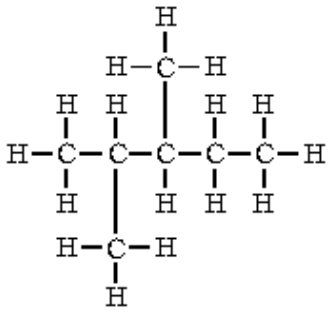
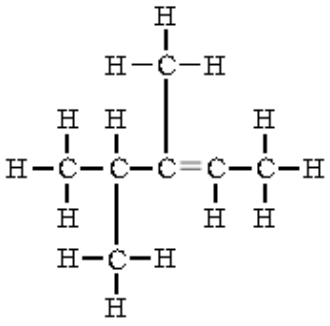
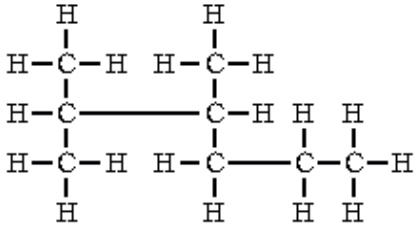
(a) From the full structural formulas in Figure 1, labelled with the letters A F, identify the three molecules that are isomeric. In your answer briefly discuss your selection and explain why you discounted the other three molecules.



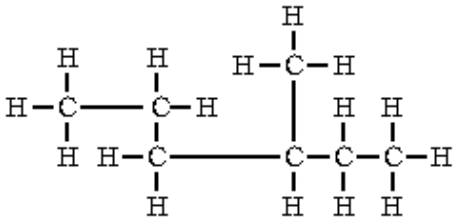
A



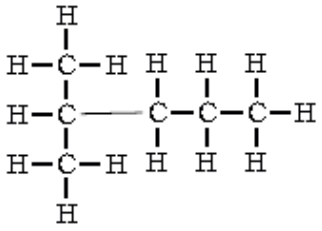
D



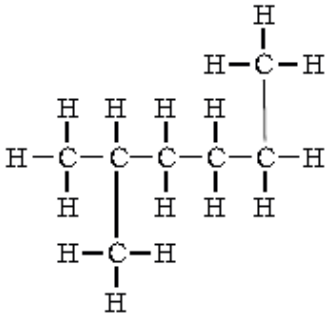
B



E



C



F

Answer:

Molecular formula of structure A : C_7H_{16}

Molecular formula of structure B: C_8H_{18}

Molecular formula of structure C: C_6H_{14}

Molecular formula of structure D: C_7H_{14}

Molecular formula of structure E: C_7H_{16}

Molecular formula of structure F: C_7H_{16}

Isomers are compounds having same molecular formula and different structural arrangement. Structures A, E and F have same molecular formula C_7H_{16} and different structural arrangement so they are isomers of each other. Molecular formulas of structures B, C and D are C_8H_{18}, C_6H_{14} and C_7H_{14} which are different from each other also different from structures A, E and F so they are not isomers.

(b) Compound **A**, shown in Figure 2, is a biologically important molecule that is produced naturally by many plants and animals. It is also used as a treatment for Parkinson's disease. This molecule contains a *chiral* carbon atom.

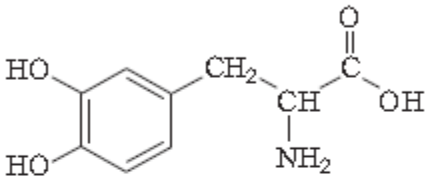


Figure 2 Compound **A**.

(i) Explain what the terms chiral atom and chiral molecule mean. (*Guideline: two or three sentences.*)

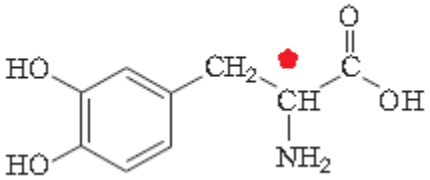
(ii) Indicate the chiral carbon atom present in Compound **A** by marking and labelling it on this copy of Figure 2.

(iii) Compound **A** contains four functional groups in addition to the benzene ring. Identify and name the functional groups in Compound **A** by circling and labelling them clearly on a copy of Figure 2. (*If you use the same copy of Figure 2 for parts (ii) and (iii) be sure the chiral carbon atom is clearly labelled rather than circled.*)

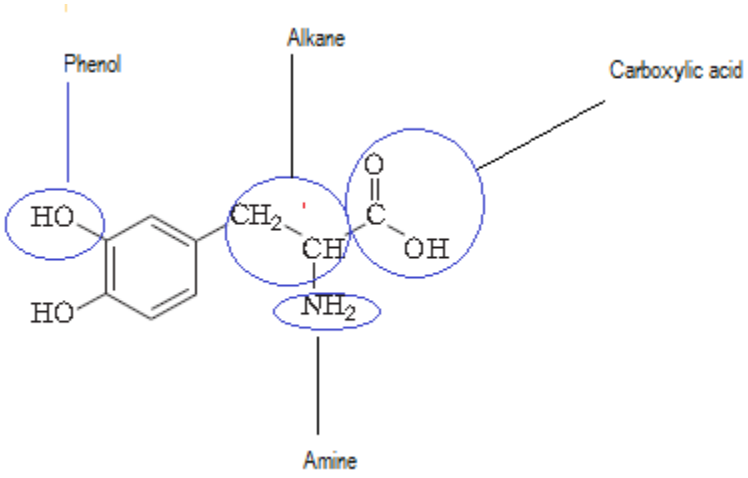
Answer:

i) Chiral atom is the atom bonded with four different groups. Chiral atom is optically active centre.
Chiral molecule is molecule having one or more chiral atoms which is not superimposable on its mirror image and also does not have plane of symmetry.

ii)



iii)



(c) Compound **B**, shown in Figure 3, is produced in the body from Compound **A**. Compound **B** works on several receptors in the brain.

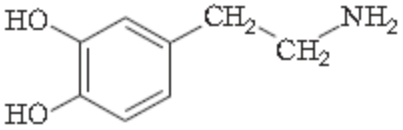


Figure 3 Compound **B**.

Identify two different types of intermolecular interactions which could be involved in binding Compound **B** to a target receptor in the brain. State which functional group(s) on Compound **B** could exhibit each of these interactions and describe the properties of each interaction. In your answer make it clear which complementary functional group would need to be present in the receptor for the interaction to occur. (*Guideline: up to 170 words.*)

Answer:

Types if intermolecular interactions

1. Hydrogen bonding
2. Van der Waals interactions

In case of intermolecular hydrogen bonding there is bonding between two molecules through hydrogen. Hydrogen bonding occurs when hydrogen atom is bonded to more electronegative atom i.e. oxygen, nitrogen and fluorine. Hydrogen bonding does not occur when there is no significant difference in electroneagtivity. In this compound in case of hydroxyl group hydrogen atom is bonded to oxygen atom and in case of amine group hydrogen atom is bonded to nitrogen atom. Both nitrogen and oxygen are more electronegative atoms. Intermolecular hydrogen bonding take place Where one molecule is hydrogen donor and another molecule is hydrogen acceptor. Hydroxyl group (-OH) and amine group (-NH2) of compound B exhibit hydrogen bonding. Hydrogen atom bonded to oxygen atom of compound B form bond with hydrogen atom bonded to nitrogen atom of receptor and vic versa.
In case of Van der Waals interactions there is interaction between non polar molecules.

(d) The -NH_2 group on Compound **B** can react with benzoic acid, shown in Figure 4.

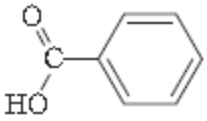
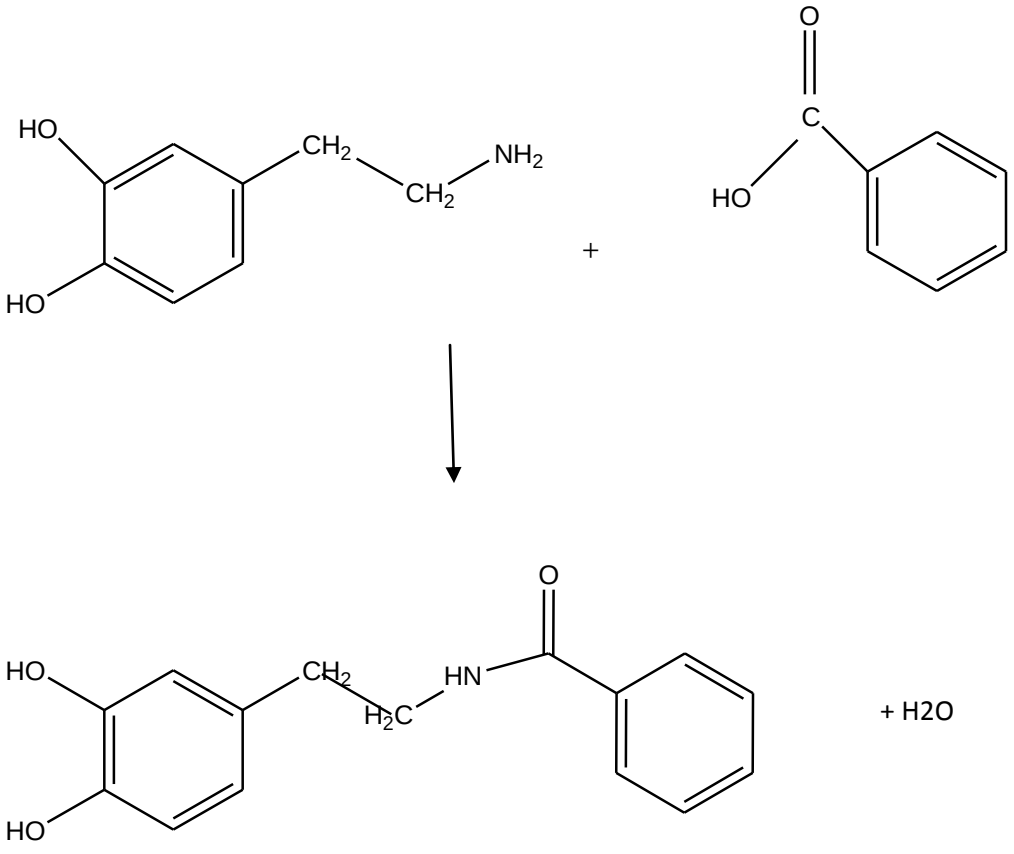


Figure 4 Benzoic acid.

Draw the product of this reaction, name the new functional group produced, state the type of reaction that has occurred, name any other products of the reaction and briefly explain how you arrived at your answer. (*Guideline: one or two sentences.*)

Answer:



New functional group produced in this reaction is amide. The type of reaction is dehydration where other product is water molecule. In this reaction hydroxyl group of carboxylic acid i.e. benzoic acid reacts with hydrogen of amine group of compound B and produced water molecule.

(e) Compound **C**, shown in Figure 5, can be produced from Compound **B** by means of a chemical process known as dehydrogenation (meaning 'removal of hydrogen').

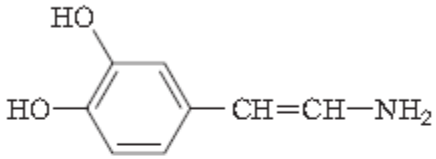
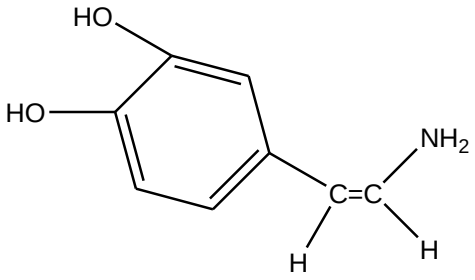


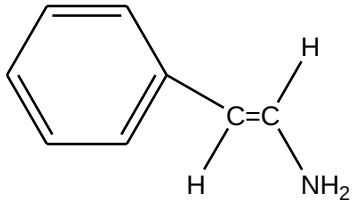
Figure 5 Compound **C**.

The presence of the double bond (C–C) in Compound **C** means that the molecule can exist in two different forms, identified by the prefix *cis* or *trans*, depending upon the arrangement of the functional groups and hydrogen atoms around the double bond. Draw the two possible forms of Compound **C** showing the positions of the functional group and hydrogen atoms. Assign each the appropriate prefix that would distinguish one from the other and briefly explain what these prefixes indicate.

Answer:



Cis



Trans

Cis isomers are the isomers in which both identical groups (hydrogen in this case) present on same side of the double bond.

Trans isomers are the isomers in which both identical groups (hydrogen in this case) present on different side of the double bond.