**What is Metabolism?**

**Metabolism** is the process of converting food and oxygen into energy in your cells. Your brain uses more energy than any other organ in your body, so its ability to **metabolise** is extremely important.

You have four sets of coloured counters which each represent a different part of metabolism:

* RED - blood with oxygen (oxyhaemoglobin).
* BLUE - blood without oxygen (deoxyhaemoglobin).
* YELLOW - sugar (glucose).
* GREEN - energy (we normally can’t measure this directly).

In front of you is a **healthy** brain with blood vessels going in and out of it. It follows some simple rules:

1. It turns **1** red counter and **1** yellow counter into a green counter.
2. When a counter is used up, flip it over. Red becomes blue, yellow becomes green.
3. The brain needs to finish with at least 2 green counters to work properly.

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|  | **In** | **Out** | **Success?** |
| RED | BLUE | YELLOW | GREEN | RED | BLUE | YELLOW | GREEN |
| ***a)*** | 3 | 2 | 2 | 0 |  |  |  |  |  |
| ***b)*** | 1 | 4 | 1 | 0 |  |  |  |  |  |
| ***c)*** | 3 | 2 | 1 | 0 |  |  |  |  |  |

When your brain is working hard it needs **more energy**. What is needed to produce **4** green counters? How do you think your brain does this in the real world?

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Sometimes the brain’s mechanism of turning sugar and oxygen into energy stops working. What do you think happens to the cells in the brain when this happens?

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Sometimes the brain gets damaged and this can affect metabolism. Our **injured** brain is less efficient. It wastes 1 red counter for every 1 that it uses properly. This means we need **2** red counters and **1** yellow counters to make 1 green.

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| --- | --- | --- | --- |
|  | **In** | **Out** | **Success?** |
| RED | BLUE | YELLOW | GREEN | RED | BLUE | YELLOW | GREEN |
| ***a)*** | 3 | 2 | 2 | 0 |  |  |  |  |  |
| ***b)*** | 1 | 4 | 1 | 0 |  |  |  |  |  |
| ***c)*** | 3 | 2 | 1 | 0 |  |  |  |  |  |
| ***d)*** | 5 | 2 | 2 | 0 |  |  |  |  |  |

How could you make sure the brain gets what it needs in this situation? (Hint: look at situation ***d)***)

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**fMRI** measures metabolism by looking at how the deoxyhaemoglobin (BLUE) signal changes between going **in** and **out**.

Look at situation ***a)*** in the injured and healthy brain. Do you think that fMRI knows if the brain is working properly by looking only at the blue signal? Why?

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Normal **NIRS** measures metabolism by looking at how both the oxyhaemoglobin (RED) and deoxyhaemoglobin (BLUE) signals change between going **in** and **out**.

Look at the change in the number of red and blue signals in ***a)***  of the healthy brain. Are there any situations in the injured brain that have the same changes but are **NOT** successes?

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Our **Broadband NIRS** system can measure a signal called *cytochrome-c-oxidase* **(CCO)**. This signal is very similar to the green signal above, meaning we can *almost* measure metabolism and energy use directly.

What benefit does this have over fMRI and normal NIRS?

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In science, a model is a way to understand something by building an approximate version of it. Kind of like a painting of a landscape - it looks similar but it isn’t the real thing. Today you built a scientific **model** of metabolism in the brain and used it to look at healthy and injured brains.