GOT ICE CREAM?

A natural behavior among mammals after they are born is to nurse from their moms during their initial growth periods. **Nursing** is the process through which a young mammal suckles milk from its mom's teats, which is the same as a nursing human baby suckling milk from his or her mother's breasts. Young mammals nurse until they are old enough to find and eat food on their own. The length of the nursing period and the nutrients in mom's milk determine how fast a young mammal will grow, and varies between mammals, depending on the environment in which a young mammal is born and raised.

A good estimate for the average yearly minimum air temperature in the United States is 48 degrees Fahrenheit.* Weddell seal pups are born on the sea ice in Antarctica, where the weather outside is around 1.4 degrees Fahrenheit. That's cold! To make matters worse for these newborn pups, they can't put on jackets and scarves or wrap up in blankets to insulate themselves (which means to prevent themselves from losing body heat) the way we can when we're cold. So how does a Weddell seal pup, a warm-blooded mammal which has a body temperature similar to ours, keep warm in such a cold environment? The answer is ingenious! Instead of insulating themselves from the outside in, they insulate themselves from the inside out, using the milk they drink from their moms.

When human babies nurse from their moms, they consume milk that is 4% fat, and they nurse for about two years. To give you idea of how much fat that is, whole milk from a cow that can be bought at the grocery store is approximately 12% fat. Low-fat milk is 2% fat. When Weddell seals nurse from their moms, they consume milk that is 60% fat, and they only nurse for approximately six weeks before they learn to dive and find food on their own. In order to understand just how much more fat a seal pup consumes during its nursing period, let's compare how much fat a nursing human baby eats in the first six weeks of its life with how much fat a Weddell seal pup takes in during the same time. To do that, first let's figure out how many days are in six weeks.

Number of days in one week	Number of weeks	Answer
$\frac{7 \text{ days}}{1 \text{ week}}$	6 weeks	42 days

$\frac{7 \text{ days}}{1 \text{ week}}$ is called a conversion factor. Days and weeks are units of time (or how we measure time), and we use conversion factors to change the units of a measurement. For this activity, we know how much milk a human baby and a seal pup drink in a day, so we need to figure how many days are in a six-week nursing period. Seven days and one week are the same length of time. By putting the unit of weeks on the bottom, the "weeks" units cancel each other out, and we're left with the units of days.

Now that we know how many days are in a six-week nursing period, we need to figure out how many grams of fat a human baby and a seal pup take in every day. However, milk is measured in units of volume, not of weight (grams and pounds are units of weight). A human baby consumes approximately 32 fluid ounces (fl.oz.) of milk every

day, and remember that human breast milk is 4% fat. A Weddell seal consumes 8-9 quarts of milk every day, and remember that Weddell seal milk is 60% fat. In order to figure out how much a particular volume of a liquid weighs, we can use the **density** of the liquid. Density is the measure of the mass of a particular volume of a liquid. Let's start with figuring out how many grams of milk a human baby drinks in a day, and how much of that is fat. We're going to use milliliters (mL) as our unit for volume, so first we need to convert fluid ounces (for human babies) and quarts (for seal pups) to milliliters. There are 30 mL in every fluid ounce of liquid, and 946.4 mL in every quart of liquid.

Number of fl.oz. a human baby drinks in a day	Multiply by conversion factor for changing fl.oz to mL	Answer in mL
32 fl.oz.	$\frac{30\ mL}{1\ fl.oz.}$	960 mL

Number of quarts a seal pup drinks in a day	Multiply by conversion factor for changing quarts to mL	Answer in mL
9 quarts	$\frac{946.4\ mL}{1\ quart}$	8517.6 mL

We've just calculated how many mL of milk both human babies and seal pups drink every day. Now we need to know how much fat is in human breast milk and Weddell seal milk, but fat is measured in grams. In order to figure out how many grams of fat is in 960 mL of human breast milk and 8517.6 mL of seal milk, we first have to convert mL to grams. This is where our density conversion factor comes in handy. For milk that is 4% fat, 1 mL weighs 1.06 grams (g).** For milk that is 60% fat, 1 mL weighs 16 g!***

Number of mL human baby drinks in a day	Multiply by density conversion factor	Answer in grams (g)
960 mL	$\frac{1.06\ g}{1\ mL}$	1017.7 g

Number of mL a seal pup drinks in a day	Multiply by density conversion factor	Answer in grams (g)
8517.6 mL	$\frac{16\ g}{1\ mL}$	136281.6 g

Next, we need to figure out what 4% of 1017.7 g is, in order to know how much fat is in a day's worth of human breast milk. We also need to figure out what 60% of 136281.6 g is, in order to know how much fat is in a day's worth of seal milk.

Number of grams a human baby drinks in a day	Find 4% (multiply by 0.04)	Answer in grams (g)
1017.7 g	0.04	40.7 g

Number of grams a seal pup drinks in a day	Find 60% (multiply by 0.6)	Answer in grams (g)
136281.6 g	0.6	81769 g

We just figured out that a human baby who drinks 32 fl.oz. of breast milk every day consumes 40.7 grams of fat every day, and a Weddell seal pup who drinks 9 quarts of milk every day consumes 81769 grams of fat every day. That's quite a difference! If we multiply both 40.7 and 81769 by 42 (the number of days in six weeks), we can figure out how many grams of fat a human baby and a Weddell seal pup drink in six weeks.

Grams of fat a human baby drinks in a day	Multiply by number of days in six weeks	Grams of fat a human baby drinks in six weeks
40.7 g	42	1709.4 g

Grams of fat a seal pup drinks in a day	Multiply by number of days in six weeks	Grams of fat a seal pup drinks in six weeks
81769 g	42	3,434,298 g

You can see just how much more fat a Weddell seal pup consumes in six weeks than a human baby. Can you think of why? Remember that seal pups insulate themselves from the inside out using the milk they drink from their moms. By drinking huge amounts of milk that contain huge amounts of fat, seal pups can pack on a thick layer of blubber, which is fat that surrounds their bodies and keeps them warm, even when the air outside is well below freezing. Humans don't live outside in temperatures as cold as those in Antarctica, so we don't need to drink large amounts of fatty milk when we're babies.

It's probably hard to imagine just how much fat a seal pup drinks during its nursing period. That's why, for this activity, we're going to pretend that we're seal pups, and we have to take in the same amount of fat every day as a seal pup in order to keep warm on the Antarctic ice. We're going to take in our fat by consuming a familiar food that contains a large amount of fat – vanilla ice cream. By figuring out how many gallons of ice cream you would have to eat every day if you were a Weddell seal pup, you can better understand just how much fat seal pups need in order to keep warm and to survive in Antarctica.

Here are some important facts about Haagen Dasz Vanilla Ice Cream:

- One small carton contains 125 mL of ice cream
- One 125 mL carton contains 29% fat
- One mL of ice cream weighs 1.15g (that's the density)****
- One gallon is equal to 3,785.4 mL

Can you calculate how many gallons of ice cream you would have to eat every day to consume as much fat as Weddell seal pups? Here are some tables to fill in to help you.

Number of mL in One Container	Multiply by Density Conversion Factor	Answer
125 mL	$\frac{1.15g}{1\ mL}$	143.8g

Number of Grams in One Container	Multiply by 0.29 (the percent fat in ice cream)	Answer
143.8g	0.29	41.7g

Number of grams of fat a seal pup consumes in a day	Divide by 41.7g (the number of grams of fat in one container)	Answer
81,769g	41.70g	1,960.9

Remember that we want to find out how many containers of ice cream you would need to eat every day to equal the fat intake of a seal pup. In every 125 mL container of ice cream, there are 41.7g of fat. Dividing the number of grams of fat a seal pup eats every day by the number of grams of fat in a 125 mL container of ice cream tells us how many containers of ice cream we need to consume in order to consume as much fat as seal pups. From this information, we can figure out how many 125 mL containers of ice cream we need to eat.

Number of servings of ice cream to consume in a day	Multiply by number of grams in one container	Answer
1,960.90	143.8g	281,977.4g

This tells us how many grams of ice cream we would need to eat every day to equal the daily consumption of fat for seal pups. Let's convert this back to mL, then into gallons so that we can see how many gallons of ice cream we'd have to eat if we were Weddell seal pups living on Antarctic ice!

Number of grams of ice cream to consume in a day	Multiply by Density Conversion Factor	Answer
281,977.4g	$\frac{1 \text{ mL}}{1.15 \text{ g}}$	245,197.7 mL

mL of ice cream to consume in a day	Divide by number of mL in a gallon	Answer
245,197.7 mL	3,785.4 mL	64.8

You just figured out that if you were a Weddell seal pup, you would have to eat 64.8 gallons on vanilla ice cream every day for the first six weeks of your life to equal the amount of fat that a pup consumes while it nurses from its mom. Even for someone who loves ice cream, that's a lot! The difference in the amount of fat consumed by human babies and by Weddell seal pups is because of the different environments that these young mammals live in. If human babies had to live on ice from the instant they were born, human mothers would produce milk with much more fat in it. Likewise, if Weddell seal pups were born on warm, tropical beaches and lived in warm water, Weddell seal moms would produce milk with much less fat in it. The warmer the environment is in which you live, the less fat you need in your body to keep warm. To see just how well fat works to keep a body warm, try the next activity!

*Number calculated by taking the average minimum temperature for each month from various cities across the country, averaging those temperatures to obtain an average minimum temperature for the year for each city, and then averaging the average minimum temperatures for the year of each city to obtain an average minimum temperature for the country that suits the purpose of this activity. Source of average minimum monthly temperatures for various U.S. cities: www.bbc.co.uk/weather.

**The density of 4% milk was measured by diluting whole milk (12% fat) with water in a 3:1 ratio, and then measuring the mass of 1 mL in grams three times and taking the average. The three values for the mass of 1 mL of 4% milk were 1.05g, 1.06g, and 1.07g.

***Since Weddell seal milk was not available to measure the density, the density was approximated by using the density of 4% milk and a direct proportion:

$\frac{4}{60} = \frac{1.06}{X}$ X = 15.9 grams (rounded up to 16 for this activity).

****The density of Haagen Dazs Vanilla Ice Cream was obtained by melting a container of ice cream and measuring the mass of 1 mL in grams three times and taking the average. The three values for the mass of 1 mL ice cream were 1.15g, 1.15g, and 1.15g.