Understandings:

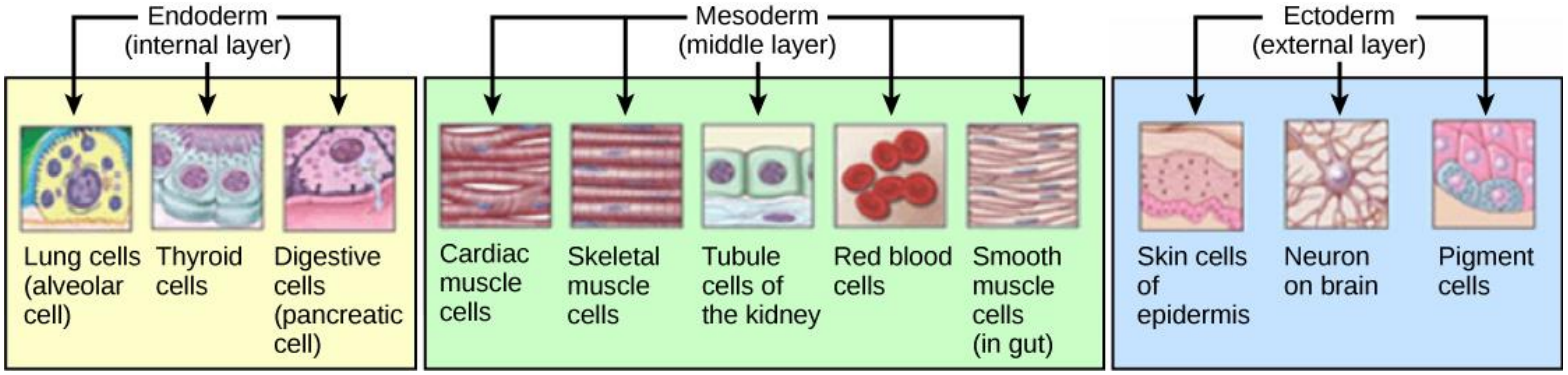
1. Explain the process of neurulation.

- First of all, what is neurulation and where is neurulation?

Neurulation is one of many processes during development. The big picture is this.

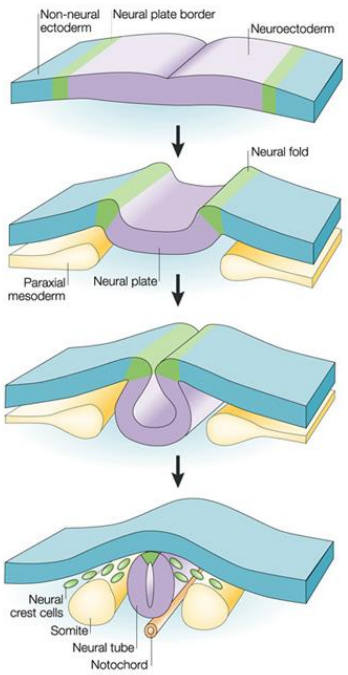
Gamete → Zygote → Morula → Blastula → Blastocyst → Gastrula → Embryo

Let's jump into gastrula. What the zygote has been doing is to divide so far and made some configurational changes (make a hollow or other kind of hokus pokus). During gastrula phase, cells are starting to differentiate and it is here where we are forming ectoderm, mesoderm and endoderm. These are the three germ layers and these will develop into the most essential parts of our body. Examples are shown.



So where does neurulation come in? Well, it is during what we call organogenesis (the genesis of organs). Once these three layers are established they start to differentiate further into organs, in this case the nervous system.

How does this then work? Well, unfortunately I cannot provide with a facilitated explanation for this since a developmental process is simply a process so we just have to know the steps.



This is a cross-section of the gastrula and we can see that there is something called neural plate (purple) on the ectoderm (blue).

This folds in and ectoderm combines itself. The process is strikingly similar to endocytosis.

The purple tube we just formed is called a neural tube and right below we simultaneously form the notochord (the definition for phylum Chordata). But well, you should ask "what is the difference between those two?"

Good question. What I can say at the moment is that notochord will become the backbone while neural tube will become the spinal cord. And yes, we still have the hole in our spinal cord.

2. Explain the development of neurons.
- The very first neurons are formed during the folding of neural plate. What we get is a neural tube as mentioned and this will develop into not only spinal cord, but apparently the brain, retina and posterior pituitary too. We would also get neural crest cells (in green dots above) that will form many other things including the autonomic nervous system.

In either case, neurons develop early at the ectoderm. And we call the cells in ectoderm that will develop into the nervous system as neuro-ectodermal cells, makes sense.

3. Explain migration of neurons.
- Neurons are produced in a factory (ectoderm) and they have to be distributed to a final place where they settle down and work. There are different methods of migration such as radial, tangential and axophilic. But do we need to know it? We just need to know that they do migrate.

4. Explain the development of axons.
- Axon is just an elongation of the cell. You know how a neuron looks like.

Perhaps the only thing new here is that there is only one axon per neuron but it may be branched and dendrites may be branched too. What determines this branching and direction of axon is chemical stimuli both during development but also during our learning stage (how much we use a particular signal pathway).

5. Explain how axons can grow out of the neural tube.
- Axons can grow to reach the very tips of our body. The longer ones are usually the neurons in peripheral nervous system.

Can they regrow? Yes they can as long as the source (cell body) is intact.

6. Explain the development of synapses.
- Synapse is the end of a neuron. It must have at least two if it is going to function (one at dendrite and one at end of axon).

7. Explain how synapses may decay.
- If one does not use a synapse, one loses it. If one uses the synapse, chemical residues will strengthen it.

8. Explain neural pruning.
- Pruning means to shorten/cut. So neural pruning happens when neurons are no longer used and they disintegrate by a process called apoptosis.

9. Explain the plasticity of the nervous system.
- Conversely, if neurons are used, it can lead to growth in dendrites or increase in receptors at the synapses. The ability to form new connections is called plasticity. Memory is a good example.

Applications and skills:

1. Explain spina bifida.

- Spina bifida is a malformation of the neural tube. If the neural tube is not completely closed, bundles of spinal cord and nerves attached to it may pop out and form a bump.

One must perform a surgical removal of this bump within 3 days to prevent further damage in the nerve. A huge bump on the back will make it vulnerable for physical damage, thus risks paralysis.

It usually occurs at the lower back because the closing of neural tube happens at both ends and the lower back is where they meet. When they do not meet, that is where nerves will leak.

2. Explain stroke and its consequences.

- Stroke happens when there is no proper blood supply to the brain. More specifically, it is the oxygen and glucose that needs to be supplied.

Strokes can happen in two ways. Ischemic stroke (90% of the cases) is when there is a blockage somewhere and therefore prevents blood flow. Haemorrhagic stroke is when there has been an accumulation of aneurysm that eventually bursts and therefore leaks blood.

Why is this so dangerous? It is dangerous primarily because neurons can only live for about 5 minutes. This is because neurons use high amounts of ATP to maintain the polarity, but as soon as they run out of ATP, they will go through of what is called excitotoxicity. Essentially, this will lead to calcium overload that can deform essential proteins. No proteins, cells die.

If you see someone having a stroke (sudden paralysis, discoordination, sudden blindness) the quickly call for the ambulance and look for an anticoagulant (not very probably that an anticoagulant will be around you though…). Since 90% of the stroke is ischemic, anticoagulant is worth a shot.

3. Be able to annotate embryonic tissues in Xenopus, used as an animal model, during neurulation.

- Xenopus is genus for frogs.

Know the three layers ectoderm, mesoderm and endoderm.

Know how the neural tube is folding.

Know the gut and gut cavity. This is the area under the endoderm.

Know the notochord. It is the dot under the neural tube and supports it.

Know the dorsal fin. Dorsal just means back.