Brain development and neuroplasticity

The description gives the sequence of development. Students must understand and be able to define highlighted words. Definitions are in column three.

Stage	Description	Definitions
Early embryo	Within 3 days of fertilisation, repeated mitotic divisions, called cleavage, generate a solid ball of cells, called a morula. The cells move to make a hollow sphere called a blastula. Further divisions turn the blastula into a blastocyst, which has an outer layer of cells called trophoblasts, and the inner cell mass. This moves down the oviduct to the uterus and about 9 days after fertilisation, it implants in the endometrium.	
	Cells continue to divide rapidly by mitosis. They move in a process called gastrulation so that by 15 days after fertilisation, three distinct cell layers can be identified. These are the germ layers, which in the course of development, differentiate into all the adult tissues and organs.	
	The outer layer is the ectoderm. It invaginates and forms the neural tube by the end of end week 4 of the embryo's development.	

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Stage	Description	Definitions
Brain development	The anterior end of the neural tube expands as cells continue to divide. By week 5, the future **cerebral hemispheres** can be identified, although the sulci and gyri that make the surface so wrinkled are not seen until the 8th month.	Cerebral hemispheres – the two haves of the cerebrum joined by the corpus callosum; the portion of the forebrain expanded, in comparison with other mammals, in which grey matter on the brain surface, forming the cerebral cortex, is associated with brain functions considered to be most developed in humans, including reasoning, logic, the senses of morals and aesthetics.
	The rate of cell division slows down and cells differentiate into **neurones** and **glial cells**.	Neurone – an electrically excitable cell that transmits information along its membrane as an electrical impulse and to adjacent cells by a chemical signal. Glial cell – cells in the nervous system that are not electrically excitable but provide myelination and physical support and protection for the excitable cells.
	Neurones migrate to different parts of the developing brain and form the different brain structures. They extend axons and dendrites, and communicate with other neurones through synapses, making neural circuits.	
	Shortly after birth, neurones stop forming, but glial cells increase in number until adolescence.	

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Stage	Description	Definitions
Establishing neural circuits	New experiences and new information are accompanied by changes to neurone connections in the brain. For example, **synapses** may form or be lost; the number of **neurotransmitter** molecules secreted or the response in the post-synaptic neurone may change. So the brain has altered **neural circuits** and **neural pathways**.	Synapse – gap between two neurones through which neurotransmitter molecules diffuse from a neurone and initiate an impulse in another. Neurotransmitter – chemical messenger that diffuses from a neurone to a target cell, which is another neurone, a muscle fibre or a gland, and transmit a signal to the target cell. Neural circuit – a group of interconnected neurones. Neural pathway – groups of nerve fibres that connect different parts of the brain
	If you pay no further attention to the experiences or information that generated these new neural circuits, the synapses that maintain them may not last. But if you repeatedly use those new circuits, such as by re-reading the notes you took at school or by practicing your scales on the piano, they become more firmly established.	

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Stage	Description	Definitions
Neuroplasticity	**Neuroplasticity** is this ability of the brain to reorganise itself by forming new neural connections. It is most rapid in the first two years of life, when so much is learned. This is a critical period for learning, but it also happens right throughout your life, although learning many things, such as a foreign language, become harder.	Neuroplasticity - the brain's ability to reorganise itself throughout life by making new connection sand breaking old ones.
	As well as contributing to learning, neuroplasticity allows the brain to make new connections that will compensate for injury, such as when people relearn to talk after a stroke.	
Developmental plasticity	**Developmental plasticity** describes changes in neural connections during development as a result of environmental interactions as well as changes induced by learning.	Developmental plasticity - changes in neural connections during development brought about by learning and by environmental influences.
	Developmental plasticity occurs mostly in the first few years of life: a newborn baby has millions of neurones. In the cerebral cortex alone, each has about 2,500 synapses and by 2-3 years, this has increased to about 15,000 per neurone i.e. double that of the average adult brain.	
	In the **critical period** in early childhood, the nervous system must receive certain sensory inputs to develop these connections properly. This has been shown in children who were born deaf. They vocalise less as babies and, unless they have other form of symbolic expression, such as sign language, their language development is poorer.	Critical period – the time during which the nervous system is especially sensitive to particular stimuli. If these do not occur at this time, it may be impossible to learn a given skill or develop a particular function e.g. vision.
	Throughout life the neural connections are fine-tuned, through interaction with the environment. Some synapses strengthen and others weaken. Eventually, some unused synapses are lost in the process called **synaptic pruning**. What remains is an efficient network of neural connections. Synaptic pruning happens mainly in adolescence and by adulthood, the number of synapses for each neurone has fallen to 1000-10,000.	Synaptic pruning – the elimination of neurones and synaptic connections, increasing the efficiency of transmission of impulses in the brain.