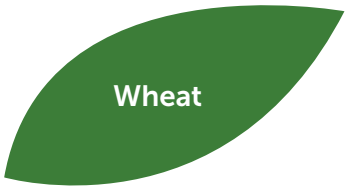
The Wheat Family Tree
Different types of grains



Einkorn *(triticum monococcum)*
This name comes from a German root meaning 'one grain' and refers to the fact that one grain grows per spikelet. It is the oldest domesticated form of wheat.

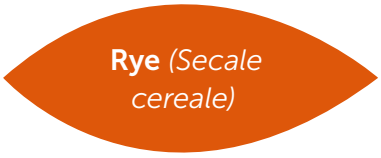
Emmer *(Triticum dicoccum)*
Also known as farro, emmer was first domesticated in the Southern Fertile Crescent. It was cultivated in the ancient civilizations of the Middle East and Europe and was particularly popular in Egypt, being used to make flatbreads and beer.

Spelt *(Triticum spelta)*
Evidence of spelt grains have been found in the Caucasus region and Southeastern Europe, dating to the 6th Century BCE. From there it spread throughout the Balkans and Europe and is now grown primarily in Germany and Switzerland.

Bread wheat *(Triticum aestivum)*
The most widely grown wheat. It is able to adapt to either winter or spring planting, giving rise to thousands of varieties grown in diverse climates.

Durum *(Triticum durum)*
Evolved from emmer, with a name meaning 'hard'. It is high in protein but low in gluten, making it most suitable for noodles, pasta, flatbreads, bulgur and couscous.

Khorasan *(Triticum turanicum)*
Named after the province in Iran where it originated, it has been trademarked as 'Kamut' in the US. It contains high levels of protein and is nutritionally superior to bread wheat.



Previously regarded as a weed within fields of wheat or barley, rye was often called the 'poverty grain' because of its ability to grow better than other cereals on poor soils. It copes well in cool and wet conditions, so it thrived in Scandinavia, Russia and Eastern Europe where it became a predominant bread grain. Thinner and taller than wheat, it has more narrow and pointed grains.

Rye flour contains less gluten than wheat (though is still unsuitable for those with coeliac disease) so bread made with it will not rise much. It is rich instead in complex sugars called 'pentosans', which contribute to its ability to absorb lots of water. It is best to use sourdough if making bread with rye flour, as the acids will counteract the effects of high enzyme activity normal to this flour, as well as creating better flavour.

The principle cereal grain for breadmaking in Southern Europe until the late fifteenth century, this grain featured as food or drink within many important civilizations. An incredibly adaptable crop, it can grow across a wide range of environments from the hot dry climate of Ethiopia to the cold and wet islands of Orkney.

It has a low gluten content and moderate protein, with the highest level of fibre of all whole grains containing beta-glucan that is important for heart health. Despite its excellent nutritional qualities, barley is today more often used for animal feed and malting for beer than for direct human consumption. To prepare barley for the latter requires a complex dehulling process due to the tight hulls on each barley grain (except in the case of 'naked', or 'hulless', barley).

The Wheat Family Tree
Different types of grains

Oat
(Avena sativa)

Oats are assumed to have been domesticated later than wheat and barley, growing instead as a weed within the farmed fields of the Fertile Crescent. Like rye oats grow well in cool and wet climates, so they thrived as they moved with wheat into more northern regions.

They are from a different family to grains such as barley, wheat and rye with spikelets forming as branches from the top of the plant rather than on a single spike.

Oats have a more complete protein than other cereals, with a good balance of amino acids. They also contain more soluble fibre than other grains, improving digestion and lowering cholesterol levels.

Different classes of wheat

You may also hear wheat referred to by different terms, which can tell you something about the way that it looks or grows. Its breadmaking quality is influenced by a combination of these factors, as well as the particular characteristics of the wheat variety itself.

Hard/soft

These terms refer to the physical characteristics of the grain itself.
Hard wheat - these grains do not break up easily. They are generally high in protein, producing a strong and elastic gluten that holds together and bounces back when stretched. Generally preferred for breadmaking.

Soft wheat - these grains are usually plump and more easily crushed. They are lower in protein, producing gluten which will stretch very far but is more likely to break than bounce back. Normally used for cakes and biscuits, though some flatter traditional breads - eg focaccia - would be made with this so-called 'weaker' flour.

Spring/ winter

These terms refer to the ideal sowing period of the grain.
Winter wheat - these need a period of prolonged cold to ensure that they grow properly in the spring and summer. In Scotland they are normally sown from mid-September to the end of November. They will grow slightly, go dormant in the colder months, then continue growing when conditions become warmer.

Spring wheat - spring wheats are sown as early as soil conditions allow, in Scotland generally from the beginning of March.

Red/ white

These terms refer to the colour of the grain.
Red wheat - the bran of these grains have more tannins, giving them a darker colour and contributing to the stronger flavour of the grains and flour made with them. Can have higher levels of protein.

White wheat - developed from red wheat by eliminating some of the genes that give the bran its colour.

The Wheat Family Tree
Activity

Demonstrate the differences between grains through a 'grain tasting' session. Below you will find a recipe for simple biscuits which can be made using different grains, allowing people to sample the varied tastes, smells, colours and textures that each provides. Encourage participants to take their time to consider these factors as they try each biscuit, noting down their impressions on a sheet of tasting notes (template provided below).

Our thanks to Mahala Le May for providing this activity template and recipe.

Discussion points

- which grain is the favourite and why?
- which grains are better suited for different types of baking? eg bread, pastry, biscuits
- what qualities the different grains would bring to different bakes? eg. structure, flavour, texture

Recipe

125 g flour*
55 g butter/fat
2-3 tbsp cold water
Pinch salt

**If possible, use a table-top mill to mill the flour freshly from grains. This way you can ensure consistency in the grind and will be able to use wholemeal flour, getting the most flavour and goodness from each grain.*

- Rub together the flour, butter and a pinch of salt to form a breadcrumb texture.
- Add the cold water a little at a time, mixing together until it just forms a dough. Try to add as little water as possible, but be aware that each flour will absorb a different amount of water.
- Wrap the dough in cling film, a reusable wrap or a small sealable bag and chill in the fridge for 15–20 minutes. Heat the oven to 180°C.
- Roll the dough out on a lightly floured surface and cut into small pieces. Transfer to a lined baking tray.
- Bake for 10-15 minutes until cooked through. Leave on the tray for a few minutes, then transfer to a wire cooling rack.

SCOTLAND THE BREAD

Grain Tasting

Grain	Grain	Grain	Grain	Grain
Appearance	Appearance	Appearance	Appearance	Appearance
Aroma	Aroma	Aroma	Aroma	Aroma
Taste	Taste	Taste	Taste	Taste
Texture	Texture	Texture	Texture	Texture
Notes	Notes	Notes	Notes	Notes

From Grain to Flour
Anatomy of a Grain

Endosperm

The inner part of the grain, this makes up the majority of the grain weight. It contains starches, carbohydrates and proteins (including the gluten-forming proteins glutenin and gliadin) which act as food for the growing seedling. However the endosperm contains relatively few vitamins, minerals or fibre and so white flour—which is produced using only the endosperm of grains—also lacks these health-giving nutrients.

Germ

This is the plant embryo - like the 'yolk' of the seed. It contains B-vitamins and most of the grain's vitamin E content as well as essential fatty acids. The healthy germ is often sifted out of flour, since the fat it contains can spoil and reduce the shelf life. However, it is included in unsifted wholemeal flour.

Bran

This is the protective outer layer (technically made up of 7 layers) of the grain. It contains important minerals, some protein, lots of B vitamins and insoluble fibre, vital for a balanced and healthy microbiome. It is included in wholemeal flour.

Extraction rate

This term denotes the amount of the original grain left in the milled flour.

Wholemeal flour contains all the constituents of the original grain—endosperm, bran and germ—mixed together, so has an extraction rate of 100%. With proper fermentation you will therefore benefit from all of the grain's vitamins, minerals and fibre.

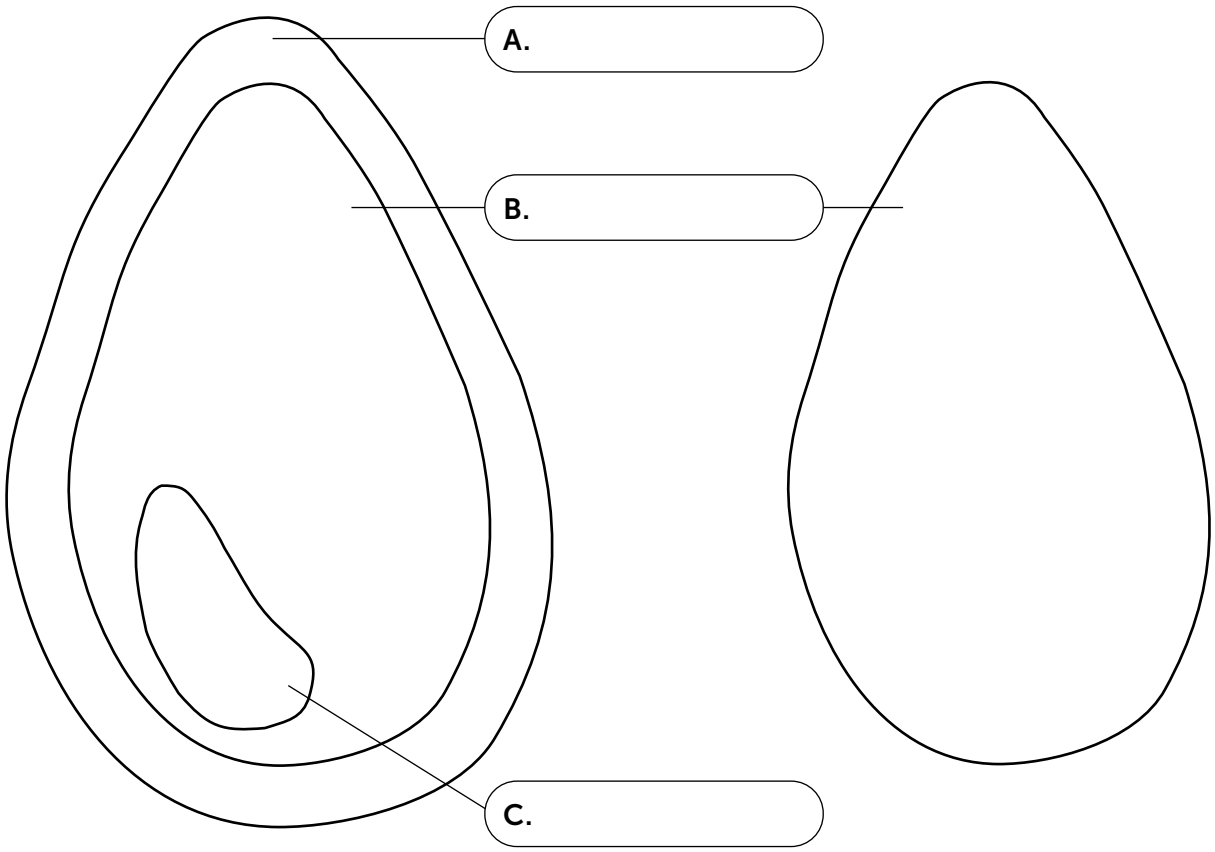
To make **white flour**, the bran and germ–constituting about 28% of the grain–is sifted out, leaving only endosperm. This produces a flour of '72% extraction'. The bran is mostly sold for animal feed while the germ is used in specialist breads or as a source of vitamin E in 'neutraceuticals'.

'Brown' flour is made by sifting out some of the bran and germ to leave about 80% of the whole grain.

Activity

Print out the diagrams below for children to colour and fill in, to check understanding of the different parts of a wheat grain, their function and the nutrients they provide.

From Grain to Flour
Anatomy of a Grain
Activity



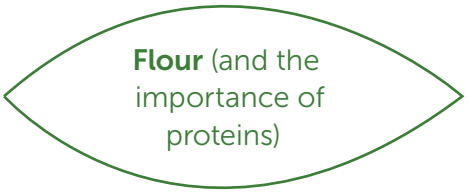
Whole Grain **Refined Grain**

What do you know about each part of a grain? Fill in the boxes below.

A.	B.	C.

Making bread and using sourdough

The four basic ingredients of Real Bread are flour, water, yeast and salt.



Wheat **flour** - which is the type most people in Scotland will use or eat in their bread - contains two main **proteins** called **glutenin** and **gliadin**. When wheat flour is mixed with **water** (or another liquid such as milk or whey), these proteins bind together to form **gluten** - a starchy, web-like structure. This gluten structure develops over time, as the flour absorbs the water. It can also be strengthened by movement, through kneading and / or gently stretching and folding the dough.

Yeast is a microscopic fungus present on the surface of grains, as well as in the air around us. When flour and water are mixed together and left for a period of time, this mixture will begin to 'ferment'. During this process, natural enzymes in the flour convert carbohydrates into sugars. Yeasts feed on these sugars, producing **alcohol** and **carbon dioxide gas**. The gas is trapped in the gluten structure and inflates it, causing the dough to rise and giving the finished bread a lighter texture. The alcohol is mostly evaporated by the heat of baking.

Lactic acid bacteria (LAB) are present in most grains, on our hands and in the wider environment. They can also be introduced into bread via a mature sourdough 'starter'. LAB feed on sugars from the carbohydrates in flour but at a slower rate than yeasts. They release lactic, acetic, butyric, ferulic and other acids which play an important role in human gut metabolism. LAB also account for the distinctive slightly acidic flavour of sourdough breads.

The more protein there is in wheat flour, the more gluten there will be in a dough made from it. However, the qualities of the gluten can vary according to different wheat varieties and how bakers handle the development of the dough.

Some glutens will be more **extensible** - this relates to how far they can be stretched without breaking. Others will be more **elastic** - they are more likely to spring back when stretched.

You may also have heard the terms 'strong' and 'weak' in relation to flours.

Strong flour generally comes from grains grown in continental climates (eg. North America, Ukraine). The gluten formed by these flours holds together as it stretches but tends to be very elastic, causing it to shrink back. This is the type of flour that might produce a typical British tin loaf.

So called **weak** or soft flours produce gluten that can stretch quite far but also ruptures easily and is not very elastic. This is the type of flour that might produce an Italian *focaccia* or French *pain de campagne*.

Flour can be made from many types of grains. The qualities of these grains will have different effects on the bread produced. For example rye flour will produce a denser loaf than wheat flour, since it doesn't contain as much gluten and therefore will not form the structure required to rise to an airy loaf.

Making bread and using sourdough

A dough made with wholemeal flour will require more water than one made with white flour, due to the additional presence of the bran and germ.

Our ancestors noticed that a flour and water paste left for a few hours would start to aerate and once cooked, would create a lighter bread. This is the original 'sourdough bread', making use of naturally occurring yeasts present on the surfaces of grains and in the environment around us. From then and throughout history bread has been made simply using these 'wild yeasts', either through a sourdough culture (this mix of flour and water) or using the yeast residue from a brewery.

Many breads nowadays are made using commercial yeast, which is one pure strain selected to give fast and predictable results. There are several different types of commercial yeast available:

Fresh/bakers yeast
A soft block of yeast cells which is pale in colour, crumbly in texture and stronger smelling than dried yeast. It has a short shelf life (normally around 1 week).

Active-dried yeast
Dried yeast that comes in the form of small granules.

Instant/fast-acting yeast
More concentrated than active-dried yeast, these types of dried yeast may come already mixed with additives.

In comparison, a sourdough culture contains a sparse mix of different strains, making the fermentation process slower and more variable. Sourdough also differs in the fact that it can introduce beneficial Lactic Acid Bacteria into the dough (see above) which commercial yeasts do not. There is research to suggest that a longer fermentation period – as is necessary to create bread using a sourdough culture – brings health benefits by generating important short-chain fatty acids and making nutrients from the flour available to our digestive systems.

The Real Bread Campaign defines genuine sourdough as made without additives and leavened only by a live sourdough starter culture – no commercial yeast or chemical raising agents.

Far from the instagrammed loaves and upmarket connotation with which it is associated today, sourdough really is the most basic bread! Do not forget that it has been made by people for thousands of years and takes many different forms, from the Ethiopian injera to Danish rugbrød.

As well as providing flavour, salt also helps to strengthen the gluten and acts as a preservative, making the bread stay mould-free for a bit longer. However some breads - such as the traditional Tuscan loaf - contain no salt at all, and many people prefer to use lower amounts of salt in their dough due to health considerations.

A brief history of grain processing in Scotland

Growing

People would sow mixes of grains together to ensure a harvest in the tough conditions, so bakes were often made with a multi-cereal mix.

Threshing

The first threshing machine was invented by Scottish engineer Andrew Meikle in 1786. Before this it was done manually or by having livestock tread over the stalks.

Milling

Water, wind and animal-powered mills featured prominently across Scotland up until the end of the 19th century.[1]

Baking

The earliest flatbreads, oatcakes, griddle cakes and bannocks were cooked on a heavy, flat iron griddle over an open fire.

Traditionally oats and barley were the most important grains in Scotland as they could withstand the rougher and wetter climate. Neither contain much gluten-forming protein, hence why oatcakes, bannocks and other flatter breads were more typical in Scotland.

The choice of staple cereal in the pre-industrial diet changed seasonally according to the harvest and relative prices of each crop. Towards the end of the 19th century in Scotland there was an upward trend in wheat consumption as wages rose, people secured more continuous employment and the price of wheat declined. As more people moved into urban areas, there was more social imitation between classes leading wheat bread to progressively become more commonly eaten at all rungs of the income ladder. Urbanisation also increased the reliance of townspeople upon professional bakers.[2]

Today arable farming is a minority of the agricultural sector in Scotland. The majority grain grown in Scotland is barley (68%), followed by wheat (24%) then oats (8%)[3].

Barley is used for malting (to make alcohol) and animal feed.[4]

Oats are used to make flakes, oatmeal or flour for porridge and other foods and also as animal feed.

The majority of wheat is made into raw alcohol or 'biodiesel' using enzymatic processing. Poorer quality grain is used for animal feed. A small amount of Scottish-grown wheat is milled into cake and biscuit flour. Almost none of the wheat grown in Scotland is used to make bread to nourish its people.

Breadmaking wheat is generally imported from England, Canada, France, the US and Germany. Italy is also an important source for imported flour for its particular baking characteristics.[5]

[1] www.maps.nls.uk/projects/mills/about.html
[2] *Dietary change and cereal consumption in Britain in the Nineteenth Century*, E.J.T Collins.
[3] www.gov.scot/publications/cereal-oilseed-rape-harvest-2021-final-estimates/pages/11/
[4] www.rhet.org.uk/media/1191/crops-and-growing-fact-cards-v1-web.pdf/
[5] www.ukflourmillers.org/importsexports/