



Blowing Hot and Cold

Why do spicy foods taste hot and minty foods taste cold?

Stock items	Consumables
Bin bags	Chilli sauce (as hot as you dare!)
Plastic spoons	Menthol chewing gum
Plastic cups	
Water	
Capsaicin molecular model	
Menthol molecular model	

Presenting ideas

Invite your *edible explorer* to eat a pea-sized amount of chilli sauce, which you've put on a clean spoon. If you're using hotter chilli sauce, reduce this amount.

- How would you describe the taste?

If needed, offer them a drink of water. Then ask them to chew the menthol chewing gum. Get them to breathe deeply when they are tasting, to allow the flavours to intensify.

- Does the chilli sauce and the menthol feel the same temperature? If not, how are they different?
- Why do you think manufacturers generally make chewing gum minty-flavoured?
- If you eat chilli sauce then chew gum, do you think the sensations might cancel each other out?

What's the chemistry?

Our nervous system is packed with receptors, which are proteins embedded in cell membranes. Ions generally cannot move freely across these cell membranes, but must enter or exit a cell through pores created by ion channels. These ion channels, which are either permanently open or open and close in response to particular stimuli, convert chemical messages into electrical signals which your brain interprets as a sensation.

Different concentrations of ions exist inside and outside these cells, which create a small electrical potential. Under certain conditions, ion channels open and allow the ions to move in or out of the cell, creating an electrical signal. Most channels are specific for certain ions and typically, the channel pore is so small that ions must pass through in single-file.

For the most part, the receptors detect the correct stimulus, be it chemical, light or vibration. But sometimes the signal from the receptor is unclear.

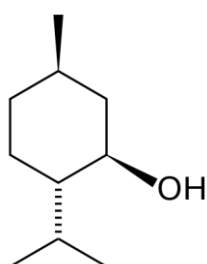


Transient receptor potential channels (TRPCs) are a type of ion channel which behave like mini thermometers. An example of which, called TRPM8, responds to lower temperatures ($< 26\text{ }^{\circ}\text{C}$) and to the menthol molecule found in minty flavours. So when you eat something minty, this ion channel opens and your senses are fooled.

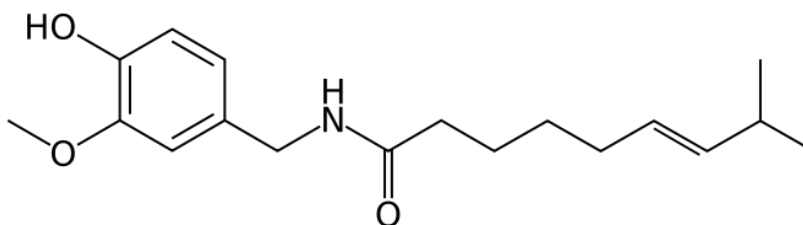
The cooling sensation it produces means menthol is found in many applications such as lip balms, decongestants, cough mixtures, mouthwashes, toothpastes and treatments for aches and pains.

Research has found that inhaling minty flavours increases oxygen uptake and athletes felt like their performance improved. Which may explain why some athletes choose to chew gum!

Another example of this type of ion channel is TRPV1. These channels respond to heat ($> 43\text{ }^{\circ}\text{C}$) and capsaicin also activates them. The burning sensation in your mouth when chewing chillies is all due to the molecule capsaicin. Your brain is convinced you're eating something hot, despite no actual change in physical temperature. TRPV1 receptors are clustered on our tongue, in our mouth and on our skin because they're supposed to prevent us from consuming food that will burn us.



Menthol



Capsaicin

Sometimes these hot and cold sensors become confused. Have you ever put your hand in really hot water and it's initially felt cold? Some cold receptors can be activated by both low temperatures and extremely high temperatures so the cold sensors give a false reading. It's usually corrected within a matter of seconds.

Have you ever jumped into really cold water and noticed the initial shock wears off pretty quickly? The proteins in the ion cells become desensitised, so it's not as bracing as your body gets used to it.

You can demonstrate how our heat sensors can be fooled. Get three containers. Fill one with cold water, one with hot water (usual bath temperature is fine) and one with warm water. Place the container filled with warm water in the middle of the three. Place one hand in the cold water and one in the hot water for a minute or two. Then simultaneously put your hands into the middle container containing the warm water. What happens?

Jo's Top Tips

As a safety precaution, I wouldn't recommend delivering this to younger students. Older students and adults are generally familiar with how hot chillies can be. But do warn people in advance.

I usually have a couple of different chilli sauces – sweet chilli and something much hotter. Bravado may sway some of your audience to try the hot stuff.

Some people can't handle the heat so always taste the amount of chilli sauce you're planning on administering.

Always wash your hands if you get chilli sauce on them. And it goes without saying, don't rub your eyes!



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