1. What is the role of BMP during gastulation?

Ans: BMP is chemo-repulsive to precommissural axons. Precommissural axons avoid BMP and migrate towards the floor plate (also, draxin repulses precommissural axons and Shh and netrin attract them). BMP originates from the roof plate.

Ans2: During gastrulation, BMP4 is a morphogen in the animal cap: neurons if cell culture of animal cap is dissociate, else if intact+BMP4 then epidermis, else if BMP4 and dissociate then epidermal cells.

1. What is the difference between differentiation and patterning? What role does Shh play in these processes?

Ans: Differentiation: a cell leaves its stem cell like state and becomes morphologically different cell which not necessarily retains the full capacity of a stem cell. For example, it can become a progenitor cell or a full oligodendrocyte. Such a differentiated cell will be capable of fulfilling a very specific task and enter G0 phase (=> lateral inhibition). Patterning: A previously homogeneous cell area (all cells share the same type, for example all of them are stem cells) are exposed to a concentration gradient of a morphogen which, depending on the local concentration, will induce different morphological changes and thus deliver different cell fates. Such cells will want to pattern even further, for example, by having cells of the same type in the neighbourhood (promote their own cell type through maybe juxtacrine or paracrine signalling while inhibiting the other cell types) and thus we get sharp boundaries (=> French flag model).

Shh is such a morphogen: Depending on its gradient it can induce the differentiation of different motoneurons.

1. Describe the hallmark symptoms of schizophrenia and ASD. What is different what is similar between the two disorders?

Schizophrenia: Positive symptoms: hallucinations, thought disorders, illusions. Negative symptoms: anhedonia, social retreat, poverty of speech. Cognitive symptoms: memory problems, attention deficit, problems in executive tasks.

ASD: compromised behavioural, social and communicative skills: might never develop language or not fully, difficulties in maintaining or initiating a conversation, avoid direct eye-to-eye contact, don’t share happiness spontaneously, obsession with one or more object for an unusually long period of time, stereotypic repetitive behaviour (like rocking on the chair etc.), don’t react to name when called by mother for example, difficulties in forming friendships, … .

Similar: both have underlying genetic disorders concerning genes of the nervous system (synapse formation/connectivity/pruning). Differences: Intelligence not necessarily impaired in schizos, schizophrenia can be treated with medics and psychotherapy for complete or partial recovery (ASD cannot).

1. What is a discrete and a topographic map? Give examples of each.

Discrete map: every sensory neuron has exactly one target neuron in the CNS (they are 1-to-1). Example: The eye: every sensory neuron in the retina transmits its signal to exactly one neuron in the tectum.

Topographic map: spatial information is conserved in information transmission and processing. A sensory neuron in the retina which is ventrally orientated will have its target neuron dorsally orientated in the tectum (since the picture is actually inverted on the retina).

1. What is the role of neurotrophins in sensory nerve circuit formation? Name 2 neurotrophins

Neurotrophins are diffusible molecules that signal survival in axons that have reached a target area and want to innervate the tissue there. Specifically, they bind to the receptor which is a complex containing trkA,B,C and p75. If no signalling occurs, p75 will not be repressed and induce apoptosis. This is also a control mechanism, since there are different neurotrophins in different areas of the body and not all axons can bind them (only those which are supposed to be there, not those which mistakenly got to that area).

Examples: NGF and BDNF (NT3, NT4, GDNF)

1. What is the difference between intermediate and final targets? Name an example of an intermediate target. How do axons navigate intermediate targets.

During axon growth, axons seek the final area through repulsive and attractive cues. Since the final target, to which it wants to connect, is not near enough, it needs closer targets for guidance called guidepost cells or also intermediate targets. Navigation occurs through contact attraction (the intermediate target has for example laminin or cadherins on its surface) or contact repulsion (intermediate target has for example tensins or transmembral semaphorin3A). Example: Cells of the floor plate: posses NrCAM that interacts specifically with axonin-1 on precommissural axons.

1. What is is true for the sleep pattern of a 1 year old?
   1. Majority spent in REM sleep
   2. Polyphasic sleep pattern
   3. Clear sleep patterns during 24h TRUE – triphasic
   4. More SWA than 10yo
2. How can exocytosis be tested with FM fluorescence? How does the dye roughly work? Do presynaptic clusters release synaptic vesicles?

Ans: Procedure: Neurons are bathed in FM fluorescence such that the FM fluorophore is taken up and integrated into the membrane. Presynaptic neurons with AZ are stimulated such that they release SV => FM fluorescence gives a light signal that can be measured: Yes, there is SV release by presynaptic clusters.

1. What is the origin and migratory path of trunk NCC? What are their derivatives?

Derivatives: sensory neurons, chromaffin cells (adrenal medulla), melanocytes, glial cells, autonomous neurons. Migratory pathway: They originate on top from the roof plate (original origin: neural plate – they are the cells from the specified borders). The NCC that will eventuall make up the trunk migrate ventrally.

1. True or false
   1. Adult neurogenesis is a dynamic process dependent on environmental factors TRUE
   2. Adult neurogenesis persists in a substantial amount in the olf. Bulb throughout life TRUE
   3. In mammalian neural stem cells there exists a diffusion barrier in the ER lumen, which contributes to asymmetric inheritance of proteins FALSE(?)
   4. There is no neurogenesis beyond the embryonic phase of life FALSE
2. True or false
   1. Cre ?? is induced by tamoxifen TRUE IF CreERT IS MEANT
   2. Cre recombinase binds to repeat elements in the Cas9 sequence FALSE
   3. In vivo fate mapping is dependent on inheritable genomic alterations from the mother cells FALSE
   4. Delaminated NCC are multipotent TRUE – they are MULTIpotent
   5. NCC give rise to some smooth muscle cells in our body TRUE
3. SWA develops parallel with (before 20 years of age)
   1. Synapse density TRUE
   2. Glucose consumption TRUE
   3. White matter volume
   4. Total sleep duration
   5. Rem sleep