**ACTIVITY: Getting the most out of milk**

Read the article [Mining milk for lactoferrin](https://www.sciencelearn.org.nz/resources/2123-mining-milk-for-lactoferrin) then answer the questions.

# Getting the most out of milk: Question sheet

**Finding**

1. What different substances can be found in milk?
2. What are proteins made of?
3. What properties of lactoferrin make it a valuable milk protein?
4. What does PFR stand for?
5. What temperature is milk fresh from a cow?

**Interpreting**

1. List the differences between the protein extraction procedure used in dairy factories and the procedure used on the farm.
2. What features of a protein determine if it can function correctly?

**Thinking**

1. What can lactoferrin be used for?
2. Would you rather drink milk with or without high-value proteins? Why?
3. Do you think farmers would buy PFRs for use on their farms? List some factors farmers would need to consider.

**Extra for experts (additional knowledge required)**

1. What gives a protein its specific structure, and why is its structure important?
2. How do the charges within a protein affect its overall structure?
3. What environmental conditions can destabilise the structure of a protein?

# Getting the most out of milk: Answer sheet

**Finding**

1. Milk is a mixture of water, fats, proteins, sugars and minerals.
2. Proteins are long chains of amino acids.
3. Lactoferrin has antimicrobial, antioxidant and anti-inflammatory properties, which make it valuable for use in medicines.
4. PFR stands for protein fractionation robot.
5. Milk fresh from a cow is at 35ºC.

**Interpreting**

1. There are several differences between the protein extraction procedure used in dairy factories and that used on the farm:
   1. Protein extraction on the farm uses a protein fractionation robot (PFR).
   2. Protein extraction at dairy factories uses milk that has been stored for up to two days. PFR protein extraction on the farm occurs almost immediately after milking.
   3. Protein extraction at dairy factories uses milk that has been de-fatted and pasteurised (heat treated). PFR extraction on the farm uses milk that has not been through either of these steps.
   4. Protein extraction at dairy factories uses milk at 4–8ºC.PFR protein extraction on the farm uses milk at 35ºC.
   5. PFR protein extraction on the farm collects a higher percentage of lactoferrin from the milk than dairy factory extraction.
2. The three-dimensional shape or structure of a protein determines whether it can function correctly.

**Thinking**

1. Lactoferrin can be used in medicine as it has anti-inflammatory and antimicrobial properties. It could be useful for treating wounds.
2. Reasons could be:
   1. With high-value proteins, because it maximises health benefits for me.
   2. Without high-value proteins, because I don’t really need them and they can be used for medicines in a form that will help people who are sick or injured.
3. Either yes or no depending on their opinion. The list of factors for a farmer to consider could include:
   1. cost to install
   2. cost to run
   3. time to run/collect proteins, especially extra labour hours
   4. availability of technical support
   5. how many PFRs required for herd/shed size
   6. collection of milk and proteins
   7. value of proteins
   8. profitability
   9. practicality.

**Extra for experts (additional knowledge required)**

1. Proteins have several levels of structure. The amino acid sequence forms the primary protein structure. When the amino acid sequences become linked, they form either sheets or helixes called the secondary structure. These secondary structures interact to form globular 3D shapes called the tertiary structure. These interact physically and chemically with other such structures in a specific manner, called the quaternary structure. This forms the active protein.
2. The net charge on the protein not only depends on the balance of positive and negative charges, but their location in the final structure of the molecule. To give a hypothetical example, if a number of positively charged amino acids are grouped on the outside of the protein, it will behave as a positive ion.
3. The structure of a protein can be destabilised by changes in temperature, pH and water availability, or the presence or absence of other chemicals, such as cofactors or toxins.