Getting Nervous

In order to better understand the process of pain, we need to better understand what it is which underlies it.

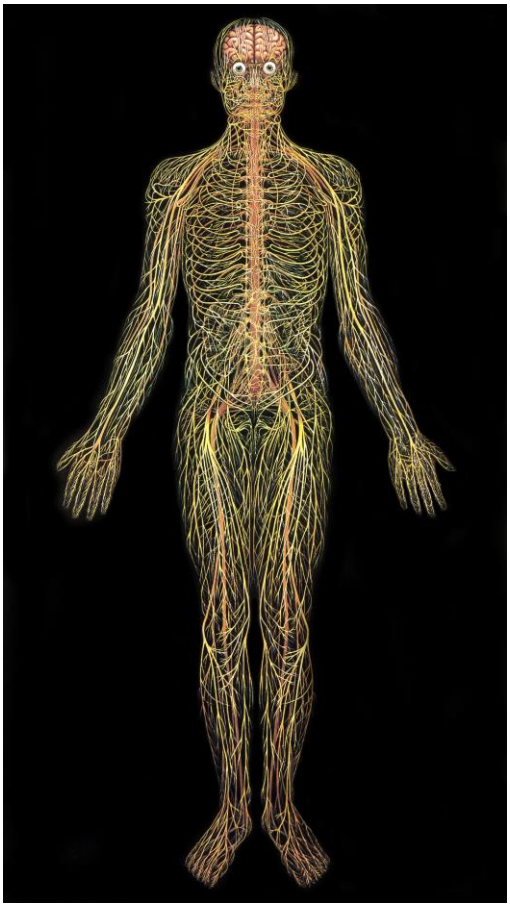
This means taking a closer look at the nervous system.

The nervous system as we know it is divided into two parts; the central nervous system (consisting of the brain and the spinal cord) and the peripheral nervous system (consisting of the peripheral nerves throughout the rest of the body). The reason we have this division is for simplicity, but also because while it is one complete system, both aspects have slightly different, although complementary roles.

Now, this division is useful from an anatomical point of view, but in reality it is one complete system, with minimal barrier between tissue.

That's why when you put stretch on the peripheral nervous tissue, you can also put stretch on the spinal cord.

To quote Lorimer Moseley and David Butler, '**there are no fences in the nervous system'**[1].



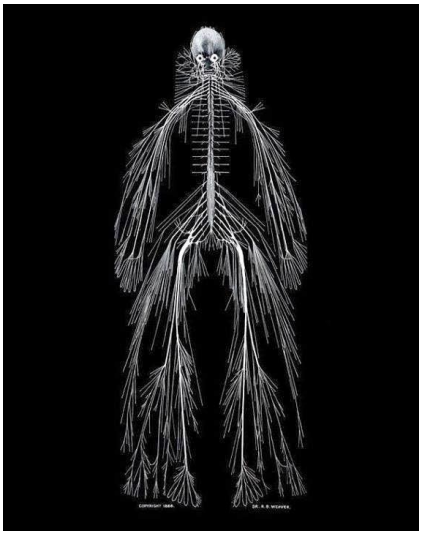
If we look at the nervous system anatomically, it looks a little something like this. This is good representation of the nervous system and how it covers almost every inch of the human body.

Most representations will show the major nerves of the peripheral nervous system, but in reality, nervous tissue covers every inch of the skin we are encased in.

It is through this expansive network of nerves that we can feel. It is the reason we have the sense of touch, ability to feel hot and cold, pressure and of course, pain.

The skin is the outer barrier of the nervous system and the way in which we interact with the world. It is the starting point where those sensation are experience.

If we want to look at the real-life nervous system, it looks like this:



The Nervous System of Harriet Cole[3]

Dr Weaver with the Nervous System of Harriet Cole[4]

As somewhat gruesome as this image is, it is also rather incredible. You can see how when laid out, the nerves essentially outline a visual image of the human body. This is in fact a complete and intact nervous system, dissected from a lady by the name of Harriet Cole in 1887 by Dr Rufus B. Weaver (she was the cleaner at the university's medical lab, but don't worry she donated her body willingly!). It was apparently the first dissection of its kind at that time[4].

And it's quite impressive.

It also gives you an appreciation for the complexity and overall coverage of the human body the nervous system has. It comprises 72km of nerves, and a brain that is roughly 1.2-1.4kg in weight (roughly 5 times the size it needs to be to run a body of our size)[5]. It makes up only 2% of the overall body mass, but uses 20% of the available energy in the body, consisting of oxygen and glucose[5]. The dissected image above shows the main components of the nervous system, as well as the larger peripheral nerves, but there is likely much, much more nervous tissue throughout the tissues and skin which we don't see there (which I mentioned with the picture further above).

To keep it healthy and functional, it *needs* this energy supply. A big part of this is transported via the bloody supply to these nerves, particularly in the peripheral nervous system.

The Peripheral Nerves

The peripheral nerves are the connection between your brain and spinal cord and your tissues. If we look at the simplistic pain pathway from yesterday, they are essentially the first point of contact for any external stimulus., which is then transferred to the central nervous system. As I've said, these nerve endings don't detect pain, the become stimulated by a number of things. Different receptors are stimulated by different things.

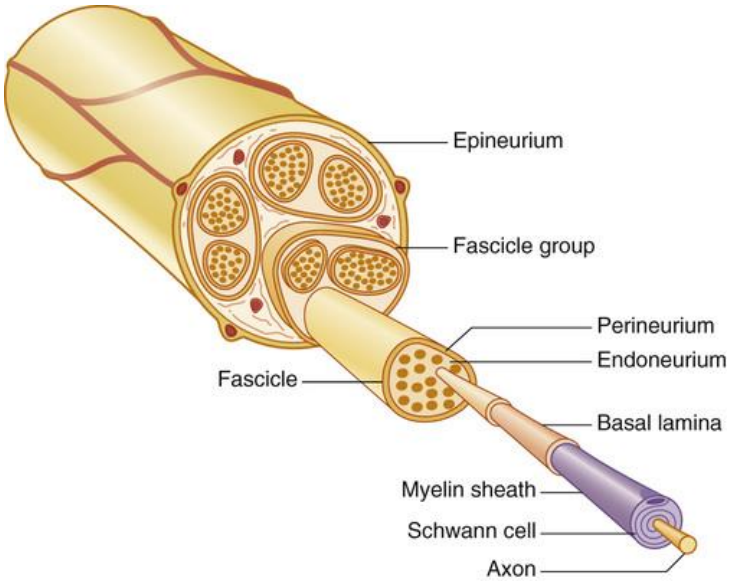
They can respond to mechanical changes such as pinch or pressure, temperature, such as hot or cold, or chemical changes both from outside the body (eg. nettles or allergens), and inside the body (chemicals released by the cells or carried in body fluids, such as lactic acid)[1].

So each of these sensors are specialised, they only open up to specific things. Most importantly, these sensors only live for a few days before they are replaced, ***which means your sensitivity is continually changing*.** You can become more sensitised to stimulus as anyone with persistent pain can attest to, but can also become ***less*** sensitised over time.

Which is important to know.

This means they also extend into the skin and are therefore your connection to the outside world. They are quite solid structures, and are able to poked and prodded just like a muscle (anyone who has hit their 'funny bone' would know, that's your ulnar nerve).

They are long cords within the body, made up of 50% ligament tissue and 50% neurones, of which there are tens of thousands in each nerve. Nerves can be injured just like any other tissue. They look like this:



Schematic presentation of a peripheral nerve[6]

These nerves can be injured by cutting, too much squeezing and pulling, by irritating chemicals around the nerve and by sustained reduction in blood supply[7]. I think those last two are important, because what that is saying is that you can have pain along the distribution of the nerve (or nerve pain as most people would put it) without actually having **physical damage to the nerve*.*** Inflammation in surrounding tissues (ie. from a separate injury) can stimulate danger signals resulting in nerve firing and pain, as can a significant reduction in blood supply.

To remain nourished, they need energy. To receive energy, they need blood supply. To maintain blood supply, they need circulation. To maintain circulation, they need movement.

To keep nerves healthy, they need movement.

Sustained positions and lack of movement can reduce blood flow, which can in turn make the nerves a little cranky.

They are sensitive little buggers.

Looking Central

So after a quick overview of the peripheral nervous system, we move further inward to the central nervous system. As I said before, for all intents and purposes, this is the brain and the spinal cord. Two very important pieces of the body, but you probably already figured that.

Once we get the peripheral nerves stimulated and they begin firing, the first place they reach is the spinal cord (which you can see on our pain pathway picture from yesterday). Where they land here is something called a synapse. Think of a synapse as a train station. The signal has been carried along one line, but it's time to change lines to it can heard towards its destination (if only train lines were *this* fast!).

As the signal hits the synapse, it causes chemicals to be poured out. The same as there are different sensors for different things in the nerves, there are different sensors in the synapse which will detect certain mixes of chemicals. Danger messages will stimulate danger sensors in the synapse, causing them to fire, which will them shoot the message up to your brain.

What makes this little changeover so important, is that it is also the area where this message can be halted if needed. Just as there are pathways heading up to the brain, there are also pathways heading down. These are extremely powerful, and can shut down the message if there is something more important at stake (1). Think of stories of people playing out grand finals with significant injuries, or stories of soldiers in war who have been able to fight on with horrific injuries, only to realise after the fact the trauma was even there.

This is quite contextual and I'll touch on it later in the week.

That's because the signal being sent down this pathway is ***60 times more powerful*** than any drug you can inject or ingest[1]. Imagine if we could harness that! It does this by allowing a flood of chemicals such as opioids or serotonin causing the sensors to become ***less*** excited.

This is called descending inhibition.

If this doesn't happen, the signal is then transferred up the spinal cord to the brain.

Back to the pain, please…

From this description of the nervous system, we can see how it controls everything we do, in particular our experience of pain. Without it we wouldn't have pain.

We also wouldn't exist, or have any form of consciousness (due to the brain).

So all pain is essentially derived from the nervous system as a response to what is happening in the tissues. This makes pain neurogenic, ie. arising from the nervous system. This can be damage to the tissues, or *potential* damage, as the brain constantly tries to make decisions to protect you.

It tries to *predict* what may happen without you thinking about it.

And it does this via the nervous system, which means that technically there is no such thing as *muscle* pain, or *joint* pain.

All pain is neurogenic.

Broken legs, papercuts, heart attacks and more are all sensations created by the brain due to **what it interprets** is happening in the body.

Not what is *actually* happening.

Tomorrow, we'll have a look at what happens once these signals leave the spinal cord and hit the brain, that slightly important lump of grey matter which sits inside you skull and how it works for you (whether you are consciously using it or not!)…

References

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7. Butler, DS, 2000, *The Sensitive Nervous System*, Noigroup Publications, Adelaide
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