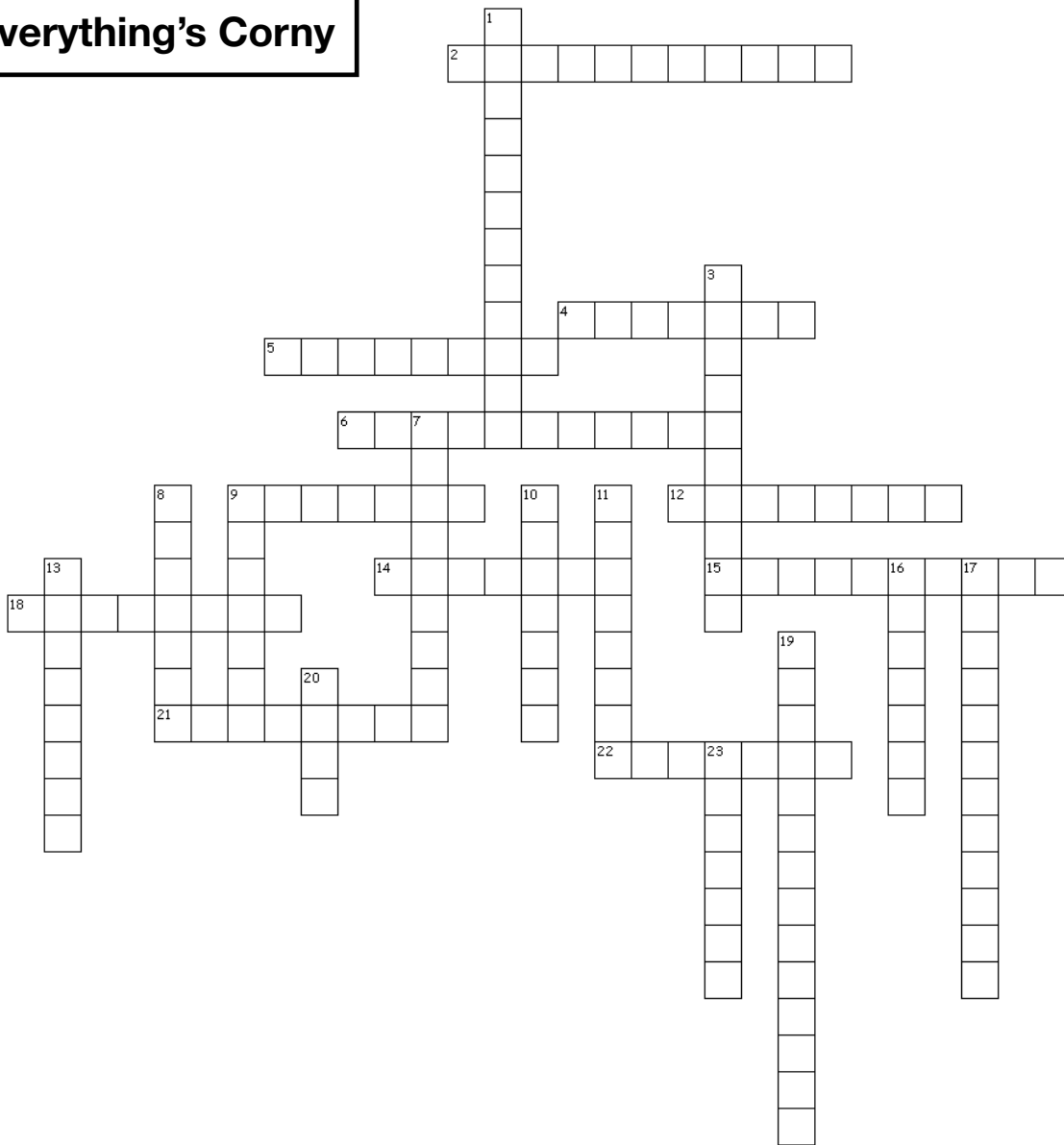
Across

7. Corn is an ingredient in these products in order to create a balanced diet for your animals
8. Corn is used to make this type of glue that seals envelopes shut
10. When crystalline cornstarch is heated to very high temperatures, it creates a _____ that is used in spark plugs
11. This type of corn is found in movie theaters and sports games
15. This type of corn syrup is used as a sweetener in many products
18. A carbohydrate used to bind the compounds in fireworks, aspirin and book pages together
19. We enjoy these corn-based products for breakfast
20. Found in shampoos and conditioners and many food products
22. More than a quarter of the ingredients come from corn to create the smell, color and cleaning ability of this product
23. Corn products are used as these in paints, dyes, resins and lacquers

Down

1. Corn is used to create these biodegradable, renewable alternatives to petroleum-based products such as utensils, cups and bottles
2. Gives corn bread that gritty texture
3. Found in toothpaste that helps with flavor and texture
4. This part of the corn plant can be used to make fiber, protein, oil and starch found in many foods
5. 15% of U.S. corn is shipped to over 100 countries around the globe
6. Absorbs moisture in diapers, thickens gravies and helps release products from industrial molds
9. Goodyear and Genencor are using corn starch as an alternative to this oil-based product
10. These types of materials are used to build homes and can contain almost every part of the corn plant
12. Made from the fermentation of corn
13. Cornstarch is used as electrical conductors in these _____
14. More than a third of all corn goes to farm animals and is called _____?
16. Blush, eye shadow and many other cosmetics use corn as an ingredient but call it by another name
17. Cornstarch and polymers are combined together to form these products with protective barriers
21. Used as a sweetener in gum

Everything's Corny



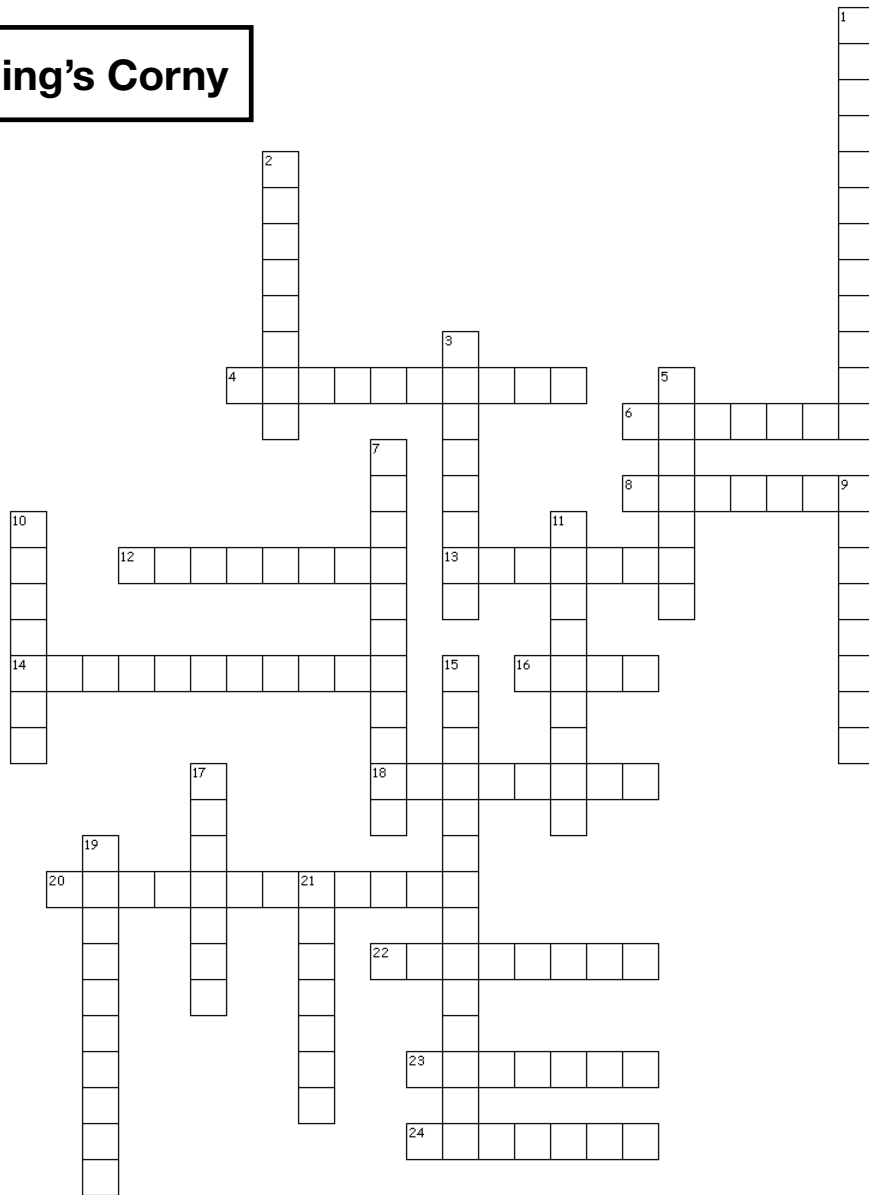
Across

2. Corn is used to create these biodegradable, renewable alternatives to petroleum-based products such as utensils, cups and bottles
4. Corn is an ingredient in these products in order to create a balanced diet for your animals
5. Used as a sweetener in gum
6. Goodyear and Genencor are using corn starch as an alternative to this oil-based product
9. 15% of U.S. corn is shipped to over 100 countries around the globe
12. Cornstarch and polymers are combined together to form these products with protective barriers
14. A carbohydrate used to bind the compounds in fireworks, aspirin and book pages together
15. Found in shampoos and conditioners and many food products
18. Gives corn bread that gritty texture
21. Corn products are used as these in paints, dyes, resins and lacquers
22. This type of corn is found in movie theaters and sports games

Down

1. This type of corn syrup is used as a sweetener in many products
3. Absorbs moisture in diapers, thickens gravies and helps release products from industrial molds
7. Cornstarch is used as electrical conductors in these
8. Blush, eye shadow and many other cosmetics use corn as an ingredient but call it by another name
9. Made from the fermentation of corn
10. This part of the corn plant can be used to make fiber, protein, oil and starch found in many foods
11. More than a quarter of the ingredients come from corn to create the smell, color and cleaning ability of this product
13. Found in toothpaste that helps with flavor and texture
16. We enjoy these corn-based products for breakfast
17. These types of materials are used to build homes and can contain almost every part of the corn plant
19. Corn is used to make this type of glue that seals envelopes shut
20. More than a third of all corn goes to farm animals and is called _____?
23. When crystalline cornstarch is heated to very high temperatures, it creates a _____ that is used in spark plugs

Everything's Corny



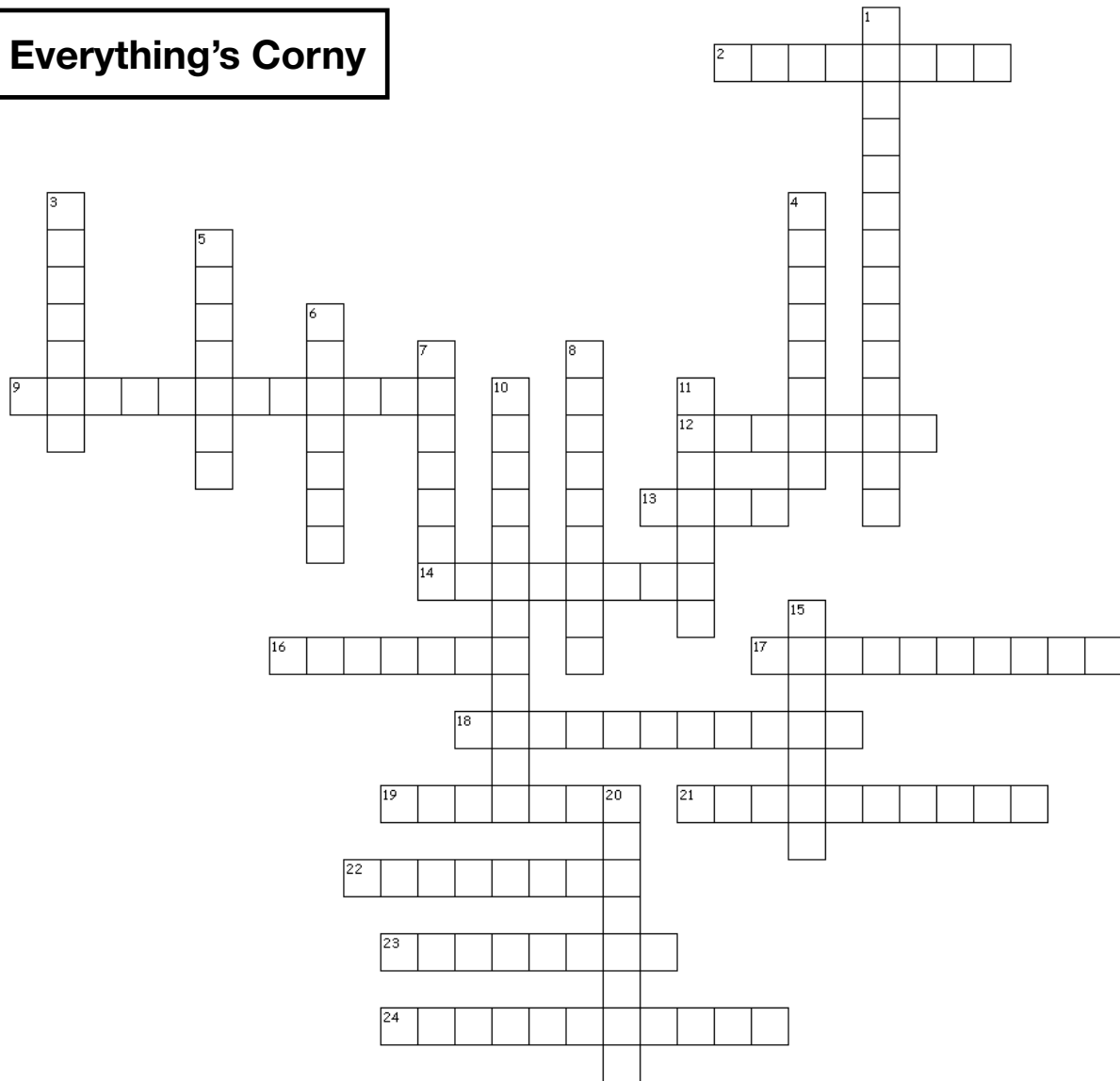
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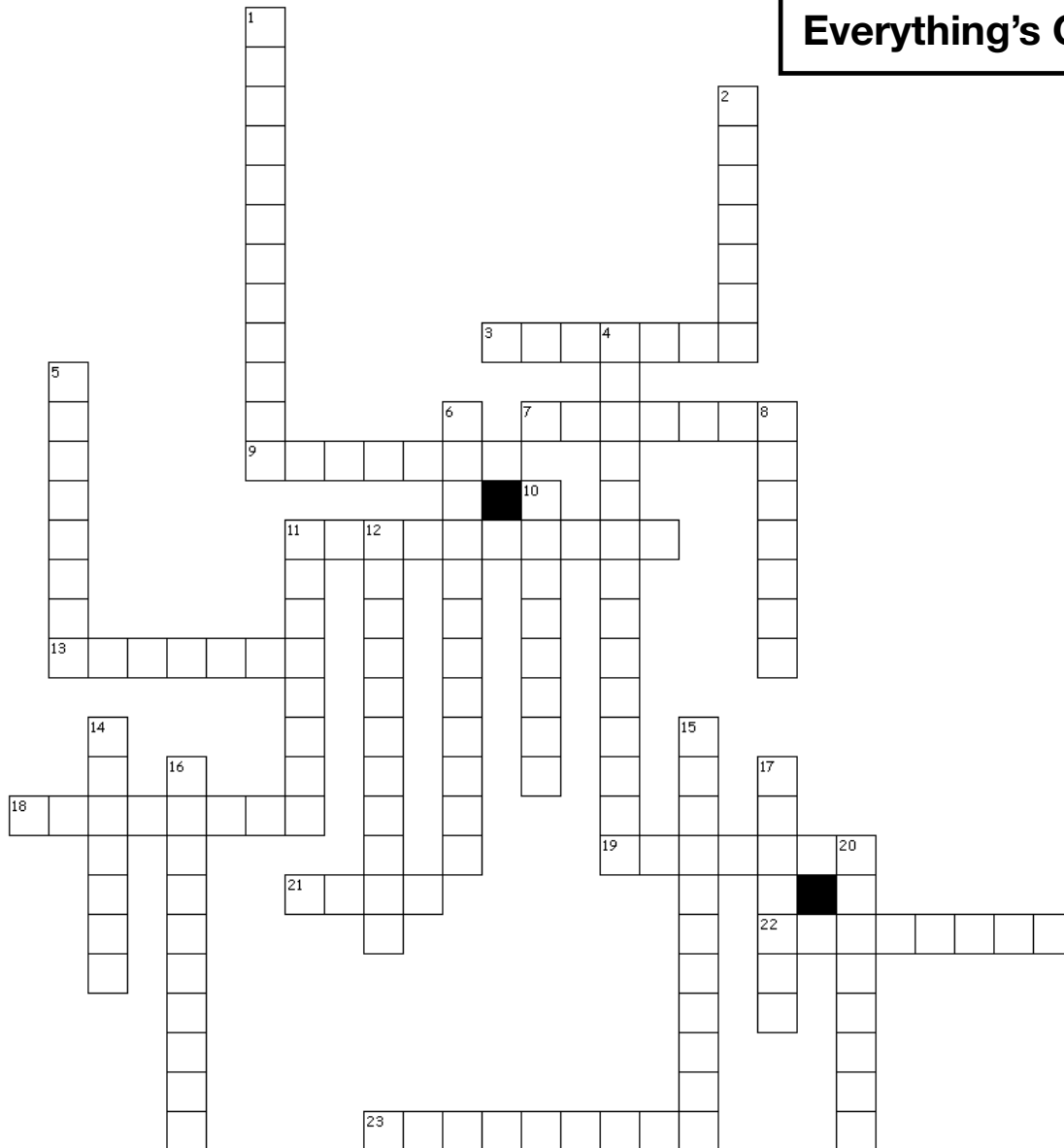
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Name: _____

Period: _____

Date: _____

Corn Graphs and Maths - World of Corn 2020

Directions: Students will use National Corn Growers Association's *World of Corn 2020* infographic to answer the following questions. This assignment is to help students find and interpret data from tables and graphs. Useful formulas can be found on the last page. Be sure to show your work in the spaces provided.

1. What is the percent increase in the number of **bushels per acre harvested** from 1929 to 2019?
2. What is the percent increase in the number of **acres harvested** from 2018 to 2019?
3. Out of **All U.S. Crop Acres Harvested**, what percentage was **corn (grain)** in 2019?
4. Based on the **Components of Yellow Dent Corn**, what percentage of the kernel is **starch**?
5. What is the **fat (oil) to protein to carbohydrate (starch)** ratio of **yellow dent corn**?
6. What is the percentage of **corn acres harvested** out of **corn acres planted**?
7. Using the number of **corn bushels produced** and the **corn crop value** in 2019, determine the **average price per bushel**.

8. Using the **nutritional label** (located on last page) from a 12-ounce can of Coca-Cola (www.coca-colaproductsfacts.com), how many cans of Coca-Cola can be made from **1 bushel of corn** when the amount of added sugars is **high fructose corn syrup**? Use 453.592 grams = 1 pound
9. In 2019, which **state** had the highest **average yield in bushels/acre**? Which **state** had the largest **total production** of corn?
- a. Highest average yield: _____ bushels/acre State: _____
- b. Largest total production: _____ 1,000 bushels State: _____
10. Which year saw the **highest price per bushel of corn**? Year: _____ Price: _____
11. What is the **Total World Corn Production** from 2019-2020 in millions of bushels? _____
12. Using the number of **bushels produced from 2019-2020**, what percentage of U.S. corn production is **exported** to other countries?
13. Looking at the **U.S. Corn Exports from 1999-2019**, why was **2012** the lowest year for corn exports?
14. Looking at the **Corn Processed by Segment 1999 – 2019**, what is the difference in millions of bushels in **Feed & Residual** between the highest processed year and the lowest processed year?
- Highest Year: _____, millions of bushels _____
- Lowest Year: _____, millions of bushels _____
- Difference: _____ millions of bushels
15. Looking at the **Corn Usage by Segment 2019** dot graph, determine how many **millions of bushels each dot represents**. Hint: make this easy on yourself. Look at a segment that has a nice whole number or percentage, like **sweeteners**.

16. Looking at **High-Fructose Corn Syrup Usage 1989 – 2019**, we see that peak usage was in 1999 and has slowly lowered each year to 2019. What is the **average decrease in HFCS usage**, in millions of bushels per year, in the 12 years between 1999 and 2019?
17. Looking at the **Sweetener Usage 1989 – 2019**, we see that the lowest level of usage was in 1989. If the use of sweeteners **increased at an average of 11.214 million bushels per year** for fourteen years, how many bushels of corn were used as sweeteners in 2019?
18. What percentage of **U.S. ethanol production** comes from **Iowa**?
19. What percentage of **U.S. ethanol production** comes from **Kansas**?
20. What percentage of planted **Biotech Corn Acreage in 2019** has **stacked traits**?

*****2 Question Bonus***Use the Corn Fed by Species 2006 – 2019 graph.**

Conversion factors: 56 pounds = 1 bushel 2204.62 pounds = 1 metric ton

21. Determine how much **grain, in pounds**, an average chicken consumes over its life if there were **9.2 billion chickens** in 2019.
22. Determine how much **grain, in pounds**, an average cow consumes over its life if there were **39 million cows** in 2019.

Helpful Mathematical Formulas

- $Percent\ Increase = \frac{End\ Value - Starting\ Value}{Starting\ Value} \times 100\%$

- $Percent = \frac{Individual\ Value}{Total\ Value} \times 100\%$

- Ratios: Find the smallest value and divide that number into the other numbers. It is OK to have final values with decimals.

Example $\rightarrow 4.5\ red : 18\ blue : 9\ green = \frac{4.5}{4.5}\ red : \frac{18}{4.5}\ blue : \frac{9}{4.5}\ green = 1\ red : 4\ blue : 2\ green$

- Conversions: Use conversion factors and dimensional analysis to find your answer.

12 inches = 1 foot 2.54 centimeters = 1 inch

- Example Question: How many inches are in 3.65 feet?

$$3.65\ feet \times \frac{12\ inches}{1\ foot} = 43.8\ inches$$

- Example Question: How many centimeters are in 3.65 feet?

$$3.65\ feet \times \frac{12\ inches}{1\ foot} \times \frac{2.54\ centimeters}{1\ inch} = 111\ centimeters$$

Nutrition Facts	
1 Serving Per Container	
Serving Size	1 Can
Amount Per Serving	
Calories	140
	% Daily Value
Total Fat 0g	0%
Sodium 45mg	2%
Total Carbohydrate	14%
39g	
Total Sugars 39g	
Includes 39g Added Sugars	78%
Cholesterol 0mg	0%
Protein 0g	
Vitamin D	0%
Calcium	0%
Iron	0%
Potassium	0%
Not a significant source of saturated fat, trans fat, cholesterol, dietary fiber, vitamin D, calcium, iron and potassium.	

Leaf Collar Method Student Worksheet

Name: _____

Group: _____

What can the corn plant tell the farmer?

Background:

Vegetative (V) stages are determined by the total number of leaves with visible collars (e.g., a plant with three visible leaf collars is at V3). A collar is the off white band at the base of the leaf blade where it extends away from the stalk. A new leaf appears every three to four days with good growing conditions until tasseling. As the plant grows, lower leaves are lost. These leaves must be counted; otherwise, the development stage will be misidentified. Split stalks to accurately determine the leaf stage. Each leaf is attached to a single node, and nodes are visible as lines across the split stalk. The first four nodes are usually indistinguishable within the crown. The 5th node is about 1/2 inch above the area that contains the first nodes. The node corresponding with the uppermost leaf, with a visible collar, defines the vegetative stage. This knowledge is important because it helps the farmer determine any inputs that might be necessary to add to his crop, as well as the crop's potential yield. Corn needs little fertilizer boost until V5, but requires a large nitrogen intake to promote yield from V8 until VT (tasseling). It is important to side dress (inject between corn rows) nitrogen before the V8 stage. This allows the plant to maximize its photosynthetic potential. Ear length is determined between the V12 and VT vegetative stages. Tassel emergence occurs from V17 to V22, depending upon the corn variety.

Procedure for Lesson:

1. Use a knife and cutting board to carefully split the stalk of a corn plant in half, vertically, down to the roots.
2. Remembering that the first four nodes are often indistinguishable within the crown, count the number of nodes to determine the vegetative stage that the corn plant is in.
3. Compare the nodes counted within the stalk to the number of leaf collars found on the outside of the plant.

Reflection

1. Why is it necessary to split the stalk to accurately determine what vegetative stage the corn plant is in?
2. How do the internal nodes compare to the external leaf collars found in/on the plant?
3. How can determining the vegetative stage of the corn plant help the farmer determine when to input fertilizers and predict the ear length?