Neuroscience (Option C2): Eduqas A Level Biology Exam Questions by Topic

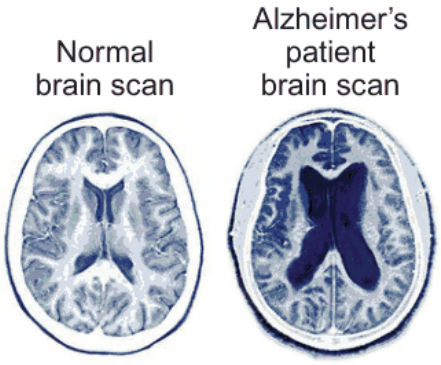
15 questions · 36 marks · about 43 minutes. Answer in the spaces, then check the mark schemes at the end.

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(c) Alzheimer's disease is a condition that causes gradual deterioration of tissue in the brain over several years. The onset of Alzheimer's disease is associated with increasing age.

Patients suffering from Alzheimer's disease show varying degrees of atrophy (brain shrinkage) as shown in the CT scan in **image 10.5**.

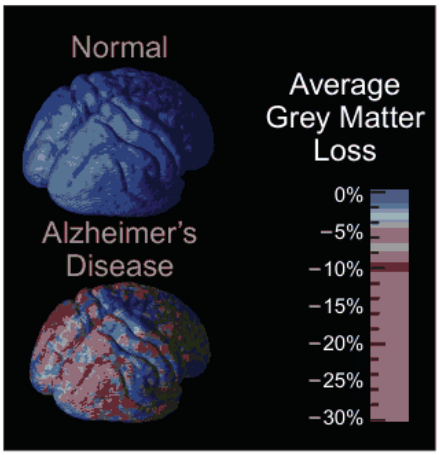
Image 10.5



The degree of atrophy can also be measured using an MRI scan such as the one shown in **image 10.6**.

Image 10.6

MRI comparison of a normal brain and the brain of a patient with Alzheimer's disease.

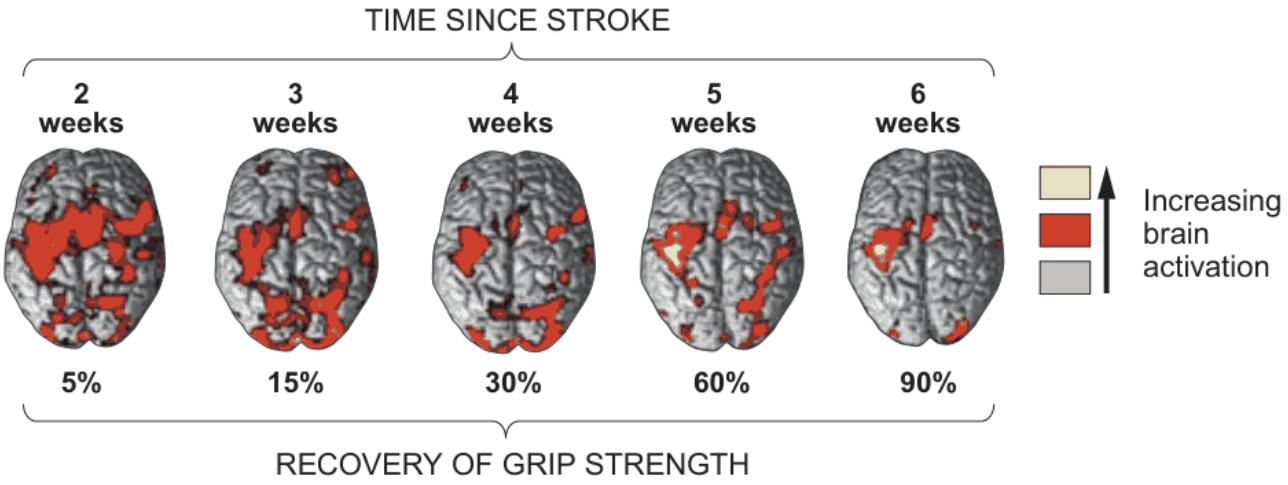


(i) Compare the way that a CT and MRI scan image is produced and suggest **two** advantages of using an MRI scan for monitoring the progression of Alzheimer's disease. [3]

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Question 2 · A level Component 3 · June 2018 · Q10(b)(i) · 3 marks

(b) A stroke is the interruption of blood flow to the brain. It may result in the death of brain cells. Individual patients can recover from strokes over a period of time. The image below shows functional magnetic resonance imaging (fMRI) scans showing the brain during repetitive gripping with the hand. Each brain image represents the activation pattern at different time points over the first six weeks after a stroke for one patient. After 6 weeks, the image is very similar to what is seen during learning of a new complex motor task in the undamaged human brain.



(i) With reference to the image, describe the advantage of fMRI over computerised tomography (CT) and magnetic resonance imaging (MRI) scans. Explain what has happened in the brain in order to recover from the stroke. [3]

Question 3 · A level Component 3 · June 2017 · Q9(b)(iii) · 2 marks

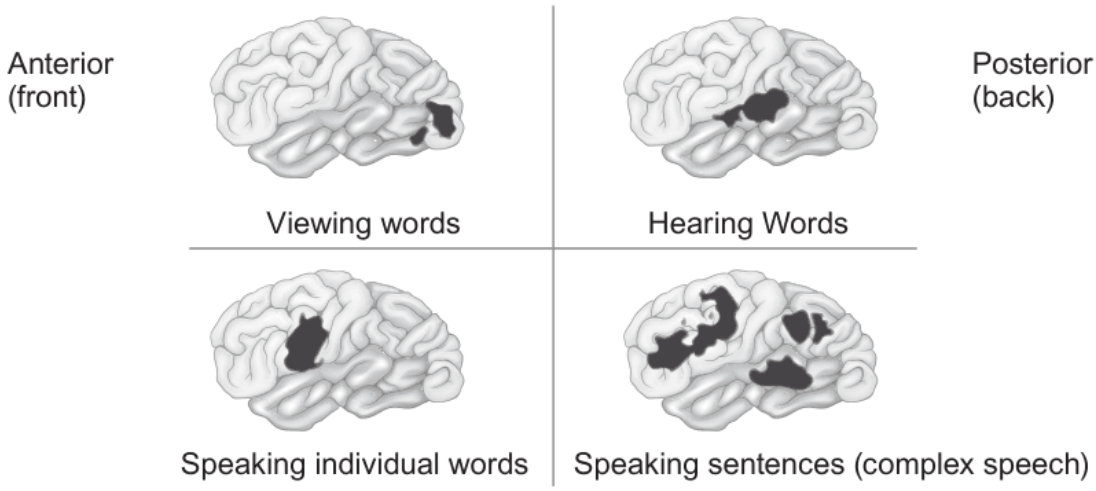
(iii) A further investigation is to be carried out to look at changes in brain activity during a map reading exercise whilst driving the taxi. Suggest a brain imaging technique that could be used and explain why it would be more suitable than MRI. [2]

Questions, mark schemes and examiners' report extracts © WJEC CBAC Ltd (Eduqas).

(d) Humans are the only primates to develop the ability to use speech.

Image 9.8 shows a PET scan of the brain of a single individual. It indicates the highest activity in different parts of the brain as the individual carries out activities associated with speech and language. These areas appear darker on the image.

Image 9.8



A PET scanner detects the quantity of radiation from the most active areas of the brain then uses the data to produce an image.

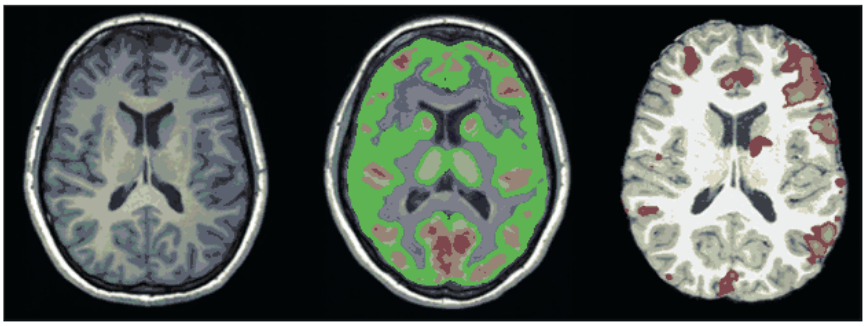
(i) Describe and explain the procedure that causes the areas of highest brain activity to appear darker in a PET scan image. [3]

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Question 5 · A level Component 3 · June 2025 · Q9(b)(i) · 2 marks

(b) **Image 9.3** shows three types of scan which are used to visualise the brain.

Image 9.3



CAT/CT Scan PET Scan fMRI Scan

(i) Describe **two** advantages of using scans to visualise the brain. [2]

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Question 6 · A level Component 3 · June 2025 · Q9(b)(iii) · 2 marks

(iii) The coloured areas on the fMRI scan correspond to increased flow of oxygenated blood in that region.
Explain how this can be used to monitor brain activity. [2]

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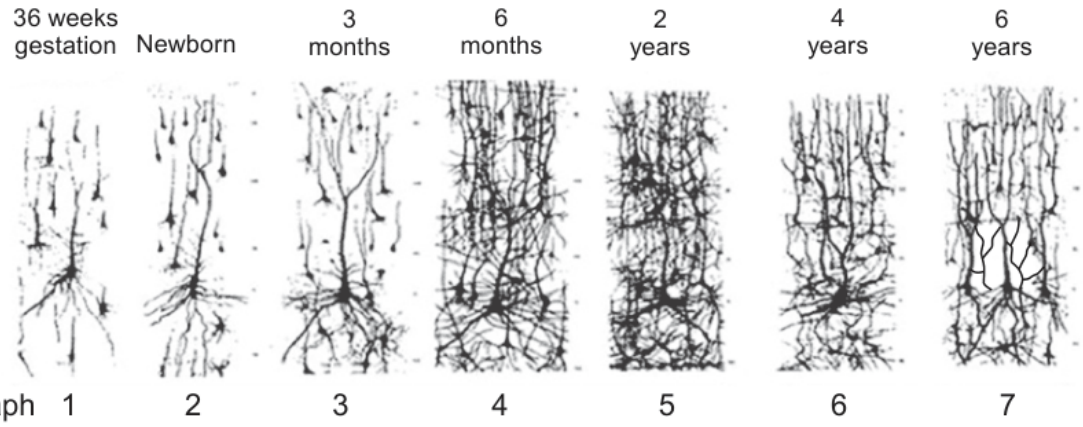
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(b) Mammals exhibit innate and learned behaviour.

Young mammals need sensory input during a critical receptive stage of early development. This enables them to develop learned behaviour that also uses motor areas of the brain.

Image 10.3 shows the developmental changes in the neurones of a human cerebral cortex before, during and after this critical time period.

Image 10.3



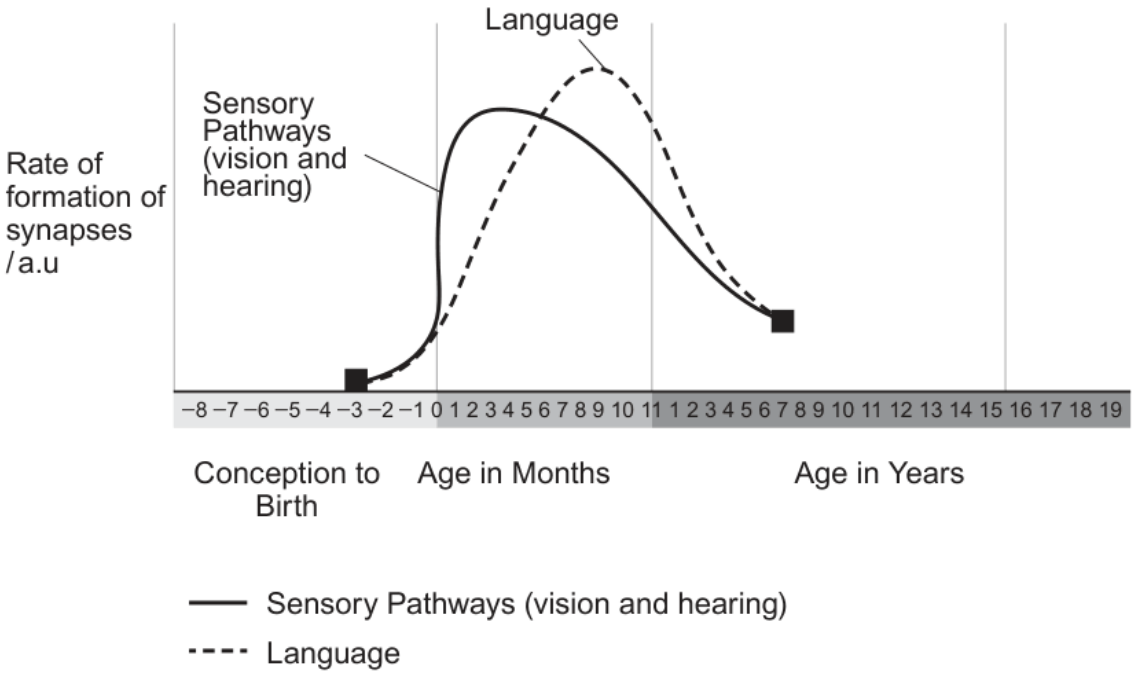
(i) State the name that describes the changes in the development of neurones illustrated in **image 10.3**. [1]

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Graph 10.4 shows the rate of formation of synapses involved in sensory pathways and language development in early childhood.

Graph 10.4



(ii) Using information from **graph 10.4**, together with your own knowledge, explain why hearing deficiency during the critical period for the formation of sensory pathways can result in poor speech and language development. [3]

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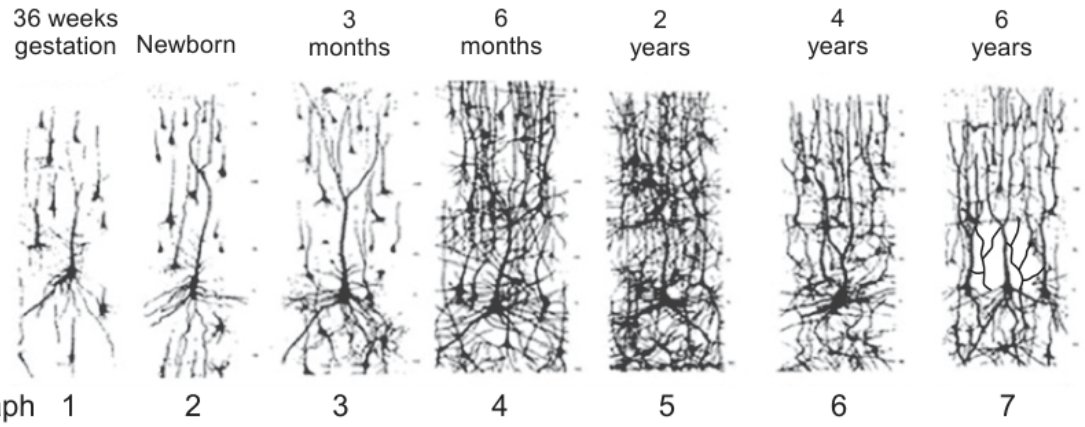
Question 9 · information from earlier in the question

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Image 10.3 shows the developmental changes in the neurones of a human cerebral cortex before, during and after this critical time period.

Image 10.3



Question 9 · A level Component 3 · Autumn 2020 · Q10(b)(iii) · 1 mark

(iii) With reference to the neurones of a 4 year old and 6 year old (photographs **6** and **7**), suggest why speech and language does not improve significantly if hearing is restored after the critical period. [1]

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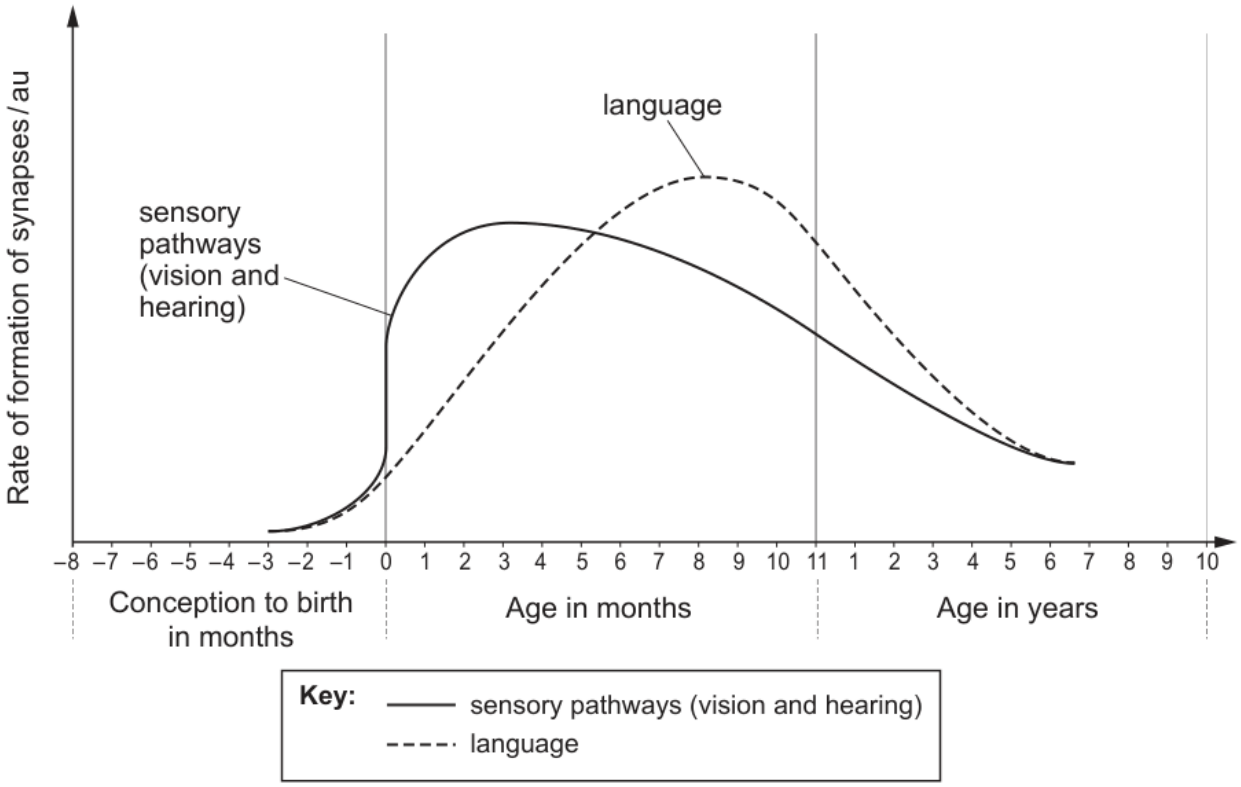
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During early childhood, the rate of formation of new synapses between neurones in the central nervous system in the healthy developing brain reaches its maximum.

Graph 9.3 shows the rate of formation of synapses involved in sensory pathways and language development in early childhood.

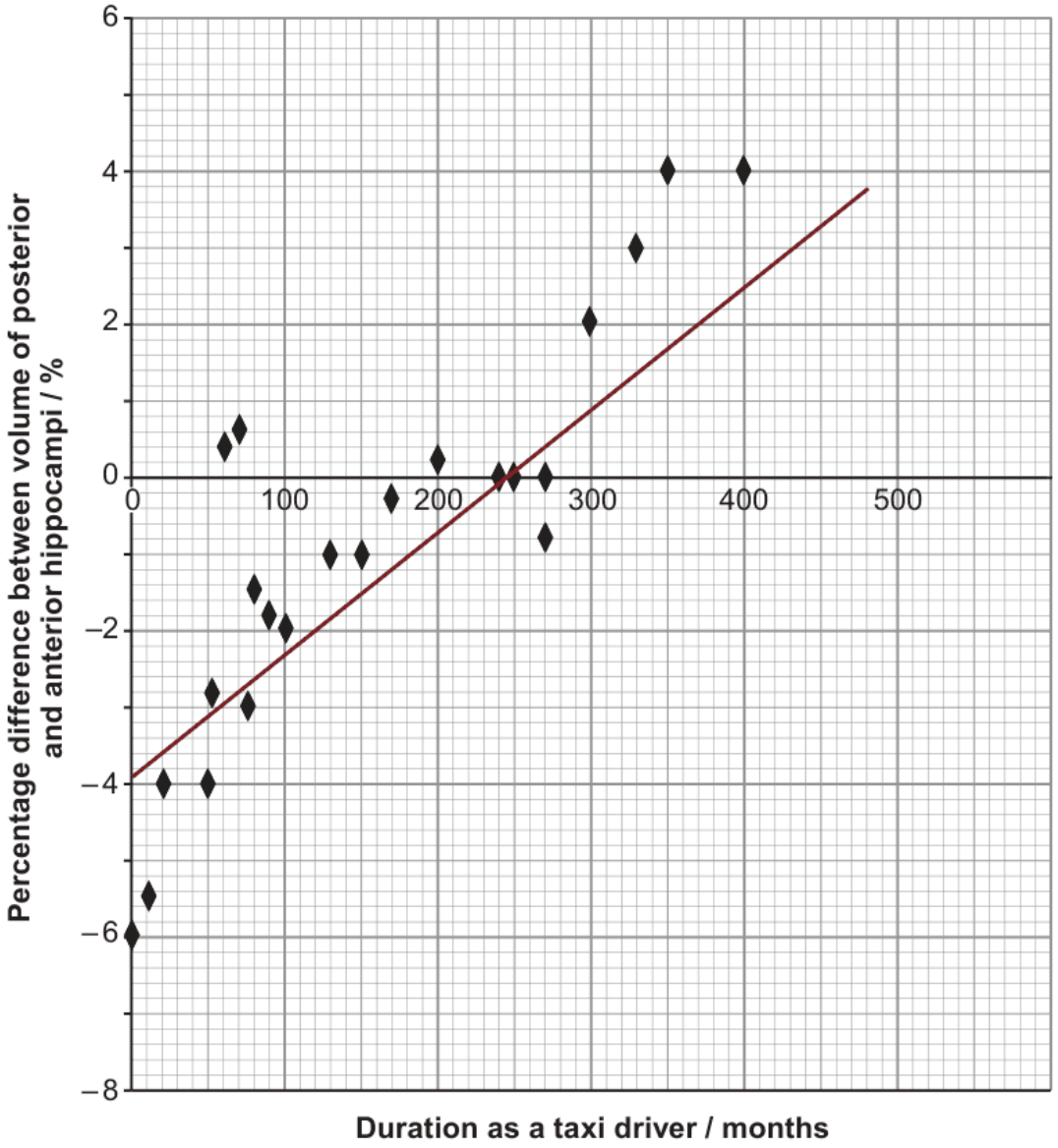
Graph 9.3



(iv) Use **Graph 9.3** to suggest why children who are not exposed to language between birth and four years of age are less likely to develop language skills. [4]

Questions, mark schemes and examiners' report extracts © WJEC CBAC Ltd (Eduqas).

The percentage differences between the volumes of the posterior and anterior hippocampi were plotted against the duration of time spent as a taxi driver.



(ii) The line shown on the graph is a correlation line. Using the trend shown and your knowledge of brain structure and neuroplasticity, what conclusions can be drawn? [4]

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Question 12 · A level Component 3 · June 2023 · Q9(b)(ii) · 2 marks

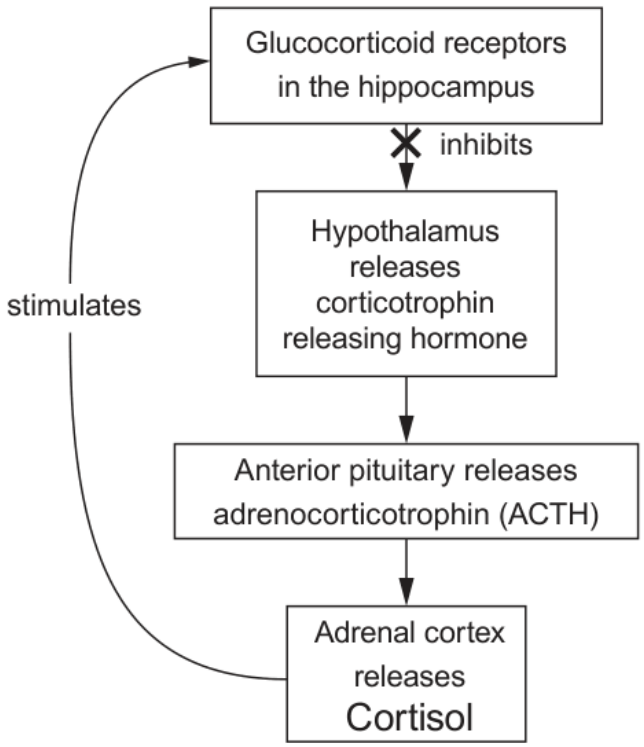
(ii) Explain how the brain can recover following a brain injury that destroys neural pathways. [2]

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One example of epigenetic modification is the methylation of DNA that prevents transcription of a gene called NR3C1. This gene codes for glucocorticoid receptor proteins in the hippocampus of the brain.

Image 9.3 shows how glucocorticoid receptors are involved in controlling the release of the hormone cortisol.

Image 9.3



Cortisol is a glucocorticoid hormone released by the adrenal cortex as a result of prolonged exposure to stress.

Blood samples from adults who suffered childhood Post Traumatic Stress Disorder (PTSD) show higher concentrations of cortisol than normal.

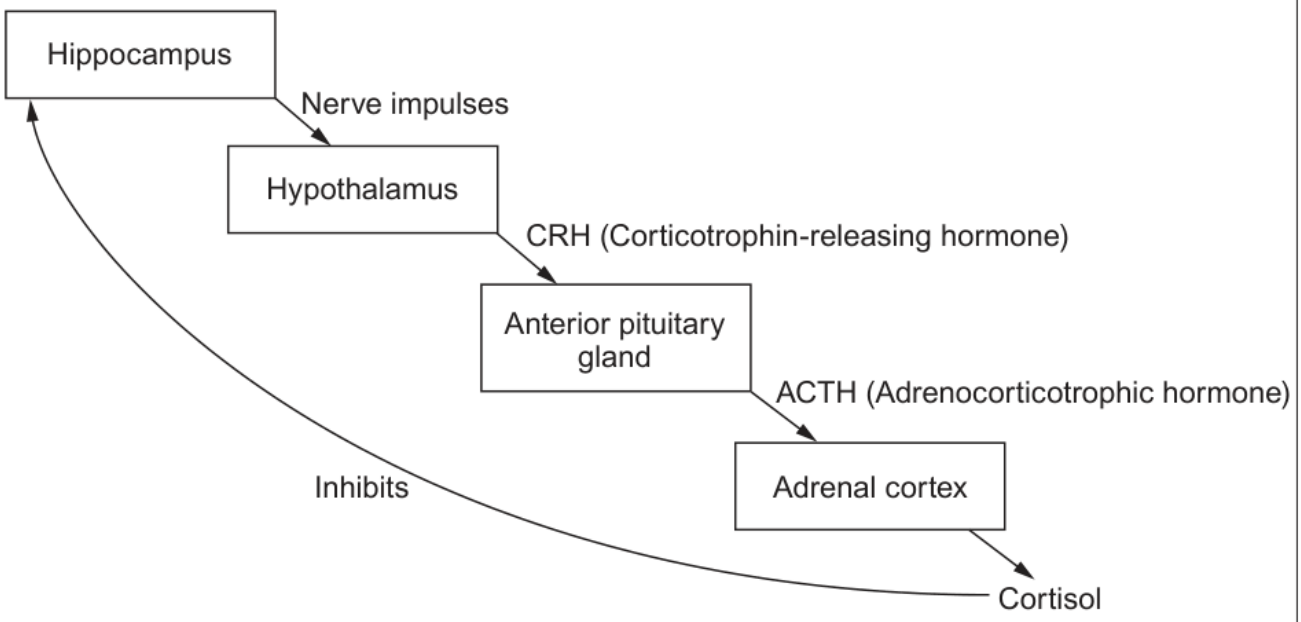
(ii) Use the information in **image 9.3** to explain how methylation of the NR3C1 gene could lead to higher incidences of stress-related mental illnesses in survivors of childhood PTSD. [3]

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Question 14 · information from earlier in the question

(c) The hypothalamus releases a hormone, which leads to the production of cortisol as shown in figure 10.5:

Figure 10.5



Question 14 · A level Component 3 · June 2019 · Q10(c)(ii) · 1 mark

(ii) The blood cortisol levels of an individual who had suffered a traumatic childhood would be expected to be higher than normal. Explain why such individuals may be pre-disposed to mental illnesses throughout their lives. [1]

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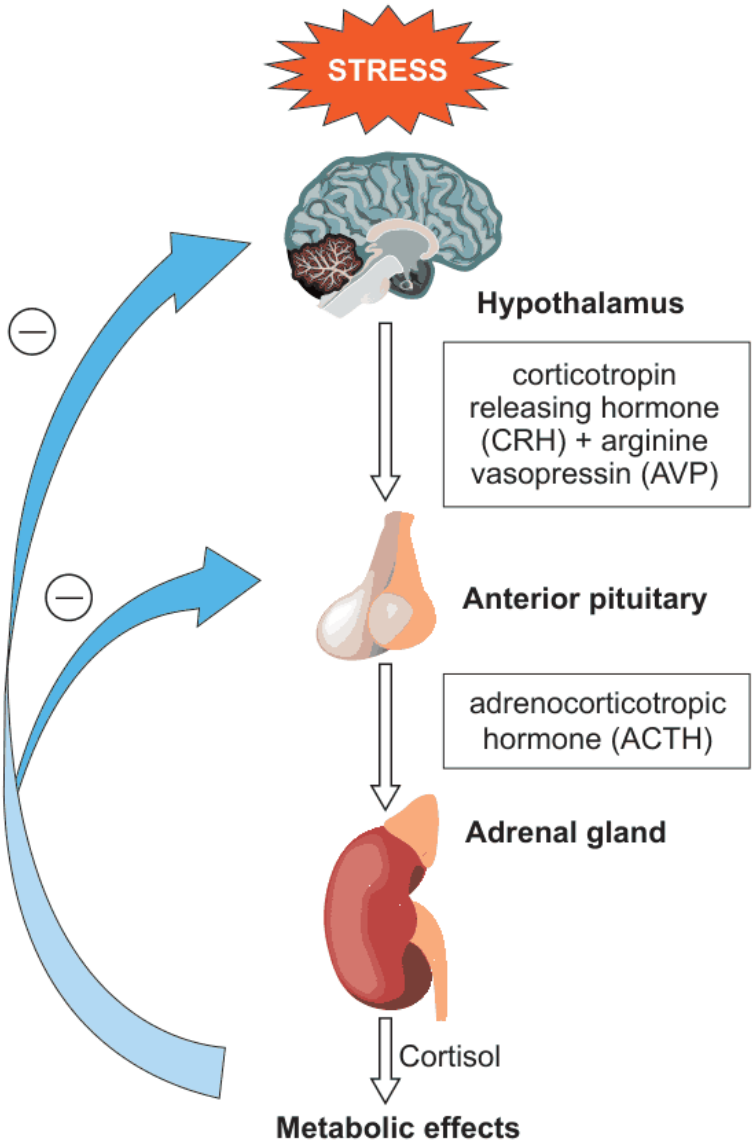
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Question 15 · information from earlier in the question

(c) Cortisol is produced by the adrenal glands in response to stress via the pathway shown in **Image 9.4**.

Image 9.4



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Question 15 · A level Component 3 · June 2024 · Q9(c)(iii) · 2 marks

(iii) Some individuals have an unusually high concentration of corticotropin releasing hormone in their bloodstreams.
Suggest a possible life event that may have caused such raised levels and explain how these raised levels would affect the way such individuals respond to stressful situations. [2]

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Mark schemes

Question 1 · A level Component 3 · Autumn 2020 · Q10(c)(i) · 3 marks

(c)	(i)	CT scan uses X-rays AND MRI scan uses magnetic field/and/or radio frequency pulses (1) CT scan, (computer) produces (multiple) 2d/cross-sectional images **and** MRI scan, (computer) can produce 3d image (1) MRI scan less risk to patient (does not involve X rays)/ MRI scan allows volumes to be measured/ MRI can show greater <u>detail</u> of soft tissue (of the brain) (1)	2	1	3

Question 2 · A level Component 3 · June 2018 · Q10(b)(i) · 3 marks

(b)	(i)	fMRI provides information on brain function + whereas MRI/CT scan provide images which show structure (1) Any two (x1) from • Neuroplasticity (1) • Undamaged axons grow new nerve endings to connect damaged neurons (1) • Recovery of function is associated with less (area of) brain activity, due to increasingly efficient neural circuitry (1)	1 1	1	3	

Question 3 · A level Component 3 · June 2017 · Q9(b)(iii) · 2 marks

(iii)		Electroencephalography /EEG (1) portable (whereas as MRI isn't)/ Owtte (1)	1	1		2

Question 4 · A level Component 3 · June 2022 · Q9(d)(i) · 3 marks

(d)	(i)		A (small quantity of) {radioactive isotope/radioactive fluorine/^{18}F} injected into the patient/subject. (1) <u>More</u> radioactivity taken up by cells that {are most active/have highest glucose uptake /have highest rate of respiration} (1) Quantity of radioactivity {converted/ transduced} to an image. (1)	1	2	3	1

Question 5 · A level Component 3 · June 2025 · Q9(b)(i) · 2 marks

(b)	(i)	Without need for surgery / non invasive (1) Show details of {entire brain / soft tissue / owtte} (1)	2			2	

Question 6 · A level Component 3 · June 2025 · Q9(b)(iii) · 2 marks

(iii)	More oxygen supplied (to neurones) in the {region of the brain / parts of brain} that are more active (1) (Aerobic) respiration provides {ATP/ energy} (to neurones) (1)	2	2		

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Question 7 · A level Component 3 · Autumn 2020 · Q10(b)(i) · 1 mark

(b)	(i)	Neuroplasticity (1)	1	1

Question 8 · A level Component 3 · Autumn 2020 · Q10(b)(ii) · 3 marks

(ii)	Any **three** (x1) from: • Maximum rate of formation of synapses for hearing is <u>before</u> maximum rate of formation of synapses for speech/language development (1) • Hearing needed (to develop speech/language/)/hearing deficiency has caused no sensory input for sound (1) • So cannot develop motor functions/description of control of mouth/larynx in order to produce speech/language (1) • Use of data (1)	2	1	3

Question 9 · A level Component 3 · Autumn 2020 · Q10(b)(iii) · 1 mark

(iii)	(many) synapses lost/synaptic pruning before hearing is restored/ remaining synapses haven't been strengthened by appropriate sensory experience connections not reinforced by sensory stimulation weaken (1)	1	1

Question 10 · A level Component 3 · June 2023 · Q9(b)(iv) · 4 marks

(iv)	**Any 4 (x1) from:** Synapse formation increases rapidly from birth to 4 months / valid use of data (1) Rate of synapse formation in sensory pathways is highest during this time (1) If {Speech/Language} areas of the brain are not stimulated synapses do not form (1) There is more pruning of unused synapses (1) After critical period – brain is 'hard wired' and more difficult/impossible to form new synapses (for language) / harder to learn language after four years / after synaptic pruning (1)	4	4

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Question 11 · A level Component 3 · June 2017 · Q9(b)(ii) · 4 marks

(ii)		Positive correlation/ as time increases percentage difference increases(1) neuro plasticity: change in structure of brain / new neurones/ new neural pathways/new (neural) connections/ new synapses/ synaptic pruning (in response to change) (1) ACC ref to strengthening / reinforcing / weakening neural pathways redistribution of neurones from anterior to posterior (1) (1) redistribution of neurones from anterior to posterior (1) (indicates) map / street name memory stored in posterior hippocampus (1)	2	2	4	2	

Question 12 · A level Component 3 · June 2023 · Q9(b)(ii) · 2 marks

(ii)		Neuroplasticity; (1) Neurones can grow and make new connections to bypass the damaged area (1)	2		2		

Question 13 · A level Component 3 · Autumn 2021 · Q9(b)(ii) · 3 marks

(ii)		(If gene/NR3C1 is not transcribed/expressed) Glucocorticoid receptors not produced. (1) So cortisol cannot bind. (1) **Any one from:** Negative feedback prevented. (1) Hippocampus continues to stimulate pathway/description of pathway/hippocampus is not inhibited from stimulating hypothalamus/corticotrophin release not inhibited. (1) Continued/higher cortisol production (causes increased stress related illness). (1)		3		3	

Question 14 · A level Component 3 · June 2019 · Q10(c)(ii) · 1 mark

(ii)	Negative feedback doesn't work, (This increases vulnerability to mental illness.)	1	1

Question 15 · A level Component 3 · June 2024 · Q9(c)(iii) · 2 marks

(iii)	May have suffered trauma during childhood (1) {Increased levels of ACTH in blood / Increased cortisol production} causing them to become over-stressed (1)	2	2		

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