# PL.a-t - Polymers and life | PL1-9 |

## PL.Q Exam questions from past papers

| State the meaning of the symbols used in the mechanism and explain how this mechanism accounts for the shape of the curve in fig 35.2? | * E is enzyme, S is substrate, ES is enzyme-substrate complex, EP is enzyme-product complex, P is product   Low [S]   * When [S] is low there are enough active sites for E to bind to all of S -> rate increases as [S] increases * Rate is proportional to [S] * Reaction is 1st Order w.r.t [S] * RDS is E+S->ES   High [S]   * When [S] is high all active sites are occupied -> no change in rate * Increasing [S] has no effect on rate * Reaction is zero order w.r.t [S] * RDS is EP -> E+P (or ES->EP) |
| --- | --- |
| Draw a ring around the pharmacophore on the structure of ‘Imatinib’ above? | **ALLOW** lines cutting bonds to do so anywhere on the bond. |
| Suggest how this pharmacophore (Compound A) interferes with the function of the enzyme? [3] | It has a complementary shape to the enzyme (1) so fits into the active site (1) blocking the substrate from entering. (1) |
| Explain how specific pairing suggests a copying mechanism for the replication of DNA? [3] | * Hydrogen bonds break between base pairs [1] * Two single strands are formed (helices) [1] * Each base forms hydrogen bonds to a new complementary base [1]     From F334 paper old spec so your choice whether you want to learn for new spec or not |
| What is the reason that CO and N2 can be distinguished by high-resolution mass spectrometry? | * C as high resolution mass spec is to 4 decimal places |
| The Mr of C6H14O is 102. Explain how high-resolution mass spectroscopy can be used to distinguish between this compound and others with the same Mr but difference molecular formula? (3) | * As the mass spec can see the Mr to 4d.p * Different compounds have different Mr values in the decimal places * Atoms of the element have Ar value that are not exact whole numbers |
| Give 1 advantage and disadvantage of using enzymes in industrial processes? | Advantages   * Allow faster reaction at lower temperatures * Saves fuel   Disadvantages   * Easily denatured * Inhibited * Sensitive to pH * Difficult to recover after use |
| Describe the appearance of the graph of rate against [S] at 70 degrees? | * Straight line at rate = 0 * Active site is destroyed so changes shape |

## PL.a-e - Structure & Bonding | PL4 | PL5 | PL7 | PL8 |

| What are amino acids? And draw general structure | A central carbon with an amine and a carboxyl group |
| --- | --- |
| When and where is a peptide link formed? | When two amino acids (also know as amino acid residue) join together via the -NH2 group and the -COOH group to produce a secondary amide group -CONH-  The peptide link is the -CONH- group  *This is condensation polymerisation as water is formed* |
| What is formed when you hydrolyse a protein (amino acid residue)? | * Two amino acids |
| Describe the set-up procedure for paper chromatography? | * **Draw** a pencil line on chromatography paper \* * **Line** must be above solvent level (so depth of solvent must be lower than the line) \* * **Spot** mixture and pure samples onto paper line (evenly spread) \* * **Place** paper in a beaker of solvent \* * **Cover** and **suspend** the paper inthe beaker with a lid \* * **Remove** paper when solvent front is near to top of paper * **Mark** how far solvent has reached (in pencil) * **Allow** paper to dry (by placing in a fume cupboard to evaporate solvent) * **Locate** any spots by spraying ninhydrin solution (as well as using iodine crystals or using a UV lamp) * More than one spot would indicate hydrolysis   Use mnemonic  Remember this as DLSPCRMAL  Do Line Solvent Properly Cause Ryan May Analyse Light  \* Can be achieved by drawing a labelled diagram |
| Describe the analysis of a paper chromatography | * After locating any spots * Measure Rf values of spots (distance travelled by spot/distance travelled by solvent) * Look up Rf values for the spotted amino acids * Compare them with measured values / reference amino acids |
| What are proteins? | Proteins are polymers that are made up of amino acid monomer units known as poly(peptides) or poly(amino acids) |
| What are the Definitions for a primary, secondary (1) and tertiary structures (1) for a protein? | * Primary structure: The sequence of amino acids (residues) * Secondary structure: The folding of the chains into helices or sheets (1) * Tertiary structure: The folding of a secondary sheet forming a 3D shape (1) |
| What is the force that holds secondary protein structures? | Hydrogen bonds (between -NH and C=O groups)  ***It holds both α-helix and β-Pleated structures*** |
| What are the 4 forces that holds tertiary protein structures? | 1. Id-Id forces 2. Ionic bonds 3. Hydrogen bonding 4. Covalent bonds |
| How does Id-Id forces hold tertiary protein structures? | Weak attractions exist between non-polar groups on the amino acid chain |
| How does ionic bonds hold tertiary protein structures? | There could be a transfer of a hydrogen ion from a -COOH to a NH2 group to form zwitterions |
| How does hydrogen bonds hold tertiary protein structures? | Hydrogen bonding exists between FON elements with an H. In amino acids this is -NH2 and-OH |
| How does covalent bonds hold tertiary protein structures? | Cysteine is an amino acid that has a thiol group (-SH). They can lose the H atom (being oxidised) and the sulfur atoms can form a disulfide bond (S-S) creating a sulfur bridge. |
| What are the 4 components of DNA with examples and what is DNA formed from? | * Phosphate * Sugar - deoxyribose sugar * Base - A,T,C,G * 2 polynucleotide strands   *U - uracil is not INCLUDED* |
| What are the 3 components of RNA and anticodon pattern? with examples | * Phosphate * Sugar - ribose sugar * Base - A,U,C,G * Anti codon to base pattern, U,A,G,C   *T - Thymine is not INCLUDED* |
| What are the 3 differences between DNA and RNA? | * DNA has a different sugar to RNA * DNA has a different base to RNA * DNA has a double strand whilst RNA is single stranded |
| What holds Adenine and Thymine together in DNA? And draw just that section of the bond | 2 Hydrogen bonds |
| What Holds Cytosine and Guanine together in DNA? And draw just that section of the bond | 3 Hydrogen bonds    Remember as OHH HNO |
| Draw the structure of 2 phosphate units, 1 deoxyribose sugar and 1 thymine unit as a condensation polymer? | * **BOTH bonds** between phosphate and sugar * Bond between sugar and base * All other details correct   ***Allow*** *phosphates with minus sign or ‘spare bonds’ or -OH groups*  *Tip: start with the pentagon and make sure to draw 3 bonds between the Phosphate and sugar not 2 (P-O-CH2-C)* |
| What does the backbone entail of in DNA/RNA and what would be its repeating units in DNA? | * Sugar - deoxyribose/ribose sugar * Phosphate * Repeating unit: deoxyribose-phosphate-deoxyribose-phosphate or vice versa |
| What is a nucleotide and what do they represent? | A phosphate-sugar-base group and they represent the monomers of a DNA/RNA chain  *They also describe a repeating unit in a DNA chain*  ***Mark schemes do not allow base-sugar-phosphate group as from the PL test MCQ*** |
| Define Pharmacophore? (1) | A part of a molecule that is responsible for a particular biological activity (or pharmacological activity, medicinal activity) [1] |
| What 4 things does the ‘fit’ of a pharmacophore into a receptor site depend on? | 1. Size and shape 2. Bond formation (id-id,ionic,covalent,hydrogen) 3. Orientation (e/z,cis/trans,optical) |
| How does Size and shape affect the ‘fit’ of a pharmacophore into a receptor site? | The pharmacophore has to have a particular structure that will fit into the receptor site |
| How does bond formation affect the ‘fit’ of a pharmacophore into a receptor site? | * Id-id interactions - can form with the receptor site * Hydrogen bonding from functional groups such as -NH2, -OH or -COOH with the receptor site * Ionic bonds - from acidic and basic functional group so forms electrostatic attractions with the receptor site |
| How does orientation affect the ‘fit’ of a pharmacophore into a receptor site? | If the pharmacophore has E/Z or/and optical isomers then only **ONE** of the isomers will fit |

## PL.f-g - Kinetics | PL6 |

| How does an enzyme work? | A substrate fits into the active site as it has a complementary shape to it and so would lower the activation enthalpy then the substrate reacts and the products leave the active site  E + S -> ES -> EP -> E + P |
| --- | --- |
| Describe an active site and give its function (3)? | * A specific shape in the enzyme (1) that fits (1) a substrate being broken down (1) |
| What are the 4 characteristics of enzyme catalysis? | * Specificity * Temperature sensitivity * pH sensitivity * Competitive inhibition   *Enzymes are biological catalysts* |
| How does Specificity affect enzyme catalysis? | Enzymes only work with specific substrates because the substrate has to fit into the active site.  This is called the ‘lock and key’ model |
| How does Temperature sensitivity affect enzyme catalysis? | At low temperatures  Reactants would have low kinetic energy thus not the activation enthalpy -> slow reaction  At high temperatures  The enzyme will begin to denature as the tertiary structures containing imf would break so the active site is destroyed -> slowing the rate of reaction |
| Draw the shape of a Rate of enzyme activity/ temperature graph and Explain the shape if optimum temp = 37 degrees C? | * Peak of curve above 37 degrees * Initially as temperature increase there are more collisions above Ea so increases rate (1) * Then the KE breaks imbs in active site so loses its specific shape and substrate can’t bind (1)   *Depending on how extreme the temperature is,* ***some*** *mark schemes don’t allow denatured* |
| How does pH sensitivity affect enzyme catalysis? | At high or low pH’s  The enzyme will begin to denature as the tertiary structures containing imf would break so the active site is destroyed -> changes the tertiary structure -> the active site is no longer the correct shape for the substrate to fit into -> slowing the rate of reaction |
| Draw the shape of a rate of enzyme activity / pH graph and Explain the shape if the optimum pH = 8? (3) | (1)   * Peak of curve above pH 8 (1) * At other pH values the active site becomes destroyed (1)   *Depending on how extreme the pH is,* ***some*** *mark schemes don’t allow denatured* |
| How does Competitive inhibition affect enzyme catalysis? | An inhibitor has a similar shape to the substrate so also fits into the active site which blocks it -> the substrate cannot bind to which there would be no active sites available to the substrate slowing down the rate of reaction |

## PL.h-j - Equilibria (acid-base) | PL1 | PL2 | PL4 |

| What are salts of carboxylic acids called? Like Na+(CH3COO-) | Carboxylates and sodium ethanoate |
| --- | --- |
| What are the products of the reactions of ethanoic acid with Mg(s), Na2CO3 (s) , NaOH (aq) ? | * Ethanoic acid + Magnesium -> Magnesium ethanoate Mg(CH3COO)2 (aq) + H2 (g) * Ethanoic acid + Sodium carbonate -> Sodium ethanoate Na(CH3COO) (aq) + H2O (l) + CO2 (g) * Ethanoic acid + Sodium Hydroxide NaOH(aq)  -> Sodium ethanoate Na(CH3COO) (aq) + H2O (l) |
| What are the 4 properties of amines? | * They are soluble in water * They can act as bases * They can act as nucleophiles * They can act as ligands (learned in developing metals-topic 9) |
| Why are amines soluble in water? | * From CH3NH2 (aq) + H2O (l) -> CH3NH3+ (aq) + OH- (aq) where the methylammonium is an ion so is soluble in water * From amines being able to form hydrogen bonds with water |
| What do amines primarily react as? | Bases. Eg, they react with HCl to produce methylammonium chloride (a salt)    This equation doesn’t include the Cl- ion |
| Draw the two step nucleophilic substitution of 1-chloropropane with ammonia as the nucleophile? | Products: propylamine / aminopropane and Ammonium chloride |
| Define Zwitterions? | A molecule with both positive and negative ions |

## PL.k-l - Organic functional groups | PL1 | PL2 |

| Functional group, prefix and suffix of carboxylic acids and name this compound | * Functional group:      * Prefix: carboxy- (dicarboxy-) * Suffix: -oic acid (-dioic acid) * 2,2 dimethylpropanedioic acid      * General formula: CnH2n+1COOH |
| --- | --- |
| Functional group, prefix and suffix of phenols | * Functional group      * Prefix: hydroxy- (dihydroxy-) * Suffix: -phenol |
| Functional group and suffix of acid anhydrides and name this compound | * Functional group:      * Suffix: -oic anhydride * Ethanoic anhydride   *The branches from R1 and R2 are always symmetrical for this course* |
| Functional group and suffix of esters and name this group and also draw the structure of phenylmethyl 2 methylbutanoate | * Functional group: * General formula: CnH2nO2      * Suffix -yl -oate     *The alcohol ends in -yl and is the prefix. The carboxylic acid ends in -anoate and is the suffix* |
| Functional group and suffix of ketones and name this compound | * Functional group: * General formula: CnH2nO * Suffix: -one * butan2-one |
| Functional group, prefix and suffix of amines? And name this compound | * Functional group: R-NH2      * Prefix: amino- (diamino-) * Suffix: -amine (-diamine) * Ethane1,2,diamine / 1,2diamino ethane |
| What are the 3 types of AMINES? | * Primary amine: The N is bonded to 1 other carbon atom * Secondary amine: The N is bonded to 2 other carbon atoms * Tertiary amine: The N is bonded to 3 other carbon atoms |
| Functional group, prefix and suffix of arenes? And name this compound? | * Functional group: * Prefix: phenyl- * Suffix: -benzene * Phenylamine / aminobenzene |
| Functional group and suffix of amides? | * Functional group: R-C=O-NH2      * Suffix: -amide (-diamide) |
| What are the 3 types of AMIDES? | * Primary amide: The N is bonded to 1 other carbon atom * Secondary amide: The N is bonded to 2 other carbon atoms * Tertiary amide: The N is bonded to 3 other carbon atoms |
| Functional group and suffix of acyl chlorides? | * Functional group: R-C=O-Cl      * Suffix: -oyl chloride (-dioyl chloride) |
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## PL.m-n - Organic reactions | PL2 | PL3 |

| When are nylons (polyamides) made? How are they named? | A diamine and a dicarboxylic acid (or diacyl chloride) reacting together to make an ester and a small molecule via condensation polymerisation (most of the time)  If 2 monomers are used its the number of carbon atoms in the diamine then its the number of carbon atoms in the dicarboxylic acid [or diacyl chloride]  (including the ones in the carboxyl groups) i.e. nylon-6,6 & nylon-6,10  If 1 monomer is used its the number of carbon atoms in the amine or carboxylic acid (or acyl chloride) section of a monomer and the monomer contains an amine + carboxylic acid [or acyl chloride] group  (including the ones in the carboxyl groups) i.e. nylon 6 |
| --- | --- |
| How and why are acyl chlorides better than carboxylic acids? | They are more reactive than carboxylic acid as Cl is a good leaving group |
| How do acyl chlorides react with alcohols and why is it good? | * To produce an ester * It’s faster (-> more reactive) and not reversible compared to carboxylic acids     *Note: This occurs via nucleophilic substitution at RTP* |
| How do acyl chlorides react with primary and secondary amines? (with example equation) | * To produce secondary and tertiary amides respectively * Example:     *The N means that the methyl group is bonded to the nitrogen rather than the main carbon chain and this occurs via nucleophilic substitution* |
| What 2 things are common for most reactions of a acyl chlorides? | 1. Carried out at room temperature 2. Any HCl (g) is given off as steamy white fumes |
| Give 2 ways esters can be hydrolysed and what does it form (with conditions) | 1. **Heating with moderately concentrated ACID (e.g H2SO4/HCl)**  * Use sulfuric acid catalyst under reflux * Forms the original reactants * CH3COOCH3 + H2O ⇋ CH3COOH + CH3OH (reversible so doesn’t give a good yield)  1. **Heating with moderately concentrated Alkali (e.g NaOH) [Saponification]**  * Use sodium hydroxide under reflux * Forms a carboxylate ion (CH3COO-) and alcohol * CH3COOCH3 + OH- -> CH3COO- + CH3OH * CH3COO- + Na+ -> Na(CH3COO) * Na(CH3COO) + CH3OH  (not reversible so high yield)   *The carboxylic acid turns into a carboxylate ion (from giving a H to the amine) and then reacts with the sodium ions in this case to form sodium propanoate*  *The anion in the salt is resistant to attack by weak nucleophiles such as the alcohol so this reaction isn’t reversible* |
| Give 2 ways amides can be hydrolysed and what does it form (with conditions) [Secondary amide for acid + alkali catalyst] | 1. ***H*eating with moderately concentrated ACID (H2SO4, e.g HCl)**  * Use conc sulfuric acid catalyst under reflux * Secondary amide forms a carboxylic acid + ammonium salt * CH3CONHCH3 + H2O -> CH3COOH + NH2CH3 * NH2CH3 + H+ -> NH3+CH3 * CH3COOH + NH3+CH3 + Cl-   *Please remember that a H is given to the NHR by the water to form NH2R and another H+ is from the acid catalyst to form an ammonium salt (NH3+R)*   1. **Heating with moderately concentrated Alkali (e.g NaOH)**  * Use sodium hydroxide under reflux * Secondary amide forms a carboxylate ion and an amine * CH3CONHCH3 + OH- -> CH3COO- + CH3NH2 * CH3COO- + Na+ + -> Na(CH3COO) * Na(CH3COO) + CH3NH2   *The carboxylic acid turns into a carboxylate ion (from giving a H from OH- to the amine) and then reacts with the sodium ions in this case to form sodium ethanoate* |
| How are primary amides hydrolysed to carboxylic acids? (reagents, type of reaction, equation) | * Reagents: moderately concentrated HCl (aq) * Type of reaction: acid hydrolysis * Equation: * CH3CONH2 + H2O -> CH3COOH + NH3 * NH3 + H+ -> NH4+ * NH4+ + Cl- -> NH4Cl * CH3COOH + NH4Cl   *Please remember that a H is given to the NH2 by the water to form NH3 and another H+ is from the acid catalyst to form an ammonium salt (NH4+) then if the catalyst has an anion like Cl- for HCl then it would form NH4Cl* |
| How are primary amides hydrolysed to ammonia? (reagents, type of reaction, equation) | * Reagents: moderately concentrated NaOH (aq) * Type of reaction: alkali hydrolysis * Equation: * CH3CONH2 + OH- -> CH3COO- + NH3 * CH3COO- + Na+ -> Na(CH3COO) * Na(CH3COO) + NH3 * Primary amides when hydrolysed forms carboxylate ion and ammonia   *The carboxylic acid turns into a carboxylate ion (from giving a H from OH- to the amine) and then reacts with the sodium ions in this case to form sodium ethanoate* |
| What does the base and acid hydrolysis of poly(esters) produce? | 1. Base - dicarboxylate salt and diol 2. Acid = dicarboxylic acid and diol |
| What does the base and acid hydrolysis of poly(amides) produce? | 1. Base - dicarboxylate salt and diamine 2. Acid - dicarboxylic acid and diammonium |

## PL.o-p - Polymers | PL1 |

| What is addition polymerisation? | When unsaturated monomers react e.g. an alkene |
| --- | --- |
| What is condensation polymerisation? | Two different monomers that add together with a small molecule usually given off as a side-product (eg, H2O or HCl).  *These monomers usually have the same functional group on both ends of the molecule (eg, diamine, dicarboxylic acid, diol, diacyl chloride).* |
| Give the 2 most common type of condensation polymers with their linkage? | 1. Poly(esters) which contain an ester link (-COO-) e.g Terylene or PET 2. Poly(amides) which contain an amide link (-CONH-) also known as nylons e.g kevlar   *They form what is called an ester linkage or amide linkage* |
|  | |

## PL.q - Isomerism | PL4 |

| Define Chiral? | A carbon atom with 4 different groups attached to it    *In a molecule a chiral carbon is often identified with an asterisk \** |
| --- | --- |
| Define Enantiomers isomers (optical isomers) and what is required of them? | * Stereoisomers which are non-superimposable mirror images of molecules * 4 different groups attached to a carbon (called the chiral centre)     *- They can both be referred as enantiomers / optical isomers*  *- They can be distinguished by shining plane-polarised light and seeing the angle of rotation.* |

## PL.r-t - Modern analytical techniques | PL9 | Nuclear Magnetic Resonance [NMR] **Learn through** **PRACTICE QUESTIONS NOT MEMORISING**

| What does chemical shift / 𝜹 represent in NMR? | It is how far the frequency of a signal is shifted from TMS measured in parts per million (ppm) |
| --- | --- |
| What are equivalent carbons? How do they show up in Carbon-13 NMR? | Carbons which are in the same environment    There is one signal peak for each set of equivalent carbons |
| What can be determined from a Carbon-13 NMR spectrum? | * The number of carbon atoms that have different environments in a molecule * Work out (sometimes only roughly) the groups to which these carbon atoms are attached |
| How do equivalent hydrogens differ from equivalent carbons in P NMR? | The intensity (peak integration value) proportional to number of equivalent H’s it represents. Eg, |
| How does electronegativity affect proton NMR? | If a H is closer to the more electronegative group, greater shift (further to the left on NMR spectrum) |
| What is spin-spin coupling in high-resolution P NMR? | * Each signal can be split based on how many neighbouring **NON-EQUIVALENT** 1H’s (neighbouring means within 3 bonds) * Yet, hydrogens bonded to nitrogen or oxygen don’t split or themselves split.        * Split number of peaks = number of nonequivalent H’s within 3 bonds + 1 (FOLLOWS THE n + 1 rule)   *The relative sizes follow Pascal’s triangle* |
| **What table should be drawn for proton NMR?** |  |

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