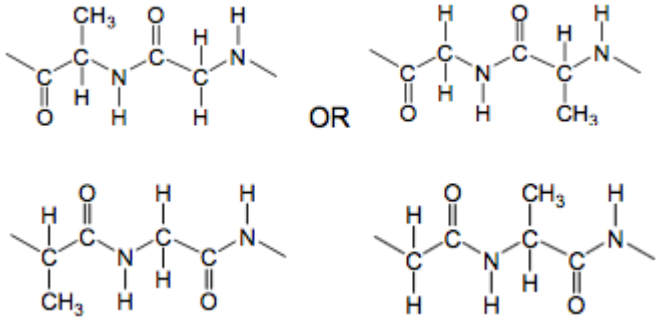
1

(a) (i)



Only one molecule of each used

M1 for 2 amide links

M2 CH_2 and $CH(CH_3)$

Allow 1 mark after one error

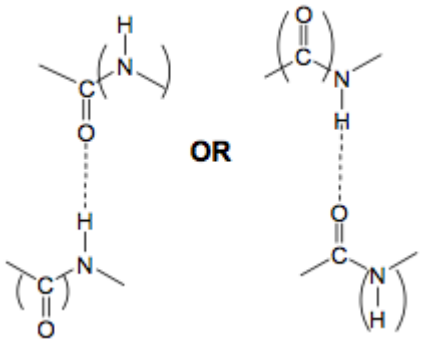
Dipeptide max 1

Treat both trailing bonds missing as one error

Ignore n

2

(ii)



No need to show lp

The covalent bond and the hydrogen bond either side of the H must be linear.

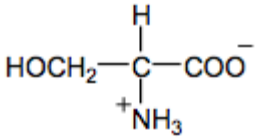
Allow

1

(b) (i) <u>2-amino-4-methylpentan(-1-)oic acid</u>

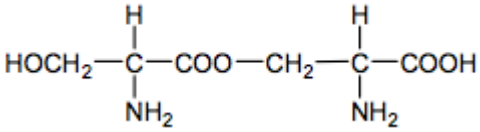
Ignore hyphens, commas, spaces

1

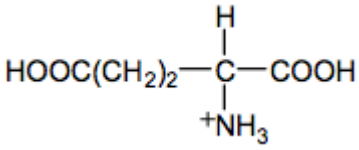
(ii) 

Allow -NH_3^+

1

(iii) 

1

(iv) 

Allow -NH_3^+

1

[7]

2 (a) Secondary

1

(b) Nitrogen and oxygen are very electronegative

1

Therefore, C=O and N–H are polar

1

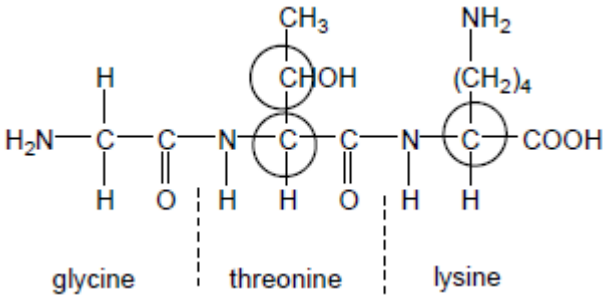
Which results in the formation of a hydrogen bond between O and H

1

In which a lone pair of electrons on an oxygen atom is strongly attracted to the δ+H

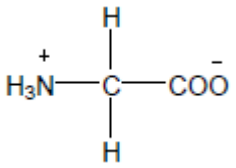
1

[5]

3 (a) 

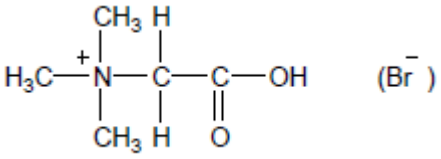
1

(b)

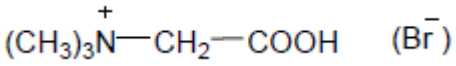


1

(c)



Allow

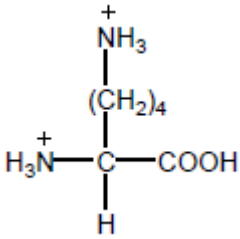


1

(d) 2-amino-3-hydroxybutanoic acid

1

(e)



1

[5]

4 (a) 2-deoxyribose

1

(b) Base A

If Base B stated, allow 1 mark only for response including hydrogen bonding

1

Top N–H forms hydrogen bonds to lone pair on O of guanine

1

The lone pair of electrons on N bonds to H–N of guanine

1

A lone pair of electrons on O bonds to lower H–N of guanine

Allow all 4 marks for a correct diagram showing the hydrogen bonding

Students could also answer this question using labels on the diagram

1

(c) Allow either of the nitrogen atoms with a lone pair NOT involved in bonding to cytosine

1

(d) Use in very small amounts / target the application to the tumour

1

[7]

5 (a) **Wear plastic gloves:**

Essential – to prevent contamination from the hands to the plate

1

Add developing solvent to a depth of not more than 1 cm^3:

Essential – if the solvent is too deep it will dissolve the mixture from the plate

1

Allow the solvent to rise up the plate to the top:

Not essential – the R_f value can be calculated if the solvent front does not reach the top of the plate

1

Allow the plate to dry in a fume cupboard:

Essential – the solvent is toxic

Allow hazardous

1

(b) Spray with developing agent or use UV

1

Measure distances from initial pencil line to the spots (*x*)

1

Measure distance from initial pencil line to solvent front line (*y*)

1

R_f value = *x* / *y*

1

(c) Amino acids have different polarities

1

Therefore, have different retention on the stationary phase or different solubility in the developing solvent

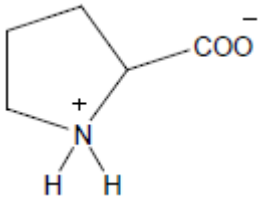
1

[10]

6 C

[1]

7 (a) (i)



Allow CO_2^- and NH_2^+

1

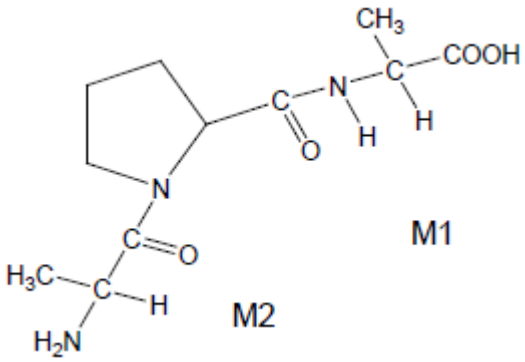
(ii) NOTE − **Two** marks for this clip

M1 for alanine section bonded through N

M2 for alanine section bonded through C

But penalise error in proline ring

1



Allow MAX 1 for correct tripeptide in polymer structure

1

(b) (i) 3-methylpent-2-ene

Ignore E-Z, commas, spaces or missing hyphens

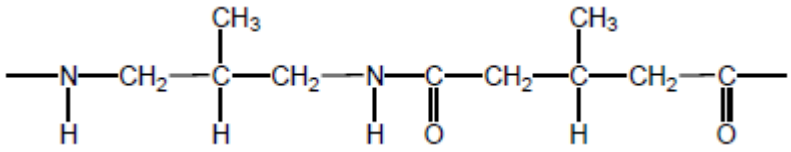
1

(ii) 4-amino-3-methylbutanoic acid

Ignore commas, spaces or missing hyphens

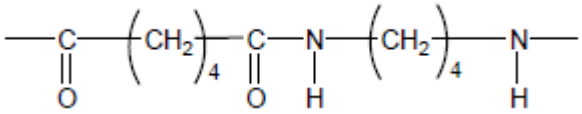
1

(iii)



or any polyamide section containing

8 carbons plus two C=O plus two N-H, such as



Trailing bonds are required

1

(iv) Non polar OR no polar groups / bonds (for attack by water / acids / alkalis / nucleophiles or for hydrolysis)

C-C bonds are strong

1

[7]

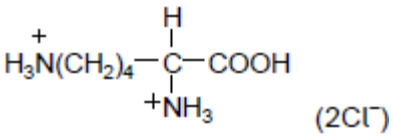
8

(a) 2,6-diaminohexanoic acid

Ignore additional , or – or spaces.

1

(b) (i)



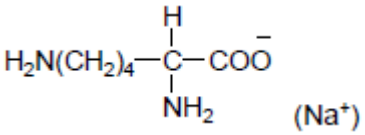
NB both N must be protonated.

Allow $-NH_3^+$ allow CO_2H Allow $-{}^+H_3N$.

Penalise – C_4H_8 – here.

1

(ii)



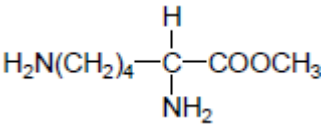
Allow CO_2^-.

Allow $-H_2N$.

Allow –COONa but penalise O–Na bond shown.

1

(iii)

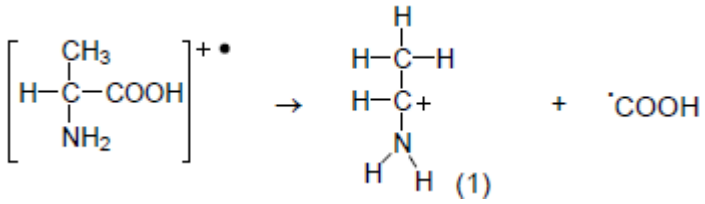


Allow CO_2CH_3.

Allow $-NH_3^+$ or $-H_2N$.

1

(c)



(1)

1 for displayed formula of fragment ion.

1 for molecular ion of alanine AND radical.

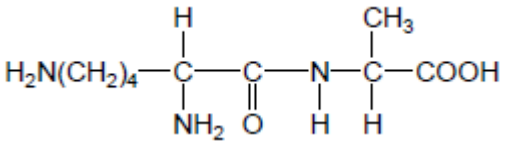
Allow molecular ion without brackets and fragment ion in brackets with outside +.

Allow dot anywhere on radical.

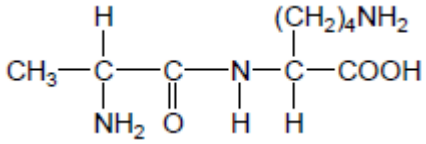
Allow $[C_3H_7NO_2]^{+\bullet}$ for molecular ion.

2

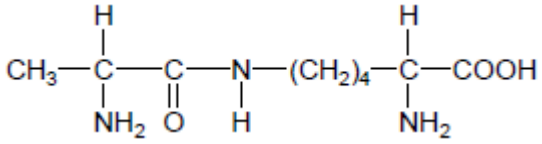
(d)



OR



OR



Dipeptide, not repeating unit /.

Allow CO_2H Allow $–H_2N$.

Allow –CONH–.

1

(e) M1 In acid lysine has double positive or more positive charge

1

M2 (Lysine ion) has greater affinity / greater attraction / adheres better / sticks better to polar / stationary phase

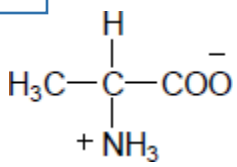
M2 only scores after a correct M1.

Ignore greater retention time.

1

[9]

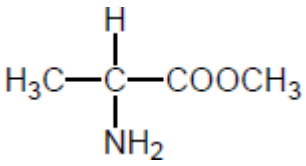
9 (a)



Allow $-NH_3^+$ and $^+NH_3-$

1

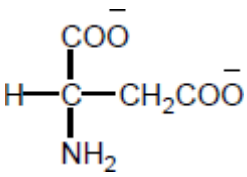
(b)



Allow protonated form, i.e. $-NH_3^+$ or $^+NH_3-$

1

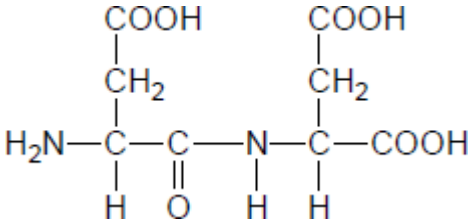
(c)



Allow – CO_2^-

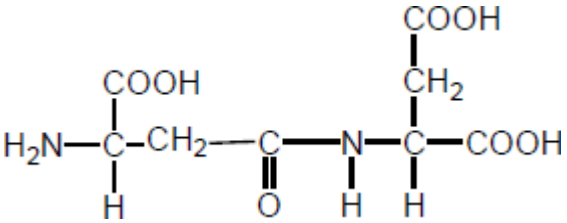
1

(d)



Allow zwitterion with any COO^-

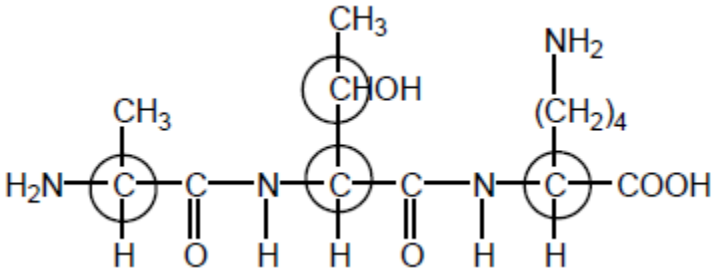
Allow use of "wrong" COOH



1

[4]

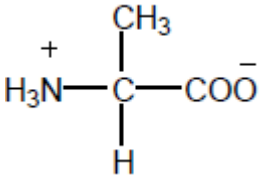
10 (a) (i)



These four only

1

(ii)



Allow − NH_3^+ and $^+NH_{3-}$

1

(iii) 2-amino-3-hydroxybutanoic acid

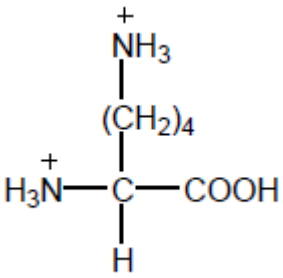
Ignore 1 in butan-1-oic acid

Do not penalise commas or missing hyphens

Penalise other numbers

1

(iv)



Allow –NH_3^+ and $^+NH_{3-}$

1

(b) (i) Condensation

Allow polyester

1

(ii) propan**e**-1,3-diol

Must have e

*Allow 1,3-propan**e**diol*

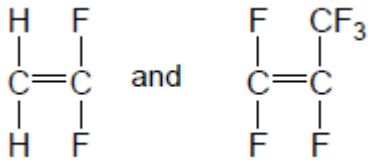
1

(c) (i) Addition

Not additional

1

(ii)



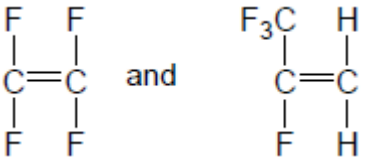
and

Allow monomers drawn either way round

Allow bond to F in CF_3

1

OR



and

1 for each structure within each pair

1

(d) c

If wrong, CE = 0

1

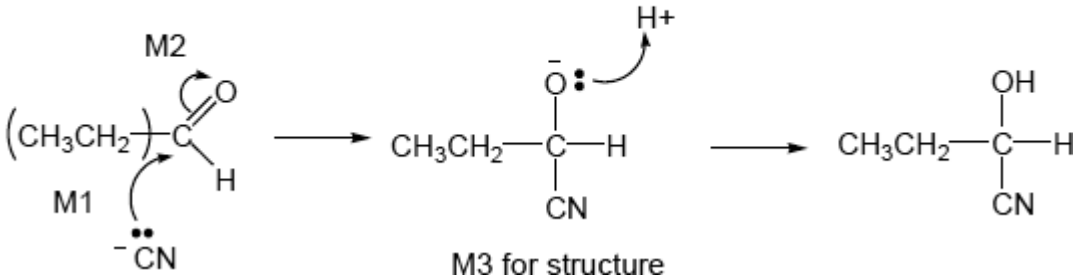
C-C or C-F bonds too strong

1

[11]

11 (a) nucleophilic addition

M4 for lp and arrow to H^+



M3 for structure

- *allow :CN–*
- *M2 not allowed independent of M1, but*
- *allow M1 for correct attack on C+*
- *+ rather than δ+ on C=O loses M2*
- *M3 is for correct structure including minus sign but lone pair is part of M4*
- *Allow C_2H_5*
- *M1 and M4 for lp and curly arrow*

1

(b) 2-bromobutanenitrile

Allow 2-bromobutane-1-nitrile

1

(c) **M1** ammonia or NH_3

Ignore temp or pressure

1

M2 excess (ammonia) excess tied to NH_3 and may score in M1 unless contradicted

Ignore concentrated or sealed container, Acid loses conditions mark

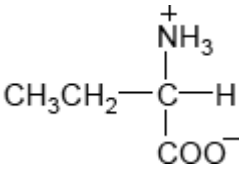
1

M3 nucleophilic substitution

Allow close spelling

1

(d) (i)



Allow C_2H_5

Allow $–CO_2^-$

Allow $^+NH_3–$

Don't penalize position of + on NH_3

1

(ii) **M1** electrostatic <u>forces between ions</u> in **X** **QOL**

Allow ionic bonding.

1

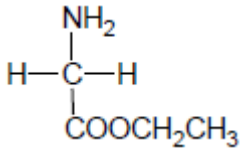
Marks independent

M2 (stronger than) <u>hydrogen bonding</u> between $CH_3CH_2CH(OH)COOH$

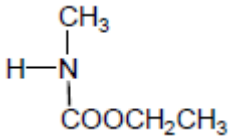
***CE** mention of molecules of **X** or inter molecular forces between **X** loses both marks*

1

(e) (i)



OR

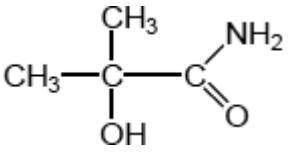


Isomer of $C_4H_9NO_2$

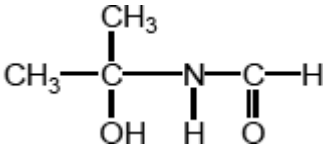
Allow NH_2–

1

(ii)



Isomer of $C_4H_9NO_2$ allow NH_2–

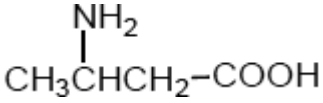
Allow 

1

(iii) $H_2N–CH_2CH_2CH_2–COOH$ or $H_2N–(CH_2)_3–COOH$

Isomer of $C_4H_9NO_2$ allow NH_2–

OR

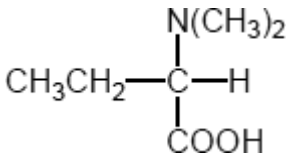


*Do **not** allow $–C_3H_6-$*

*Beware – do not credit **X** itself*

1

(f)



*Answer has 6 carbons so **NOT** isomer of **X***

Allow C_2H_5

Must have bond from C to N not to methyl group

1

[16]