

Bits and Bites

for learning about pulse nutrition,
cells and body systems

PULSE *café*



Student activities for
Alberta Junior High Science
Cells and Systems

Welcome to the **PULSE Café**! Enjoyed by many cultures around the world for thousands of years, pulses are an affordable, nutritious and versatile food. We hope that the **PULSE Café** will encourage students to explore the nutrition, food and farming of this adaptable crop.

Alberta farmers are proud to grow pulses like dry beans, dry peas, lentils and chickpeas because they are good for the farm, for food and for you!

Did you know that the word “pulse” comes from the Latin word *puls* which means thick soup? Easy to prepare in a variety of dishes like hummus, chili, black bean brownies or split pea soup, pulses are high in protein and fibre and low in fat, making them the perfect fit for a balanced diet and busy lifestyle.

Alberta Pulse Growers represents the 6 500 farmers who grow pulses in Alberta. We are proud to support education and provide the **PULSE Café** resources for teachers and students in junior high Science programs.

FIND Alberta Pulse Growers

 www.albertapulse.com/eating-pulses/

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Pulse plant cells have unique characteristics.

inside a pulse

The terms “pulses,” “legumes” and “beans” are often used interchangeably. However, they refer to different plants and plant parts.

A **legume** refers to any plant from the *Fabaceae* family and includes its leaves, stems and pods. A **pulse** is the dry edible seed from a legume plant. Pulses include dried peas, lentils, beans and chickpeas.

For example, a pea pod and the fresh peas inside it are legumes. A pea is considered to be a pulse when it’s dry. The entire legume plant is what you see in a crop field – and the entire plant can be used as a cover crop or as feed for livestock. **Cover crops** are grown for the soil rather than for harvest. Cover crops add nutrients and protect the soil. The seeds – or the pulses – are what end up in our food.

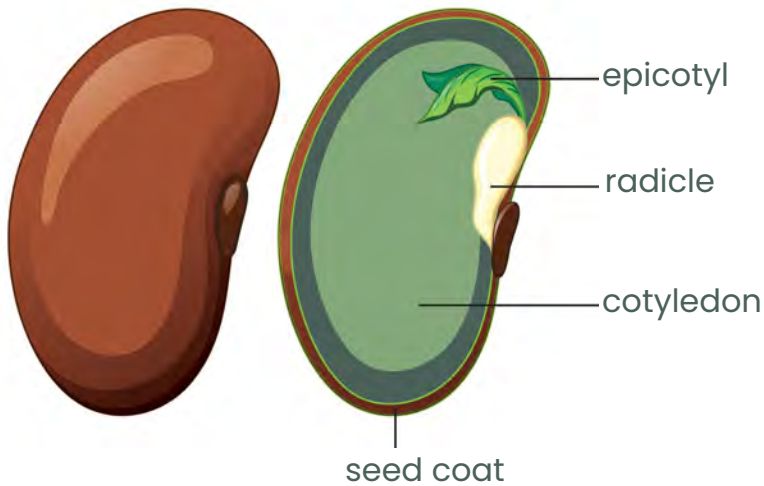
Beans are one type of pulse. However, there are many types of beans.

Dry beans include Great Northern, Pinto, Cranberry, Pink, Small Red, Yellow, Black Shiny and Black Matte. Pinto and Great Northern beans make up the majority of beans grown in Alberta.

The pulses that we eat are seeds that contain the embryo of a future plant.



parts of a seed



The future roots and leaves of the plant are in the seed.

A small, white root-like structure sticking out from one side of the bean – called the **radicle** – is the future root of the plant. The seed leaf – called the **cotyledons** – are not yet photosynthetic. They are filled with stored starches, fats and proteins to supply energy to the developing embryo. The **epicotyl** is the region above the cotyledon. It pushes the plant above the soil.

Later, once the embryo has used the food stored in the cotyledon, the plant will begin to make its own food through photosynthesis.



TRY THIS

Select a dry bean such as a Pinto, Great Northern or Black bean. Cover some of the beans with water and let them soak for 12 to 24 hours.

Use a ratio of 3 to 1 for the water to dry beans. For example, use 3 cups water for every 1 cup of dry beans.

Set aside some of the dry beans to make later comparisons.

1. Take the beans out of the water and compare them to the dry beans. What do you notice?
2. Remove the soft outer coating of the soaked beans. Break the inside of the bean in half lengthwise and use a magnifying glass or microscope to look closely at the shapes, colours and structures inside. Record your observations.

How does this lab illustrate the movement of water into the dry beans?



gallery of Alberta pulses



Green field peas are small and round and have a sweet flavour. They do not need to be soaked before cooking.



Yellow peas are small and round. They have a mild flavour and do not need to be soaked before cooking.



Whole red lentils have a sweet and nutty flavour and do not need to be soaked before cooking.



Red split lentils change colour and lose their shape the longer they are cooked. They do not need to be soaked before cooking.



Green lentils have a peppery flavour and hold their shape when cooked. They do not need to be soaked before cooking.



Black beans have a nut-like flavour. They are small and shiny and have a white centre.



Great Northern beans are a medium-sized white bean and have a mild nutty flavour.



Pinto beans have reddish brown speckles of colour. They turn pink when they are cooked. The word *pinto* means painted in Spanish.



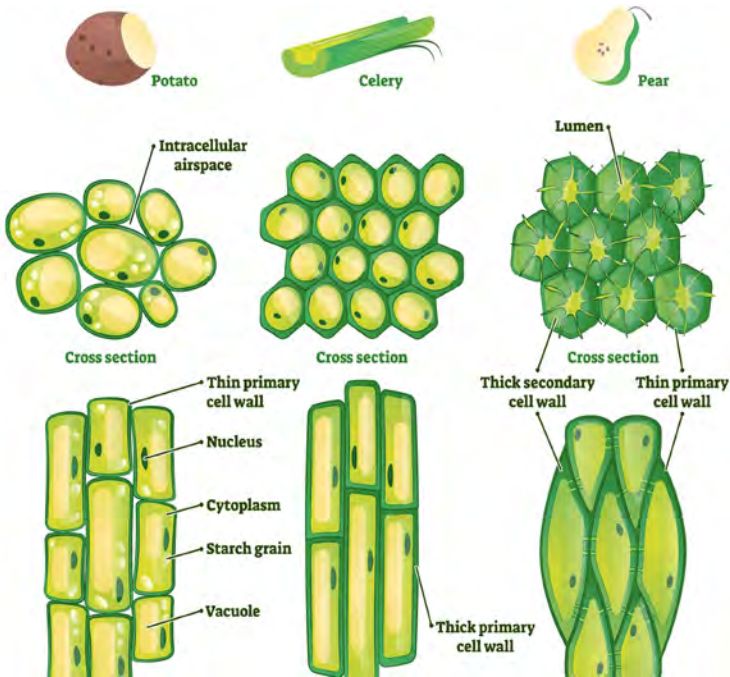
Kabuli chickpeas are large and beige coloured, with a thin skin. They have a nutty flavour and are also known as **Garbanzo beans**.



Faba beans are also known as **Fava beans** or **broad beans**. They are large, flat beans with a light green and beige colour.

types of plant tissue

parenchyma tissue collenchyma tissue sclerenchyma tissue



structures and functions

Cells are the basic units of all plants and animals. Different types of cells have different functions. These cells can look very different under a microscope.

The cells that plants use to grow are called **meristematic** cells. When these cells divide, they can produce any type of cells.

Parenchyma cells do the work in the plant. These cells perform most of the photosynthesis, but also store and transport nutrients.

Collenchyma cells can do some photosynthesis and storage, but they provide most of the structure of the plant.

Sclerenchyma cells have thickened cell walls compared to other types of cells. However, these cells are dead and found in the parts of the plant that are no longer growing. They contain lots of cellulose. The sclereids make up the coating of seeds.

Cells do not function individually. They clump together to form tissues. **Plant tissue** is a collection of cells that are close or grouped together. Each plant tissue has specific functions.

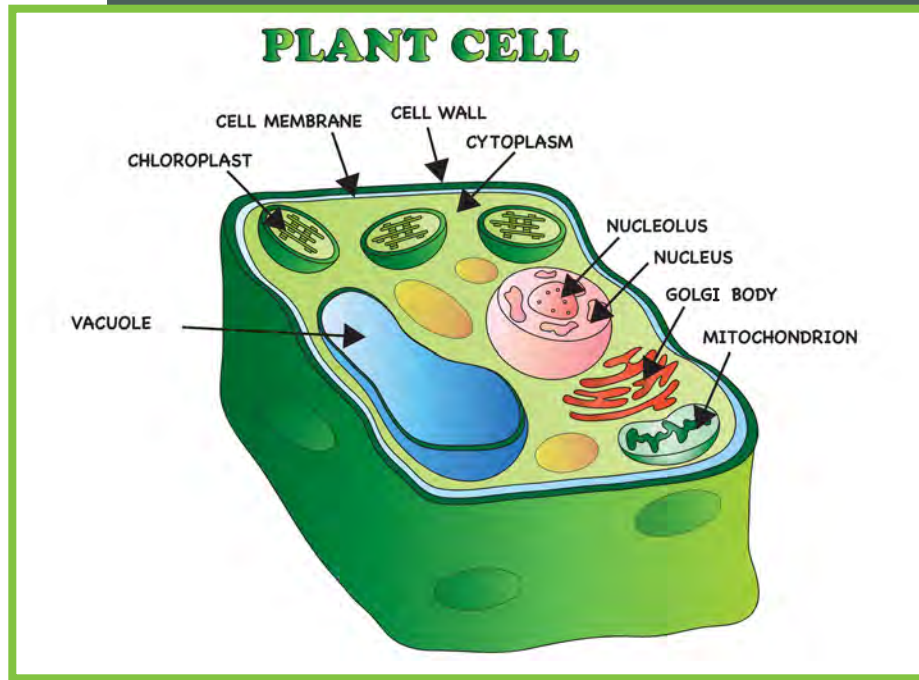
The seed coat of a dry pea seed consists mainly of parenchyma cells with an outer layer of sclerenchyma. Do you think other pulse seeds have similar types of cells? Why do you think this?

If you have the opportunity, check this out under a microscope!



The structures found in pulse cells provide the protein, carbohydrates and fibre that we may associate with eating foods made with pulses like dry peas and beans, chickpeas or lentils.

All plant cells – including the cells that make up pulses – have similar characteristics. They have a cell wall, a cell membrane and structures inside them called **organelles**. Like different types of cells, different organelles have specific functions.



<i>Organelle</i>	<i>Structure of the Organelle</i>	<i>Functions/Organelle's Job</i>
Cytoplasm	Jelly-like structure inside the cell and enclosed by the cell membrane	Gives support to the organelles within it
Chloroplast	Green structure that is oval in shape and contains chlorophyll	Converts light energy into chemical energy for the plant
Vacuole	A large, round sac that is filled with fluid	Stores water, food or waste materials for the plant cell and helps to maintain a rigid shape
Cell membrane	A porous, thin tissue that forms the outer surface of the cytoplasm	Regulates the passage of materials in and out of the cell and helps protect and give the cell structure
Nucleus	An oval shaped structure that is enclosed in a membrane	Controls the genetic material that is responsible for controlling the activities of the cell
Cell wall	Made of cellulose that forms a rigid structure	Provides protection and structure for the cell and allows substances like water, oxygen and carbon dioxide to move through
Mitochondrion	Shaped like a bean or peanut and contains internal membranes	Breaks down sugars to release energy that is used by the cell, often called the powerhouse of the cell
Golgi body	Shaped like a stack of flat pouches with small sacs	Collects and distributes proteins and lipids, often called the shipping and receiving department of the cell



TRY THIS

Work with your class to discuss how to prepare a thin slice of onion skin and a thin slice of the soaked bean seed coat.

Go through the process of preparing a wet mount slide for each.

- Can you identify the cell wall and cell membrane?
- Can you identify the type of cells in each?
- What similarities and differences can you observe?



TRY THIS

Revisit what you have learned about osmosis and diffusion in plants. Watch the video from the Ontario Science Centre at <https://youtu.be/09q96-CguZ0>.

The **nucleus** contains the cell's hereditary information and controls the cell's growth and reproduction.

The **cell membrane** helps to separate the inside of the cell from what is outside it.

The cell membrane allows certain substances to enter and leave a cell. At the same time, it prevents harmful material from entering and essential material from leaving.

Cells are **semipermeable**. This means they allow some substances through the cell wall or membrane and keep other substances out. The cell wall is a barrier that the membrane presses against. This barrier keeps the structure of the cell rigid.

What role does the semipermeable cell wall and membrane play in osmosis and diffusion? Revisit your understandings of these two concepts in your response.



The cellular structure of a pulse seed affects the nutrients it provides.

why pulses provide nutrients

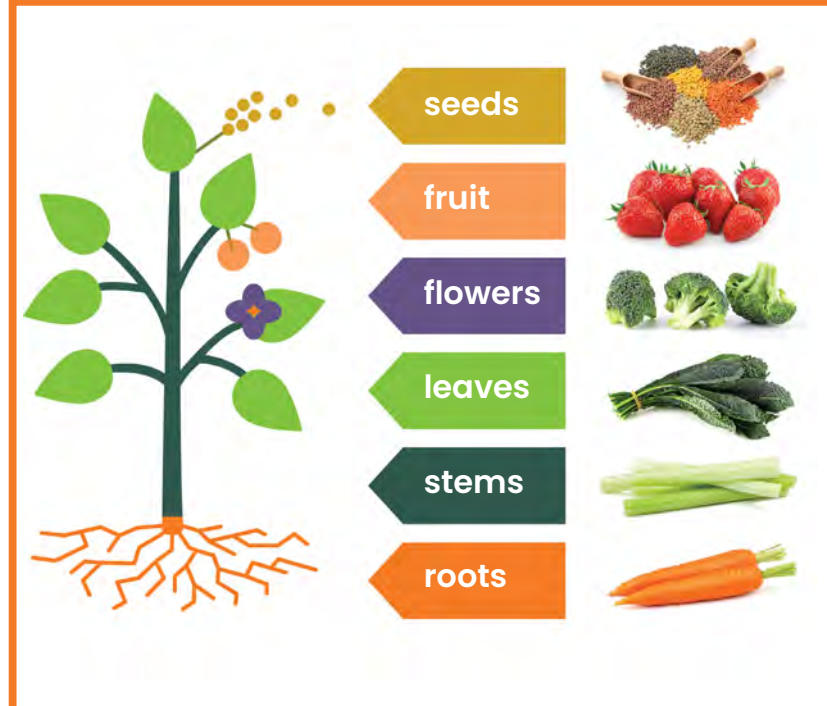
Plants – vegetables, fruits, cereals, legumes and pulses, seeds and nuts – are an essential part of the human diet. They provide a food source that is rich in a wide variety of nutrients, vitamins and minerals.

Human body systems need various plant parts to support our growth and health. The plant parts we depend upon include:

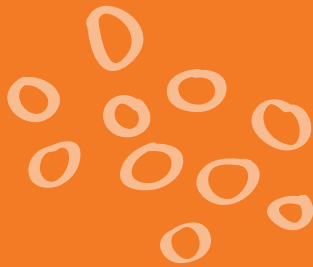
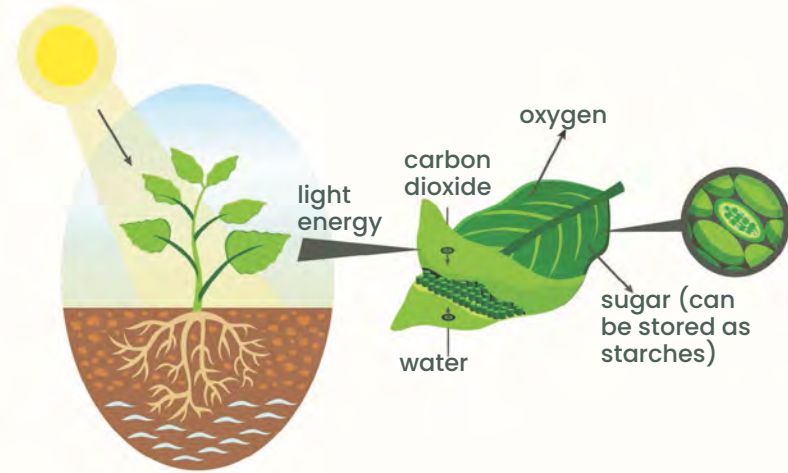
- Stems
- Leaves
- Flowers
- Tubers or Roots
- Fruit
- Seeds

Plants provide essential **nutrients** – carbohydrates, proteins and lipids, or fats – as well as vitamins and minerals and dietary fibres.

The nutrient composition varies between the different plant parts. This is influenced by the different roles each part plays in both the developing and full-grown plant.



inside a plant cell



For example, roots – like carrots – store energy while ensuring that water and minerals are drawn from the soil. This energy is often in the form of **carbohydrates**.

Inside a plant, excess **sugar** is stored as **starch**. Starches are present in many foods we eat and turned into energy or stored as fat and **glycogen** – the stored form of glucose – by the human body. The plant uses these starches as stored food sources.

Seeds – including pulses – are packed with nutrients – carbohydrates, fats and proteins – that are used to sustain the development of shoots and then the entire plant as it grows. These nutrients are also present in foods consumed and required by the human body.

The pulses that we eat are seeds that contain the embryo of a future plant. The future roots and leaves of the plant are in the seed.

What is a nutrient? Use examples from any pulses that are part of your diet to construct a definition and explain the role that cells play in providing nutrients to the human body.





TRY THIS

Test for the presence of nutrients in food. Select one or more of the following food samples:

- Crushed raw potatoes
- Crushed nuts
- Crushed or powdered soybean seeds
- Crushed dry red split lentils

Test for starch:

- Use safety goggles. Take a test tube and put a crushed or powdered food sample in it.
- Add a few drops of iodine solution.
- Observe for a dark blue-black colour. This indicates the presence of starch.

Test for protein:

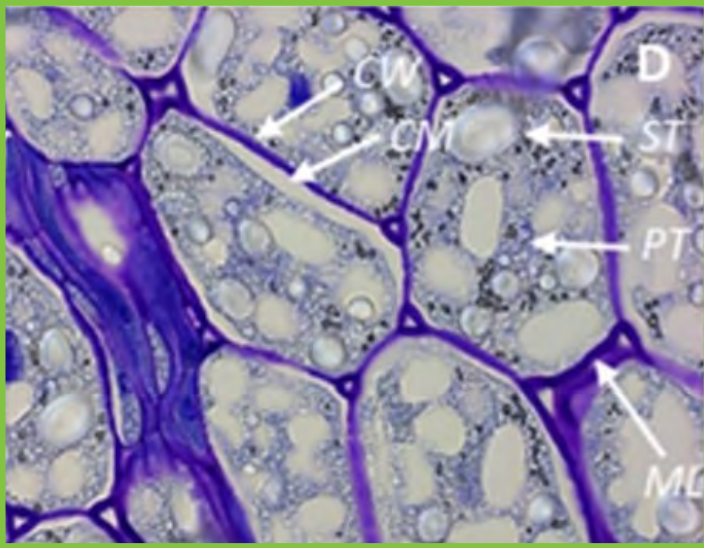
- Watch a class demonstration or follow instructions and safety procedures for this test.
- Observe for a blue-violet colour. This indicates the presence of protein.

Test for fats:

- Use safety goggles. Place crushed or powdered food sample between the folds of brown paper. Press the sample between the folds with your thumb.
- Observe for a translucent patch on the paper at the place where the food sample was pressed. This indicates the presence of fats.



under a microscope



A microscopic image of a soaked yellow pea cell, with the following elements and nutrients labelled:

CW: cell wall; CM: cell membrane; ML: middle lamella; ST: starch; PT: protein

The middle lamella is a layer that cements together the primary cell walls of two adjoining plant cells.

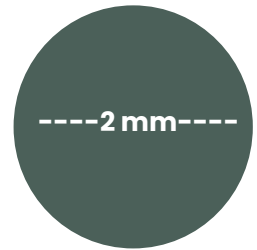
If this photo shows a field of view of 4 mm, what would you estimate the size of these yellow pea cells to be?



Image from Di Stefano, E., Tsopmo, A., Oliviero, T. et al. Bioprocessing of common pulses changed seed microstructures, and improved dipeptidyl peptidase-IV and α -glucosidase inhibitory activities. *Sci Rep* 9, 15308 (2019).: Creative Commons Attribution 4.0 International License.

Microscopes provide a way to identify and describe different types of cells. How large would a cell in a pulse seed be? Here's an example.

- A microscope has a field of view that is 2 mm. This is important to know because the field of view of the microscope is used as your measuring stick. The **field of view** is the diameter of the viewing area that you see when looking through the microscope's lens. It can be measured with a ruler.



- Two cells fit across the diameter of the field of view. Because we know the field of view, we know that each cell is 1 mm long.



The size of a cell can therefore be measured with the following steps:

1. Determine or identify the diameter of the field of view.
2. Estimate how many cells would fit across the diameter.
3. Divide the diameter by the number of cells that fit across to get the size of an individual cell.

roots and nodules

Legume roots have characteristic root nodules. These nodules are full of nitrogen-fixing bacteria.

These photos show a fava bean. All plants from the *Leguminosae* family, including fava beans (or faba beans) and peas, have these nodules.

TRY THIS

Gather the following:

- A ruler
- A calculator or multiplication chart

Follow these steps, using the fava bean root and cell images on this and the following pages.



1. *IMAGE 1 shows a ruler under a microscope. This image has been taken at 40 times magnification. Use your ruler to measure the distance between one millimeter marking and the next on the image. What is your measurement?*

2. *Create a ratio that compares 1 mm to the distance you measured under the microscope in Step 1.*



The bacteria in root nodules take nitrogen from the air, which the plant cannot use, and converts it into a form that plants can use. This nitrogen is important for the plant in its growth and development. It also cuts down on the use of synthetic fertilizer.



The sizes of nodules vary



This photo shows a fava bean root with nitrogen fixing nodules.

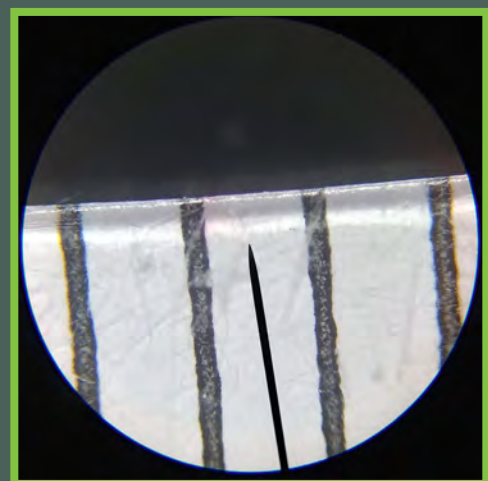


IMAGE 1: A ruler showing millimetre markings at 40x magnification



Before nitrogen-fixing can occur, nodules must be formed. The process by which plant roots are infected by soil bacteria is known as **infection**. The process in which nodules are formed is known as **nodulation**.

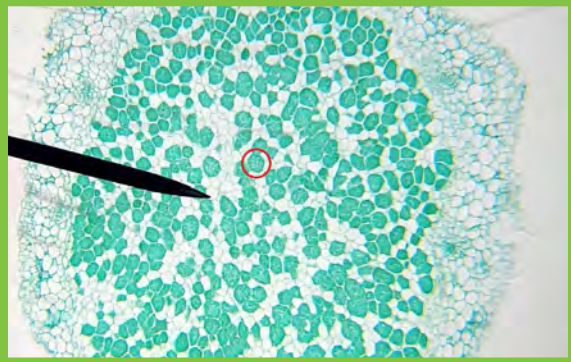


IMAGE 2: A cross section of a root nodule taken at 40x magnification showing:

1. Root nodule cells that are not infected – showing clear
2. Infected root nodule cells that have nitrogen fixing bacteria living inside of them – showing green. The bacteria are so small, 0.002mm, that they cannot be seen at this magnification.

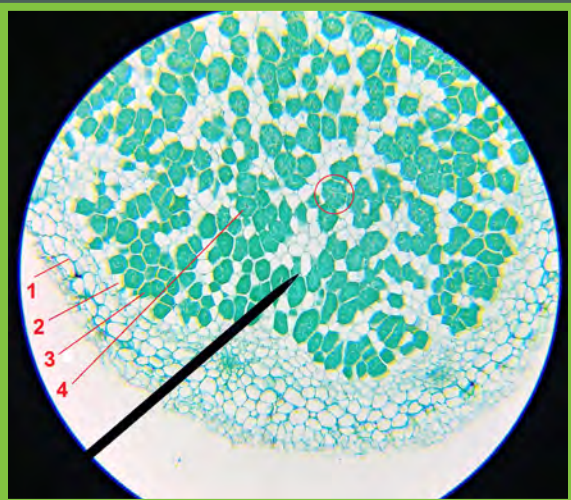


IMAGE 3: A cross section of a root nodule taken at 100x magnification showing:

1. Cell walls
2. Non-infected root nodule cells
3. Infected root nodule cells
4. The nucleus of a cell

3. Use IMAGE 2 to determine if it is under the same magnification. If it is, measure the cell that is circled red with your ruler. Write down the measurement.

4. Use a calculator and apply the ratio you calculated in Step 2 to the measurement you recorded in Step 3. This will calculate the ACTUAL measurement of the cell. This should be a small number.

5. Measure two other areas in IMAGE 2 and apply the ratio to find their actual sizes.

6. IMAGE 3 was taken at 100x magnification. This means it is 2.5x more magnified than the image in IMAGE 2. Figure out the ratio needed to calculate the size with this magnified image.

7. Measure the area of IMAGE 3 circled in red with your ruler, and apply the ratio from Step 6 to figure out the object's actual size.

8. Measure two other parts of IMAGE 3 and apply the ratio you calculated in Step 6 to find their actual sizes.

9. Examine IMAGE 4. This image was taken at 400x magnification. Find the ratio needed to calculate the size of the cell, then apply it to the cell circled in red.

10. Record your calculated cell sizes from Steps 4, 7 and 9 and find the average size of an infected fava bean root nodule cell.

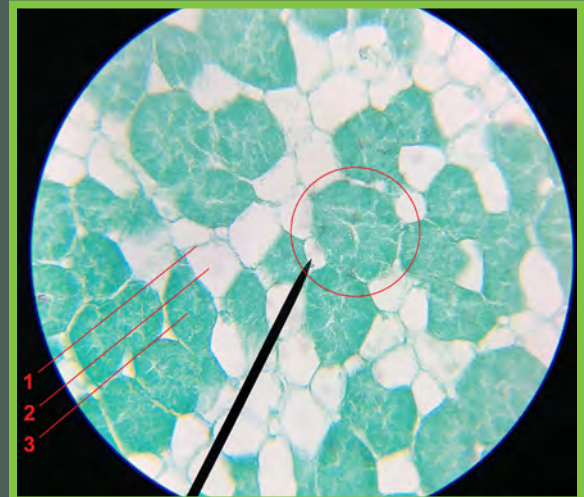
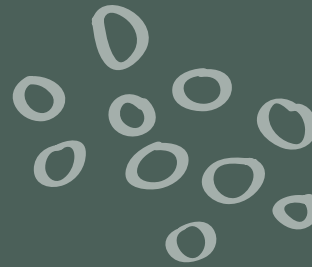


IMAGE 4: A cross section of a root nodule taken at 400x magnification showing:

1. Cell walls
2. Non-infected root nodule cells
3. Infected root nodule cells



Pulse nutrients support the healthy functioning of human body systems.



TRY THIS

How do the range of pulses grown in Alberta support the healthy functioning of human body systems? The chart provides the nutrients found in eight different types of pulses.

Design and create your own bar graphs or circle graphs to compare nutrients provided by different pulses. Then, challenge your understanding by answering the questions that follow.

pulses by the numbers

Dried peas, beans, lentils and chickpeas provide several nutrients – including protein, fibre, iron, folate and potassium. They contain complex carbohydrates, are low in fat and cholesterol-free. They can be used as both a meat and starch alternative.

<i>Pulse Nutrients</i> per 100g cooked	Protein (g)	Fat (g)	Fibre (g)	Iron (mg)	Magnesium (mg)	Potassium (mg)	Zinc (mg)	Calcium (mg)	Folate (µg)
Split Peas	8.3	0.4	8.4	1.3	36	362	1.0	14	65
Lentils	9.0	0.4	8.9	3.3	36	369	1.3	19	181
Chickpeas	8.9	2.6	8.7	2.9	48	291	1.5	49	172
Pinto Beans	9.0	0.7	9.0	2.1	50	436	1.0	46	172
Great Northern Beans	8.3	0.5	7.0	2.1	50	391	0.9	68	102
Black Beans	8.7	0.5	7.0	2.1	70	355	1.1	27	149
Faba (Fava) Beans	7.6	0.4	6.2	1.5	43	268	1.0	36	104
Soybeans	16.6	9.0	6.3	5.1	86	515	1.2	102	54

Source: Canadian Nutrient File and Pulse Canada

1. Which pulses could you use as a meat alternative? Why would you use these?



2. Compare three different pulses to describe which choices provide the most fibre?



3. What choices could you make to increase the iron in your diet? Use a comparison to describe your choices. For example, how much more iron do lentils have than peas?



4. Select one of the nutrients in the Pulse Nutrients chart on the previous page. How does this nutrient contribute to the healthy functioning of the human body?





the journey of a pulse

You may have heard the saying, “you are what you eat.” Plants are the ultimate source of everything we eat. Animals that provide sources of food need plants to grow and survive. And the nutrients found in plants are essential for all human body systems.

The major nutrients that human body systems need to function properly are protein, carbohydrates and fat. These nutrients journey through the body. This is called **nutrient transportation**.

Nutrient transportation ensures that each body system gets everything it needs to function. The nutrients that pulses provide move through body systems like any other nutrient found in different food choices.

Before the nutrients in a pulse can be used by other body systems, they have to be broken down. **Enzymes** found in the digestive system break them down into different types of molecules:

- Lipids (or fats) are broken down into fatty acids.
- Proteins are broken down into amino acids.
- Carbohydrates are broken down into glucose.

Consider the rest of the journey:

- From the digestive system, pulse nutrients move into the small intestine.

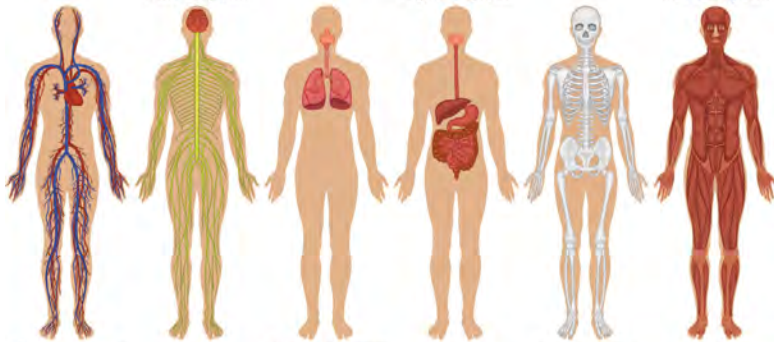


human body systems

nervous system

digestive system

muscular system



circulatory system

respiratory system

skeletal system





The nutrients obtained from plants are called phytonutrients. Plants make up 80 percent of the food we eat and produce 98 percent of the oxygen we breathe.

Many diets around the world rely on pulses as a source of protein. The amount of protein in beans, lentils, chickpeas and peas is two to three times the levels found in cereal grains like wheat, rice, quinoa, oats, barley and corn.

For example, eating just 125 mL of lentils provides the same amount of protein as 250 mL of quinoa or 500 mL of rice or corn.



why pulse nutrients matter

Plants are an essential source of nutrients for human body systems. Consider the following examples.

- A type of fibre found in oats reduces cholesterol and lowers blood pressure.
- Fruits and vegetables (especially orange carrots, pumpkins, and sweet potatoes) are high in vitamin A, important for healthy eyesight, the human immune system and digestion.
- And flavonoids found in chocolate can improve learning and memory and help to prevent and even treat brain disorders.
- Plants gave us medicines like aspirin and the anti-cancer drug Paclitaxel – and plant compounds continue to be tested for new medicinal properties. We depend on plants.

Pulses contain both soluble and insoluble fibre. **Soluble fibre** can help manage body weight, blood sugar levels and lower cholesterol. **Insoluble fibre**, on the other hand, assists with digestion and regularity.

Protein and fibre help you to feel fuller longer. In addition to fibre, pulses also have other carbohydrates that are complex and take longer to break down compared with simple sugars.



This means they provide energy for a longer time after you eat them compared with a quick energy source like sugars.

Pulses contain **resistant starch**, a complex carbohydrate that behaves like fibre in the body. Resistant starch can increase production of good bacteria for a healthy gut.

Pulses can help to manage blood sugar levels and diabetes because they do not cause blood sugar levels to rise as much as sugary or starchy foods that are low in fibre.



Proteins are created from 20 different amino acid building blocks. Nine of these amino acids cannot be produced by the body. These are called “essential” because they must come from foods we eat.

Most plant proteins have low levels of at least one essential amino acid. However, when two or more plant-based sources of protein are combined, each food can provide increased amounts of the essential amino acid that the complementary food is lacking.

proteins in human body systems

PROTEIN IN THE IMMUNE SYSTEM

- Antibodies fight invaders
- Are activated during infections

PROTEIN IN THE MUSCULAR SYSTEM

- Supports muscle movement
- Releases oxygen to muscles
- Stores and releases oxygen

PROTEIN IN THE BLOOD

- Transports oxygen
- Fights infection

PROTEIN IN THE DIGESTIVE SYSTEM

- Digestive enzymes help break down food

PROTEIN IN BODY STRUCTURES AND TISSUES

- Keratin is a structural protein that is found in skin, hair and nails
- Collagen is a structural protein of bones, tendons, ligaments and skin



The iron content in pulses can help transport oxygen throughout the body.

The fibre in pulses is not generally absorbed by the body, which can increase stool volume. The fibre also serves to bind toxins and cholesterol in the gut so these substances can be removed from the body.



Potassium is a mineral found in the foods you eat. It helps your muscles work, including the muscles that control your heartbeat and breathing.

Folate is found in a wide range of foods including vegetables, legumes and pulses, eggs and fruit. Your body needs folate for energy and healthy growth.



TRY THIS

Create your own infographic that focuses on the benefits of one or more nutrients found in pulses for human body systems.

You may choose to create your infographic focused on the role of protein, carbohydrates – such as starch, fats, fibre or vitamins and minerals like folate, potassium, calcium or iron.

For example, your infographic can explore the role that fibre plays with body systems or how starch benefits body systems. Or you can focus on protein and use your own examples that illustrate the body system benefits that pulses provide.

- Use the protein infographic on page 19 as a model.
- Highlight examples in this section that connect to different body systems – digestive, circulatory, respiration, muscular.
- Ensure you use examples that illustrate the effect of pulse nutrients on at least three different body systems.
- Add examples from some of the foods you eat – or are interested in trying – that include pulses.



Research has shown that eating pulses can lower blood cholesterol and reduce blood pressure, which improves heart health. Pulses are low in saturated and trans fats and high in soluble fibre. These are also important for a heart health.

The protein in pulses, combined with the calcium and magnesium, can support bone health. Magnesium helps your body absorb and use calcium. Protein helps to build muscle, which helps keep bones strong.

Many people associate only the digestive system with food and nutrition. What examples would you use to expand their understanding of how human body systems work together?





TRY THIS

Find classmates with infographics that are focused on **differing** pulse nutrients. Combine your ideas to create a **group display** or **group infographic** that addresses and illustrates how body systems are affected by a range of nutrients and what pulses can provide to meet nutritional needs.

food stimuli

Food choices can be influenced by **external stimuli** – which are detected by your senses. This response to food can be stimulated by the sight, smell, taste, feel and even thought of food.

- Taste stimulates the mouth to produce saliva and digestive enzymes.
- The smell of food can stimulate the saliva glands. It can also result in a negative reaction to a food.
- Sight can also stimulate saliva production and digestive enzymes.

What body system is using external stimuli to prepare the stomach to receive food?



Hunger is an **internal stimulus**. It can be triggered by changes in the body that include low energy or blood sugar, physical contractions in the stomach muscles caused by hormones as well as emotions and feelings.

What body systems are involved with the internal stimuli that cause hunger?





TRY THIS

What initiates your body's external and internal stimuli when it comes to food? What foods make you hungry just by looking at them? Smelling them? Hearing sounds associated with cooking or preparing them?

Find three examples of pulse recipes that stimulate a response. Browse the recipes on the Alberta Pulse Growers website at <https://albertapulse.com/recipe/>.

Use a **cause and effect chart** to explain and illustrate what motivates your choices.

- What is the dish that appeals to you? Why does it appeal to you? Identify it in the first box of the chart.
- What sensory stimuli do you think prompts your interest? Add a description to the first box – the cause box.
- What is your body's reaction to this stimulus? Describe it in the second box of the chart – the effect box.



Nutrient-dense foods have lots of vitamins, minerals and other nutrients that our bodies need. They do not have too much saturated fat, sugars and sodium. Research identifies foods like fruits and vegetables, whole grains, fish, lean meat and poultry, peas, beans, nuts and seeds as nutrient-dense foods.

nutrient benefits of pulses



How could you use the bubble chart above to explain why pulses are considered nutrient-dense foods?



Investigations and research into cooking and eating pulses supports improvements in human health.

pulse research

Pulses are proven to have many health benefits. They can be an essential part of plant-based diets. However, some people hesitate to add pulses to their diets on a regular basis.

Concerns that can be associated with pulses include their effect on flatulence or a lack of knowledge about how to best prepare them. Read on to find out more!

Pulses are available in either canned or dried forms.

- **Canned pulses** have already been soaked and cooked, so they can be used directly in various recipes.
- **Dried pulses** need to be soaked and cooked before they can be eaten. The way they are prepared depends on the type of pulse and how old they are. Some pulses – such as lentils and split peas, do not need to be soaked in advance and only need to be cooked.

As with all other foods that contain carbohydrates, gas can be produced in the large intestine when pulses are consumed. So yes, pulses can cause **flatulence** – or the gas expelled by farts!

Why and how does this happen? Carbohydrates include sugars, fibre and starch. When the digestive system does not completely digest these carbohydrates, bacteria in the large intestine breaks them down and forms gas.

Pulses can cause gas because they contain a specific type of sugar called an **oligosaccharide**. The human body cannot fully digest this type of sugar.

Therefore, oligosaccharides will make it all the way to the large intestine without being digested. However, they provide benefits too! Oligosaccharides feed and support the growth of beneficial bacteria in the colon.

Pulses are not the only food that contain oligosaccharides. They are also found in vegetables like white onions, leeks, garlic, kale, Brussels sprouts and red cabbage and fruits like nectarines, watermelon, pears, blueberries, raspberries and bananas.

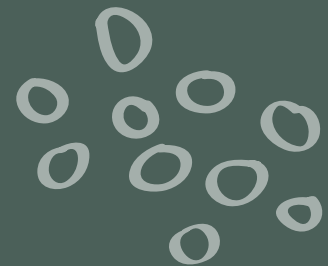


Gas can also be caused by changes in eating habits and/or patterns. Pulses are high in fibre. If a person typically eats a low fibre diet and then adds high fibre foods, they may experience gas. This can also occur with other high fibre fruits, vegetables and grains - for example, bran cereal.

However, the digestive system will often adapt to both the presence of oligosaccharides and foods with high fibre content. For example, the more you eat, the more likely your digestive system will adapt and you may experience a reduction in gas.

Make a hypothesis. Gas is caused by the human body's inability to digest oligosaccharides. What do you think cooking or preparing pulses must be designed to do?





to soak or not to soak



There have been more scientific and home cooking investigations than you might think into ways to reduce the farting that can result from eating pulses!

Some pulse preparation and cooking tips emphasize the need to soak pulses before cooking them, while others do not.

The decision to soak pulses depends on its type and the way they are being used in food.

The following preparation and cooking tips come from some of these investigations.

- Use unsalted water; salt toughens pulses during cooking.
- Tomatoes, vinegar and other acidic ingredients slow the cooking process. They should be added once the pulses are tender.
- Seasonings like dry herbs or chopped onion or garlic can be added during cooking to maximize flavours.
- The use of baking soda to aid in cooking pulses is not recommended unless they are cooked in hard water. If baking soda is needed, limit the amount to 1/8 teaspoon per 2 cups (0.5 mL per 500 mL) of water.
- After soaking pulses, the used water should be thrown away and replaced with fresh water before cooking.



TRY THIS

Open a can of beans and record what you see. The foamy or cloudy looking liquid in canned pulses comes from the release of some starch when they are processed.

- What do you think happens to some of the oligosaccharides when you rinse the canned beans, lentils or chickpeas?
- How does this liquid compare to the liquid produced when you soak or boil dry pulses?

Design a lab that makes these comparisons.

- The foam that forms on the surface should be scooped out when the water reaches boiling point.
- When canned pulses are used, the liquid should be drained and the pulses should be well rinsed.

Which of these preparation and cooking tips do you think are designed to reduce the gas that can result from the oligosaccharides in pulses?



Which of these preparation and cooking tips have you and your family tried? Why did you select these methods?





TRY THIS

What is the difference when you start with dried beans or chickpeas? What happens when they are soaked in water? What should the temperature of the water be? How quickly do they soften? Try this to find out.

- Prepare ice cold water by filling a jug or container with ice cubes and then adding cold tap water.
- Fill two beakers or transparent cups each with about 250 mL of a dry pulse of your choosing – any type of dry bean or chickpea.
- Use a marker to make a line on the side of each beaker that is aligned with the top of the pulses if your container does not have measurements on it.
- Work with a classmate to fill both beakers or cups at the same time. Fill one with ice cold water and the other with very hot tap water.
- Set a timer so you can check on the level of both cups every 10 minutes for the next 45 minutes. Each time you check the level, record or mark it.

Is cold or hot water more quickly absorbed by the pulses?

Try this with different types of beans (pinto, black or kidney). Do some types of beans absorb water faster than others? What does this tell you about how long they may need to be soaked before cooking?

Adapted from How Dried Beans Absorb Water: Scientific American online. www.scientificamerican.com/article/soupy-science-investigate-how-dried-beans-absorb-water/



The following proportions are recommended for cooking different dry pulses.

- 1 cup (250 mL) dry pulses = 2 ½ cups (625 mL) cooked pulses
- For every 1 cup (250 mL) of split peas, use 2 cups (500 mL) of water
- For every 1 cup (250 mL) of beans, use 3 cups (750 mL) of water
- For every 1 cup (250 mL) of lentils, use 3 cups (750 mL) of water
- For every 1 cup (250 mL) of chickpeas, use 3 cups (750 mL) of water



digging deeper

The science of pulse cooking considers what happens to pulses at the cellular level – both when they are prepared for cooking and when they are actually cooked.

What do the proportions of pulses to water tell you about the absorption of water into the seed coat and cotyledons of the pulse seed? Make one observation!



Pulses must be cooked before they are consumed.

- When pulses are presoaked, water is absorbed through a tiny opening called a **micropyle**. This process is quite slow. The water then moves into the cotyledons. This causes the seed and the starch granules inside the cells to start to swell.
- Heat causes this softening and swelling to continue.
- Once the moisture in the cotyledon is high enough, **starch gelatinization** happens. The starch granules swell and thicken. The pulse is now considered to be “cooked.”

Food scientists have learned that different substances can be used to speed up or slow down this cooking process. For example, if you want to make a dish quickly, you may find that pre-soaking the pulse is part of the recipe.

If, however, a dish needs a longer cooking time to develop the flavours, you may want to slow down the softening of the pulse.

Food scientists have found that softening can be slowed down by adding **acidic ingredients** (like tomatoes or vinegar) or sugar.

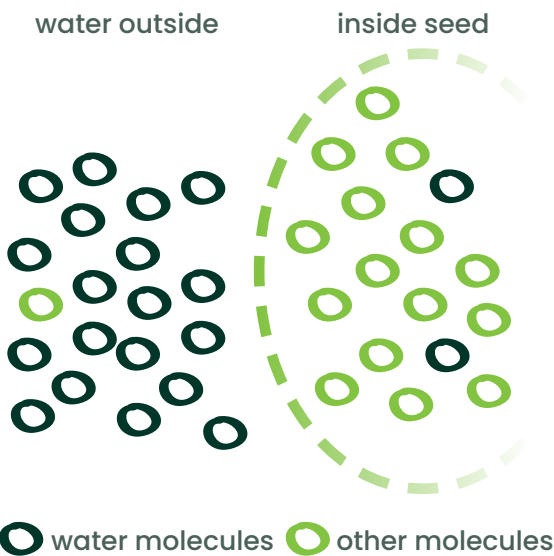
- Acidic ingredients work by making structures called **hemicelluloses** found in the cell wall more stable. This makes it stronger and less likely to dissolve in water.
- Sugars work in two ways. They strengthen the cell walls. This slows down the swelling of the starch granules inside the cells.



For pulses that require longer cooking times, what is the purpose of soaking the pulses in advance? Address the cellular structure of the plant cell in your response.







TRY THIS

Watch an animated simulation of the process of osmosis from Simbucket at <https://simbucket.com/osmosis/>.

Discuss how the movement of molecules can explain what happens when you soak pulses.

The water absorbed by pulses when they are soaked is an example of osmosis in action. This is how it happens:

- There is more water in the bowl or pot than there is inside the pulse seed.
- The micropyle in a pulse is covered by a white spongy cover called the **caruncle**. The caruncle can act like a cell membrane acts. It is semipermeable, letting water move from outside to inside the seed.
- As water is absorbed in the pulse seed, it swells. Eventually, there is more water inside than outside.

The movement of a substance, like water, across a cell membrane is called **diffusion**. Osmosis is a type of diffusion. **Osmosis** is the movement of water across a membrane from an area where there is **more** water (compared with other molecules) to an area where there is **less** water (compared with other molecules).

You notice that pulses soaked in tap water absorb almost all the water and grow in size the most. Pulses soaked in salt water grow less, some liquid remains in the cup and the pulses look a bit shriveled. How does osmosis help explain this?



Science and research have helped develop storage, preparation and cooking processes for pulses that people use everyday.

For example, researchers at the **Guelph Research and Development Centre** tested how pulses were affected when they were cooked with different methods:

- Microwave
- Slow cooker
- Pressure cooker
- Traditional pot

They also looked at how different cooking liquids affected the pulses. They used the following liquids:

- Water
- Salty solution
- Sweet solution
- Acidic solution

Which of these cooking liquids do you think slowed down the cooking process the most? Why do you think this?





This pulse research project focused on improving the components in pulses that can promote good health. At the same time, it also looked at ways to reduce the factors that interfere with the absorption of nutrients or slow down digestion, like the oligosaccharides that cause flatulence.

Source: Do cooking conditions affect the nutritional quality of pulses? Food in Canada online.



TRY THIS

How would you design and duplicate this research as your own lab experiment?

Find out how your results compare to the results of this research described on the next page.





TRY THIS

Explore the four pulse recipes on the following pages. Select one of the recipes.

Answer the questions with the recipe to apply what you have learned about the science of plant cells and human body systems.



The **Guelph Research and Development Centre** research found the following results:

- Slow cooking was most effective at maintaining the components that promote good health and minimizing those that can interfere with digestion.
- Slow cooking pulses was also effective when it was combined with a salty solution of about one percent salt – or about 5 mL per litre of water.
- The salty solution heated up faster than water on its own and encouraged the movement of gas-producing compounds – like oligosaccharides – out of the seed.
- The sugary and acidic solutions either made the pulses mushy or harder.

How does research such as this contribute to human health? What are the two strongest benefits you think come from food science research?



Alberta Beans & Bacon

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Ingredients

- 2 cups (500 mL) Great Northern Beans, soaked overnight
- 6 cups (1.5 L) water
- 1 large Spanish onion, chopped
- 3 sprigs of fresh parsley
- 1/2 lb (227 g) sliced bacon
- 1 can (7.5 oz/213 mL) tomato sauce
- 1/2 tsp (2 mL) salt
- 1/4 tsp (1 mL) ground black pepper

Directions

1. Drain beans and discard soaking water.
2. In a large saucepan, combine beans, water, onion, parsley and bacon. Bring to a boil over medium heat. Reduce heat, cover and simmer 1 hour and 15 minutes, or until beans are tender-firm.
3. Drain beans and onion. Discard parsley and remove bacon. Dice bacon and brown in a small skillet over medium heat. Add tomato sauce, salt and pepper to beans, return to low heat, cover and simmer 10 minutes. Add bacon and simmer 5 minutes longer.
4. Serve hot with pumpernickel bread.

Why are the tomatoes in this recipe added near the end of the cooking process?



Great Northern beans are used in this recipe. How do you think the directions would change with a different type of pulse?





Alberta Beans & Bacon



How do the preparation tips for this recipe depend on the process of osmosis?



Yellow split peas are used in this recipe. How do you think the directions would change with a different type of pulse?



Beet & Split Pea Garden Burgers



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Ingredients

- 3 tsp (15 mL) canola oil, divided
- 1 cup (250 mL) mushrooms, finely chopped
- 1 cup (250 mL) beets, scrubbed & finely chopped
- 1 cup (250 mL) cooked yellow split peas (see preparation tips)
- 2 Tbsp (30 mL) yellow mustard
- 1 tsp (5 mL) smoked paprika
- 1 1/2 cups (375 mL) quick oats
- 2 eggs, beaten
- salt & pepper to taste
- Garnishes: butter lettuce, pickles, red onion, sriracha mayo and crumbled feta

Preparation Tips

For 1 cup (250 mL) cooked yellow split peas:

- Rinse & drain 6 Tbsp (90 mL) dry yellow split peas.
- Combine split peas and 1 cup (250 mL) water in a medium size pot.
- Bring to a gentle boil, reduce heat and simmer 30 minutes or until peas are very soft and mushy. Add water as required to keep the peas covered while cooking.
- Drain any excess water and gently rinse.



Beet & Split Pea Garden Burger



Directions

1. Heat skillet on medium high, add 1 tsp (5 mL) oil as well as mushrooms and beets. Sauté for 3-5 minutes. Season with salt and pepper to taste. Remove from heat.
2. In a medium bowl, combine yellow peas and sautéed beet and mushroom mixture. Add mustard, paprika, oats and eggs. Stir well to combine into a uniform mixture. Cover and refrigerate for 30 minutes, or up to 24 hours. Mixture will set up and easily form patties after chilling.
3. Using clean hands, make 6 burger patties.
4. Heat skillet on medium high, add remaining 2 tsp (10 mL) oil and cook burgers until golden and heated through, about 4-5 minutes per side.
5. Garnish with fresh lettuce and your favourite condiments! Enjoy with or without whole wheat buns.

What nutrient needs are met when pulses are used as a meat alternative?



Red split lentils are used in this recipe. How do you think the directions would change with a different type of pulse?





Peanut butter, tahini, pea butter or sunflower seed butter are all great alternatives to almond butter in this recipe.

This recipe is a great base for different toppings, including fresh berries, cut melons, apples or any other in-season fruit. Explore varying textures by adding hemp seeds, pumpkin seeds or toasted sunflower seeds.



Red Lentil Overnight Oats



Red Lentil Overnight Oats



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Ingredients

- 1 cup (250 mL) 1% milk, or preferred milk
- 3/4 cup (175 mL) plain, non-fat Greek yogurt, or preferred yogurt
- 2 Tbsp (30 mL) unsweetened almond butter (or alternatives)
- 1 Tbsp (15 mL) maple syrup
- pinch salt
- 1 1/4 cup (300 mL) dry rolled oats
- 3/4 cup (175 mL) cooked red split lentils (see tips)
- 1 Tbsp (15 mL) whole chia seeds
- zest of 1 lime

Topping

- 1/2 cup (125 mL) toasted, unsweetened coconut flakes
- 1 whole, ripe banana, sliced

Directions

In a medium glass bowl, whisk together milk, yogurt, almond butter, maple syrup and salt until fully combined.

Stir in rolled oats, cooked lentils, chia seeds and lime zest.

Cover, refrigerate and allow to sit overnight.

Next day, stir lentil/oats mixture, adjust thickness with more milk as needed. Garnish and serve with sliced banana and toasted coconut flakes. Drizzle with more maple syrup if desired or other preferred fruit.

Tips

To make 3/4 cup (175 mL) cooked red split lentils:

Stove top: In a medium pot, bring 1/3 cup (75 mL) dry red split lentils with 1 cup (250 mL) water to a boil. Reduce heat and simmer 5-7 minutes or until lentils soft and cooked through, adding more water as needed. Drain and rinse.

Microwave: Combine 1/3 cup (75 mL) dry red split lentils and 1 cup (250 mL) water in a large microwave safe bowl. Cook on high, uncovered for 5 minutes, stir, then cook on high for another 5-9 minutes until lentils are soft and cooked through. Add more water as needed. Carefully remove the hot bowl from the microwave, drain and rinse the lentils.

You can make the lentils up to 3 days ahead of time or double the recipe and freeze extra cooked lentils to use when you make this recipe again!

You can make this recipe ahead for the week in mason jars for on-the-go breakfasts. Keep the toppings separate until you are ready to enjoy for best results.

There are two different pulse cooking options in this recipe. Which option do you think is most likely to reduce oligosaccharides? What research could you base this choice on?





Why are canned chickpeas used in this recipe?



How do you think the recipe directions would change with a different type of pulse?



Chickpea Snack Cake

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Ingredients

- 1 can (14 oz/398 mL) chickpeas, drained & rinsed (yields 1 1/4 cups/300 mL cooked chickpeas)
- 1 cup (250 mL) brown sugar
- 1/4 cup (60 mL) butter, melted
- 1 egg
- 1 tsp (5 mL) vanilla
- 1/2 cup (125 mL) unsweetened, shredded coconut (see tips)
- 3/4 cup (175 mL) chopped pecans (see tips)
- 1/2 tsp (2 mL) baking soda
- 1/4 tsp (1 mL) salt
- 1 1/2 cups (375 mL) whole wheat flour
- 1/2 cup (125 mL) rolled oats
- 1 cup (250 mL) cream cheese
- 1/4 cup (60 mL) maple syrup

Directions

Preheat oven to 350°F (180°C).

In a food processor, blend chickpeas until smooth and no round peas remain.

In a large mixing bowl, whisk mashed chickpeas with brown sugar, melted butter, egg, vanilla, coconut and pecans.

In a separate bowl combine baking soda, salt, flour and oats.

Add dry ingredients to the chickpea mixture and stir well.

Press into a lightly greased or parchment paper lined 9 x 13-inch (23 x 33 cm) baking pan.



Chickpea Snack Cake



Bake for 25 minutes or until a knife inserted in the center comes out clean. Remove from oven and cool.

Whip together cream cheese and maple syrup. Spread or drizzle over cake before cutting into squares.

Tips

If desired, toast the coconut and pecans in the preheated 350°F (180°C) oven for 3-5 minutes. Watch carefully as the coconut will brown quickly.

What additional nutrient needs can be met when pulses are added to a dessert or baking recipe?





