

Southern York County School District Instructional Plan

Name:	Dates: September
Course/Subject: Organic Chemistry and Biochemistry	Unit Plan 1: Organic Chemistry
Stage 1 – Desired Results	
<p>PA Standard(s)/Assessment Anchors Addressed:</p> <p>3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances</p> <p>3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions</p> <p>3.4.12A—Characterize and identify important classes of compounds</p> <p>3.4.10A—Understand that carbon can form several different types of compounds.</p> <p>3.2.12B—Evaluate experimental information for appropriateness and adherence to relevant science processes.</p>	
<p>Understanding(s): <i>Students will understand . . .</i></p> <p>1. The structure and function of organic compounds affects our everyday life.</p>	<p>Essential Question(s):</p> <ul style="list-style-type: none"> ▪ Why do we study organic chemistry?
<p>Learning Objectives: <i>Students will know . . .</i></p> <ul style="list-style-type: none"> ▪ Organic chemistry is the study of compounds containing carbon. ▪ Chemists obtain organic compounds either by isolation from plant and animal sources or by synthesis in the laboratory. ▪ Carbon normally forms four bonds and has no unshared pairs of electrons. ▪ Nitrogen normally forms three bonds and has one unshared pair of electrons. ▪ Oxygen normally forms two bonds and has two unshared pairs of electrons. ▪ A functional group is a site of chemical reactivity; a particular functional group, in whatever compound it is found, always undergoes the same types of chemical reactions. ▪ Functional groups are characteristic structural units by which we both classify and name organic compounds. Important functional groups include the hydroxyl group, the amino group, the carboxyl group, and the ester group. 	<p>Students will be able to:</p> <ul style="list-style-type: none"> ▪ Support why organic chemistry is a separate branch of chemistry. ▪ Provide examples of organic compounds that are isolated from nature. ▪ Provide examples of organic compounds that are synthesized in the laboratory. ▪ Compare and contrast molecular formulas and structural formulas. ▪ Draw structural formulas from given molecular formulas using the HONC1234 rule. ▪ Identify functional groups in structural formulas. ▪ Identify alcohols and amines as primary, 1°, secondary, 2°, or tertiary, 3°. ▪ Determine the boiling point and melting point of a given substance. ▪ Determine the identity of an unknown substance using the boiling and melting points.

Name:	Dates: September/October
Course/Subject: Organic Chemistry and Biochemistry	Unit Plan 2: Alkanes
Stage 1 – Desired Results	
<p>PA Standard(s)/Assessment Anchors Addressed:</p> <p>3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances</p> <p>3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions</p> <p>3.4.12A—Characterize and identify important classes of compounds</p> <p>3.4.10A—Understand that carbon can form several different types of compounds.</p> <p>3.2.12B—Evaluate experimental information for appropriateness and adherence to relevant science processes.</p>	
<p>Understanding(s): <i>Students will understand . . .</i></p> <p>1. The structure and function of alkanes affects our everyday life.</p>	<p>Essential Question(s):</p> <ul style="list-style-type: none"> ▪ How are alkanes important to our lives?
<p>Learning Objectives: <i>Students will know . . .</i></p> <ul style="list-style-type: none"> ▪ Hydrocarbon contains only carbon and hydrogen. ▪ Saturated hydrocarbon contains only single bonds. ▪ An alkane is a saturated hydrocarbon whose carbon atoms are arranged in an open chain. ▪ Constitutional isomers have the same molecular formula but different connectivity of their atoms. ▪ Alkanes are named according to a set of rules developed by the International Union of Pure and Applied Chemistry (IUPAC). ▪ The IUPAC name of an alkane consists of two parts: a prefix that tells the number of carbon atoms in the parent chain, and the ending –ane. ▪ Substituents derived from alkanes by removal of a hydrogen atom are called alkyl groups and denoted by the symbol R—. ▪ Natural gas consists of 90-95% methane with lesser amounts of ethane and other lower molecular weight hydrocarbons. ▪ Petroleum is a liquid mixture of thousands of different hydrocarbons. ▪ A cycloalkane is an alkane that contains carbon atoms bonded to form a ring. ▪ To name a cycloalkane, prefix the name of the open-chain alkane with a 	<p>Students will be able to:</p> <ul style="list-style-type: none"> ▪ Draw constitutional isomers for a given molecular formula. ▪ Name alkanes using the IUPAC system as well as some common names. ▪ Draw alkanes from provided IUPAC and common names. ▪ Describe the fractional distillation of petroleum. ▪ Name cycloalkanes using the IUPAC system as well as some common names. ▪ Draw cycloalkanes provided IUPAC and common names. ▪ Draw cyclopentane in the envelope conformation. ▪ Draw cyclohexane in the chair conformation. ▪ Determine the lowest energy conformation of a group of substituted cyclohexanes. ▪ Name cis-trans isomers of cycloalkanes using IUPAC nomenclature rules. ▪ Draw cis-trans isomers of cycloalkanes provided IUPAC and common nomenclature rules. ▪ Predict the state of matter for an alkane provided the molecular formula. ▪ Predict the boiling points of alkanes provided the structural formula. ▪ Predict the products and balance oxidation of alkane reactions.

- **cyclo—.**
- A **conformation** is any three-dimensional arrangement of the atoms of a molecule that results from rotation about a single bond.
- The lowest energy-conformation of cyclopentane is an **envelope conformation**.
- The lowest energy-conformation of cyclohexane is a **chair conformation**.
- In a **chair conformation**, six C—H bonds are **axial** and six C—H bonds are **equatorial**.
- A substituent on a six-membered ring is more stable when it is equatorial than when it is axial.
- **Cis-trans isomers** of cycloalkanes have (1) the same molecular formula and (2) the same connectivity of their atoms, but (3) a different orientation of their atoms in space because of the restricted rotation around the C—C bonds of the ring.
- For **cis-trans isomers** of cycloalkanes, **cis** means that substituents are on the same side of the ring; **trans** means that substituents are on the opposite sides of the ring.
- Alkanes are nonpolar compounds, and the only forces of attraction between their molecules are London dispersion forces.
- At room temperature, low-molecular-weight alkanes are gases, higher-molecular-weight alkanes are liquids, and very-high-molecular-weight alkanes are waxy solids.
- For any group of alkane constitutional isomers, the least branched isomer generally has the lowest boiling point.
- Alkanes are insoluble in water but soluble in each other and in other nonpolar organic solvents such as toluene.
- All liquid and solid alkanes are less dense than water.
- The **oxidation of alkanes** to carbon dioxide and water, an exothermic reaction, is the basis for our use of them as sources of heat and power.
- The **halogenation of alkanes** is the reaction of an alkane with chlorine or bromine. This reaction results in the substitution of a halogen atom for a hydrogen.

Name:	Dates: October
Course/Subject: Organic Chemistry and Biochemistry	Unit Plan 3: Alkenes and Alkynes
Stage 1 – Desired Results	
<p>PA Standard(s)/Assessment Anchors Addressed:</p> <p>3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances</p> <p>3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions</p> <p>3.4.12A—Characterize and identify important classes of compounds</p> <p>3.4.10A—Understand that carbon can form several different types of compounds.</p> <p>3.2.12B—Evaluate experimental information for appropriateness and adherence to relevant science processes.</p>	
<p>Understanding(s): <i>Students will understand . . .</i></p> <ol style="list-style-type: none"> 1. Structural diversity allows for functional diversity underlying the processes and variety of life. 	<p>Essential Question(s):</p> <ul style="list-style-type: none"> ▪ How are alkenes and alkynes important in chemistry and our everyday lives?
<p>Learning Objectives: <i>Students will know . . .</i></p> <ul style="list-style-type: none"> ▪ An alkene is an unsaturated hydrocarbon that contains a carbon—carbon double bond. ▪ An alkyne is an unsaturated hydrocarbon that contains a carbon—carbon triple bond. ▪ The structural feature that makes cis-trans stereoisomerism possible in alkenes is restricted rotation about the two carbons of the double bond. ▪ The cis or trans configuration of an alkene is determined by the orientation of the atoms of the parent chain about the double bond. ▪ If the atoms of the parents chain are located on the same side of the double bond, the configuration of the alkene is cis; if they are located on opposite sides, the configuration is trans. ▪ In IUPAC names, the presence of a carbon—carbon double bond is indicated by the prefix showing the number of carbons in the parent chain and the ending –ene. Substituents are numbered and named in alphabetical order. ▪ The presence of a carbon—carbon triple bond is indicated by the prefix that shows the number of carbons in the parent chain and the ending –yne. ▪ The carbon atoms of the double bond of 	<p>Students will be able to:</p> <ul style="list-style-type: none"> ▪ Name alkenes and alkynes using the IUPAC nomenclature rules. ▪ Name alkenes using the cis-trans or E/Z nomenclature system. ▪ Identify alkenes and alkynes based on their physical properties. ▪ Explain why cis-trans/E,Z isomerism is possible in alkenes. ▪ Name molecules that have more than one double or triple bond, or double and triple bonds. ▪ Identify molecules that can be classified as terpenes. ▪ Predict products or determine reactants of addition reactions of alkenes.

<p>a cycloalkene are numbered 1 and 2 in the direction that gives the smaller number to the first substituent.</p> <ul style="list-style-type: none"> ▪ Compounds containing two double bonds are called dienes, those with three double bonds are called trienes, and those containing four or more double bonds are called polyenes. ▪ Because alkenes and alkynes are nonpolar compounds and the only interactions between their molecules are London dispersion forces, their physical properties are similar to those of alkanes with similar carbon skeletons. ▪ The characteristic structural feature of a terpene is a carbon skeleton that can be divided into two or more isoprene units. The most common pattern is the head of one unit bonded to the tail of the next unit. ▪ A characteristic reaction of alkenes is addition to the double bond. 	
Name:	Dates: October/November
Course/Subject: Organic Chemistry and Biochemistry	Unit Plan 4: Benzene and It's Derivatives
Stage 1 – Desired Results	
PA Standard(s)/Assessment Anchors Addressed: 3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances 3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions 3.4.12A—Characterize and identify important classes of compounds 3.4.10A—Understand that carbon can form several different types of compounds. 3.2.12B—Evaluate experimental information for appropriateness and adherence to relevant science processes.	
Understanding(s): <i>Students will understand . . .</i> <ol style="list-style-type: none"> 1. Structural diversity allows for functional diversity underlying the processes and variety of life. 	Essential Question(s): <ul style="list-style-type: none"> ▪ How are benzene and its derivatives important in chemistry and our everyday lives?
Learning Objectives:	

Students will know . . .

- The functional group of an **alcohol** is an **–OH (hydroxyl)** group bonded to a tetrahedral carbon atom.
- The functional group of an **ether** is an atom of oxygen bonded to two carbon atoms.
- The IUPAC name of an alcohol is derived by changing the –e of the parent alkane to –ol. The parent chain is numbered from the end that gives the carbon bearing the –OH group the lower number.
- The common name for an alcohol is derived by naming the alkyl group bonded to the –OH group and adding the word alcohol.
- Alcohols are classified as **1°, 2°, or 3°**, depending on the number of carbon atoms bonded to the carbon bearing the –OH group.
- Compounds containing hydroxyl groups on adjacent carbon are called **glycols**.
- Alcohols are polar compounds in which oxygen bears a partial negative charge and both the carbon and the hydrogen bonded to it bear partial positive charges.
- Alcohols associate in the liquid state by **hydrogen bonding**. As a consequence, their boiling points are higher than those of hydrocarbons of similar molecular weight.
- Because of increased London dispersion forces, the boiling points of alcohols increase with their increasing molecular weight.
- Alcohols interact with water by hydrogen bonding and are more soluble in water than are hydrocarbons of similar molecular weight.
- Alcohols have about the same pKa values as pure water. For this reason, aqueous solutions of alcohols have the same pH as that of pure water.
- Common names for ethers are derived by naming the two groups bonded to oxygen followed by the word “ether”.
- A **cyclic ether**, oxygen is one of the atoms of the ring.
- Ethers are weakly polar compounds. Their boiling points are close to that of hydrocarbons of similar molecular weight.
- Because ethers form hydrogen bonds

Students will be able to:

- Name alcohols, ethers, and thiols according to IUPAC rules.
- Identify alcohols as primary (1°), secondary (2°), or tertiary (3°).
- Distinguish between the physical properties of alcohols, thiols and ethers.

<p>with water, they are more soluble in water than hydrocarbons of similar molecular weight.</p> <ul style="list-style-type: none"> ▪ A thiol contains an –SH (sulfhydryl) group. ▪ Thiols are named in the same manner as alcohols, but the suffix of the parent alkane is retained and –thiol is added. ▪ Common names for thiols are derived by naming the alkyl group bonded to the –SH group and adding the work mercaptan. ▪ The S–H bond is nonpolar and the physical properties of thiols resemble those of hydrocarbons of similar molecular weight. 	
<p>Name:</p>	<p>Dates: November/December</p>
<p>Course/Subject: Organic Chemistry and Biochemistry</p>	<p>Unit Plan 5: Alcohols, Ethers, and Thiols</p>
<p>Stage 1 – Desired Results</p>	
<p>PA Standard(s)/Assessment Anchors Addressed:</p> <p>3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances</p> <p>3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions</p> <p>3.4.12A—Characterize and identify important classes of compounds</p> <p>3.4.10A—Understand that carbon can form several different types of compounds.</p> <p>3.2.12B—Evaluate experimental information for appropriateness and adherence to relevant science processes.</p>	
<p>Understanding(s): <i>Students will understand . . .</i></p> <ol style="list-style-type: none"> 1. Structural diversity allows for functional diversity underlying the processes and variety of life. 	<p>Essential Question(s):</p> <ul style="list-style-type: none"> ▪ How are alcohols, thiols, and esters important in chemistry and to our everyday lives?
<p>Learning Objectives: <i>Students will know . . .</i></p> <ul style="list-style-type: none"> ▪ The functional group of an alcohol is an –OH (hydroxyl) group bonded to a tetrahedral carbon atom. ▪ The functional group of an ether is an atom of oxygen bonded to two carbon atoms. ▪ The IUPAC name of an alcohol is derived by changing the –e of the parent alkane to –ol. The parent chain is numbered from the end that gives the carbon bearing the –OH group the lower number. ▪ The common name for an alcohol is derived by naming the alkyl group bonded to the –OH group and adding 	<p>Students will be able to:</p> <ul style="list-style-type: none"> ▪ Name alcohols, ethers, and thiols according to IUPAC rules. ▪ Identify alcohols as primary (1°), secondary (2°), or tertiary (3°). ▪ Distinguish between the physical properties of alcohols, thiols and ethers.

the word alcohol.

- Alcohols are classified as **1°, 2°, or 3°**, depending on the number of carbon atoms bonded to the carbon bearing the –OH group.
- Compounds containing hydroxyl groups on adjacent carbon are called **glycols**.
- Alcohols are polar compounds in which oxygen bears a partial negative charge and both the carbon and the hydrogen bonded to it bear partial positive charges.
- Alcohols associate in the liquid state by **hydrogen bonding**. As a consequence, their boiling points are higher than those of hydrocarbons of similar molecular weight.
- Because of increased London dispersion forces, the boiling points of alcohols increase with their increasing molecular weight.
- Alcohols interact with water by hydrogen bonding and are more soluble in water than are hydrocarbons of similar molecular weight.
- Alcohols have about the same pKa values as pure water. For this reason, aqueous solutions of alcohols have the same pH as that of pure water.
- Common names for ethers are derived by naming the two groups bonded to oxygen followed by the word “ether”.
- A **cyclic ether**, oxygen is one of the atoms of the ring.
- Ethers are weakly polar compounds. Their boiling points are close to that of hydrocarbons of similar molecular weight.
- Because ethers form hydrogen bonds with water, they are more soluble in water than hydrocarbons of similar molecular weight.
- A **thiol** contains an **–SH (sulfhydryl)** group.
- Thiols are named in the same manner as alcohols, but the suffix of the parent alkane is retained and –thiol is added.
- Common names for thiols are derived by naming the alkyl group bonded to the –SH group and adding the work mercaptan.
- The S—H bond is nonpolar and the physical properties of thiols resemble those of hydrocarbons of similar molecular weight.

Name:	Dates: January
Course/Subject: Organic Chemistry and Biochemistry	Unit Plan 6: Chirality—The Handedness of Molecules
Stage 1 – Desired Results	
PA Standard(s)/Assessment Anchors Addressed: 3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances 3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions 3.4.12A—Characterize and identify important classes of compounds 3.4.10A—Understand that carbon can form several different types of compounds. 3.2.12B—Evaluate experimental information for appropriateness and adherence to relevant science processes.	
Understanding(s): <i>Students will understand . . .</i> 1. Structural diversity allows for functional diversity underlying the processes and variety of life.	Essential Question(s): <ul style="list-style-type: none"> ▪ How is chirality important to chemistry and our everyday lives?
Learning Objectives: <i>Students will know . . .</i> <ul style="list-style-type: none"> ▪ A mirror image is the reflection of an object in a mirror. ▪ Enantiomers are a pair of stereoisomers that are nonsuperposable mirror images. ▪ A racemic mixture contains equal amounts of two enantiomers and does not rotate the plane of polarized light. ▪ Diastereomers are stereoisomers that are not mirror images. ▪ An object that is not superposable on its mirror image is said to be chiral; it has handedness. An achiral object lacks chirality (handedness); that is, it has a superposable mirror image. ▪ The most common cause of chirality in organic molecules is the presence of a tetrahedral carbon atom with four different groups bonded to it. Such a carbon is called a stereocenter. ▪ We use the R,S system to specify the configuration of a stereocenter. ▪ For a molecule with n stereocenters, the maximum number of stereoisomers possible is 2^n. ▪ Light with waves that vibrate in only parallel lines is said to be plane polarized. ▪ We use a polarimeter to measure optical activity. A compound is said to be optically active if it rotates the plane of polarized light. 	Students will be able to: <ul style="list-style-type: none"> ▪ Identify molecules as mirror images to each other. ▪ Compare and contrast enantiomers and diastereomers. ▪ Identify carbon atoms as stereocenters. ▪ Describe the common cause of chirality in molecules. ▪ Use the R,S system to specify the configuration of a stereocenter. ▪ Identify a molecule as dextrorotatory or levorotatory.

<ul style="list-style-type: none"> ▪ If a compound rotates the plane clockwise, it is dextrorotatory; if it rotates the plane counterclockwise, it is levorotatory. ▪ Each member of a pair of enantiomers rotates the plane of polarized light an equal number of degrees, but in opposite directions. ▪ An enzyme catalyzes biological reactions of molecules by first positioning them at binding sites on its surface. An enzyme with binding sites specific for three of the four groups on a stereocenter can distinguish between a molecule and its enantiomer or one of its diastereomers. 	
Name:	Dates: January/February
Course/Subject: Organic Chemistry and Biochemistry	Unit Plan 7: Amines
Stage 1 – Desired Results	
PA Standard(s)/Assessment Anchors Addressed: 3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances 3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions 3.4.12A—Characterize and identify important classes of compounds 3.4.10A—Understand that carbon can form several different types of compounds. 3.2.12B—Evaluate experimental information for appropriateness and adherence to relevant science processes.	
Understanding(s): <i>Students will understand . . .</i> 1. Structural diversity allows for functional diversity underlying the processes and variety of life.	Essential Question(s): <ul style="list-style-type: none"> ▪ How are amines relative to chemistry our everyday lives?
Learning Objectives: <i>Students will know . . .</i> <ul style="list-style-type: none"> ▪ Amines are classified as primary, secondary, or tertiary, depending on the number of carbon atoms bonded to the nitrogen. ▪ In an aliphatic amine, all carbon atoms bonded to nitrogen are derived from alkyl groups. ▪ In an aromatic amine, one or more of the groups bonded to nitrogen are aryl groups. ▪ In a heterocyclic amine, the nitrogen atom is part of a ring. ▪ In IUPAC nomenclature, aliphatic amines are named by changing the final -e of the parent alkane to -amine and 	Students will be able to: <ul style="list-style-type: none"> ▪ Categorize amines as primary, secondary, or tertiary. ▪ Distinguish between aliphatic, aromatic and heterocyclic amines. ▪ Construct names for amines using IUPAC and common names. ▪ Interpret information about amines based on physical properties. ▪ Compare the basicity of aliphatic and aromatic amines. ▪ Predict the products of reactions of amines.

<p>using a number to locate the amino group on the parent chain.</p> <ul style="list-style-type: none"> ▪ In the common system of nomenclature, aliphatic amines are named by listing the carbon groups bonded to nitrogen in alphabetical order in one word ending in the suffix –amine. ▪ Amines are polar compounds, and primary and secondary amines associate by intermolecular hydrogen bonding. ▪ All classes of amines form hydrogen bonds with water and are more soluble in water than are hydrocarbons of comparable molecular weight. ▪ Amines are weak bases, and aqueous solutions of amines are basic. ▪ The base ionization constant for amine in water is denoted by the symbol K_b. ▪ Aliphatic amines are stronger bases than aromatic amines. ▪ All amines, whether soluble or insoluble in water react with strong acids to form water-soluble salts. ▪ We can use this property to separate water-insoluble amines from water-soluble nonbasic compounds. 	
Name:	Dates: February
Course/Subject: Organic Chemistry and Biochemistry	Unit Plan 8: Aldehydes and Ketones
Stage 1 – Desired Results	
PA Standard(s)/Assessment Anchors Addressed: 3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances 3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions 3.4.12A—Characterize and identify important classes of compounds 3.4.10A—Understand that carbon can form several different types of compounds. 3.2.12B—Evaluate experimental information for appropriateness and adherence to relevant science processes.	
Understanding(s): <i>Students will understand . . .</i> 1. Structural diversity allows for functional diversity underlying the processes and variety of life.	Essential Question(s): <ul style="list-style-type: none"> ▪ How are ketones and aldehydes relative to chemistry and our everyday lives?
Learning Objectives:	

Students will know . . .

- An **aldehyde** contains a carbonyl group bonded to at least one hydrogen atom.
- A **ketone** contains a carbonyl group bonded to two carbon atoms.
- We derive the **IUPAC** name of an aldehyde by changing the **-e** of the parent alkane to **-al**.
- We derive the **IUPAC** name of a ketone by changing the **-e** of the parent alkane to **-one** and using a number to locate the carbonyl carbon.
- Aldehydes and ketones are polar compounds. They have higher boiling points and are more soluble in water than nonpolar compounds of comparable molecular weight.
- Aldehydes are oxidized to carboxylic acids but ketones resist oxidation.
- **Tollen's Reagent** is used to test for the presence of aldehydes.
- Aldehydes can be reduced to primary alcohols and ketones to secondary alcohols.
- Addition of a molecule of alcohol to an aldehyde or ketone produces a **hemiacetal**.
- A hemiacetal can react with another molecule of alcohol to produce an **acetal**.
- A molecule containing an **-OH** group bonded to a carbon of a carbon-carbon double bond is called an **enol**.
- Constitutional isomers that differ in the location of a hydrogen atom and a double bond are called **tautomers**.

Students will be able to:

- Classify molecules as aldehydes or ketones.
- Formulate IUPAC names for aldehydes and ketones.
- Formulate common names for ketones.
- Interpret the physical properties of aldehydes and ketones.
- Predict the products of the oxidation of aldehydes reactions using O_2 and $K_2Cr_2O_7$.
- Predict the products of the reduction of aldehydes and ketones using H_2 with a transition metal catalyst and $NaBH_4$.
- Predict the product of the addition of a molecule of alcohol to aldehydes and ketones.
- Predict the product of the addition of a molecule of alcohol to a hemiacetal.
- Develop the equilibrium equation between keto and enols.
- Identify molecules as tautomers.

Name:

Dates: March

Course/Subject: Organic Chemistry and Biochemistry Unit

Unit Plan 9: Carboxylic Acids

Stage 1 – Desired Results**PA Standard(s)/Assessment Anchors Addressed:****3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances****3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions****3.4.12A—Characterize and identify important classes of compounds****3.4.10A—Understand that carbon can form several different types of compounds.****3.2.12B—Evaluate experimental information for appropriateness and adherence to relevant science processes.**

Understanding(s):

Essential Question(s):

<p>Students will understand . . .</p> <p>1. Structural diversity allows for functional diversity underlying the processes and variety of life.</p>	<ul style="list-style-type: none"> ▪ How are carboxylic anhydrides, esters, and amides relative to chemistry and our everyday lives?
<p>Learning Objectives: Students will know . . .</p> <ul style="list-style-type: none"> ▪ The functional group of a carboxylic acid is the carboxyl group, —COOH ▪ IUPAC names of carboxylic acids are derived from the name of the parent alkane by dropping the suffix <i>-e</i> and adding <i>-oic acid</i>. ▪ Dicarboxylic acids are named as <i>-dioic acids</i>. ▪ Common names for many carboxylic acids and dicarboxylic acids are still widely used. ▪ Carboxylic acids are polar compounds. Consequently, they have higher boiling points and are more soluble in water than alcohols, aldehydes, ketones and ethers of comparable molecular weight. ▪ Fatty acids are long unbranched-chain carboxylic acids. They can be saturated or unsaturated. ▪ A triglyceride is a triester of glycerol. ▪ A micelle is a spherical arrangement of molecules in an aqueous environment in which the hydrocarbon parts are on the inside and the hydrophilic parts are on the surface. ▪ Carboxylic acids are weak acids, which react with strong bases to form water-soluble salts. ▪ Treatment of a carboxylic acid with an alcohol in the presence of an acid catalyst gives an ester. ▪ When exposed to a very high temperature, carboxylic acids can undergo decarboxylation. 	<p>Students will be able to:</p> <ul style="list-style-type: none"> ▪ Classify molecules as carboxylic acids ▪ Formulate IUPAC names for carboxylic acids. ▪ Formulate common names for carboxylic acids. ▪ Interpret the physical properties of aldehydes and ketones. ▪ Describe the process of saponification. ▪ Classify fatty acids as saturated or unsaturated. ▪ Identify molecules as fatty acids. ▪ Predict the reaction of fatty acids with strong bases to form soap. ▪ Predict the reaction of carboxylic acids with bases. ▪ Predict the reduction of carboxylic acids with Lithium Aluminum Hydride ▪ Predict Fischer Esterification reactions ▪ Predict decarboxylation reactions.
<p>Name:</p>	<p>Dates: April</p>
<p>Course/Subject: Organic Chemistry and Biochemistry</p>	<p>Unit Plan 10: Carboxylic Anhydrides, Esters, and Amides</p>
<p>Stage 1 – Desired Results</p>	
<p>PA Standard(s)/Assessment Anchors Addressed:</p> <p>3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances</p> <p>3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions</p> <p>3.4.12A—Characterize and identify important classes of compounds</p> <p>3.4.10A—Understand that carbon can form several different types of compounds.</p> <p>3.2.12B – Evaluate experimental information for appropriateness and adherence to relevant science processes.</p>	

<p>Understanding(s): <i>Students will understand . . .</i></p> <ul style="list-style-type: none"> ▪ Structural diversity allows for functional diversity underlying the processes and variety of life. 	<p>Essential Question(s):</p> <ul style="list-style-type: none"> ▪ How are carboxylic anhydrides, esters, and amides relative to chemistry and our everyday lives?
<p>Learning Objectives: <i>Students will know . . .</i></p> <ul style="list-style-type: none"> ▪ Carboxylic acids are weak acids, which react with strong bases to form water-soluble salts. ▪ Treatment of a carboxylic acid with an alcohol in the presence of an acid catalyst gives an ester. ▪ When exposed to a very high temperature, carboxylic acids can undergo decarboxylation. ▪ The most common laboratory method for the preparation of esters is Fischer Esterification. ▪ Amides can be prepared by the reaction of an amine with a carboxylic anhydride. ▪ Hydrolysis is a chemical process in which a bond is split and the elements of H₂O are added. ▪ Hydrolysis of a carboxylic anhydride gives two molecules of carboxylic acid. ▪ Hydrolysis of a carboxylic ester requires the presence of either concentrated aqueous acid or base. Acid is a catalyst and the reaction is the reverse of Fischer Esterification. Base is a reactant and are required in stoichiometric amounts. ▪ Phosphoric anhydrides consist of two phosphoryl groups (P=O) bonded to the same oxygen atom. ▪ Step-growth polymerization involves the stepwise reaction of difunctional monomers. Important commercial polymers synthesized through step-growth processes include polyamides, polyesters, and polycarbonates. 	<p>Students will be able to:</p> <ul style="list-style-type: none"> ▪ Classify molecules as carboxylic anhydrides, esters, and amides. ▪ Formulate IUPAC names for carboxylic anhydrides, esters, and amides. ▪ Formulate common names for carboxylic anhydrides, esters, and amides. ▪ Formulate a method for preparing esters. ▪ Formulate a method for preparing amides ▪ Predict the products for the hydrolysis of a carboxylic anhydride. ▪ Predict the products for the hydrolysis of esters ▪ Predict the products for the hydrolysis of amides. ▪ Identify phosphoric anhydrides and phosphoric esters. ▪ Categorize products created by Step-Growth Polymerization.
<p>Name:</p>	<p>Dates: May/June</p>
<p>Course/Subject: Organic Chemistry and Biochemistry</p>	<p>Unit Plan 11: Carbohydrates</p>

Stage 1 – Desired Results

PA Standard(s)/Assessment Anchors Addressed:

- 3.4.12A—Apply rules of systematic nomenclature and formula writing to chemical substances
- 3.4.12A—Classify and describe, in equation form, types of chemical and nuclear reactions
- 3.4.12A—Characterize and identify important classes of compounds
- 3.4.10A—Understand that carbon can form several different types of compounds.
- 3.2.12B—Evaluate experimental information for appropriateness and adherence to relevant science processes.

Understanding(s):

Students will understand . . .

- Structural diversity allows for functional diversity underlying the processes and variety of life.

Essential Question(s):

- How are carbohydrates relative to chemistry and our everyday lives?
- How does our knowledge of nomenclature, chirality, hemiacetals and acetals affect our understanding of carbohydrates?

Learning Objectives:

Students will know . . .

- **Monosaccharides** are polyhydroxyaldehydes or polyhydroxyketones.
- The most common monosaccharides have the general formula $C_nH_{2n}O_n$, where n varies from 3 to 8.
- Names that contain the suffix *-ose*, and the prefixes *tri*, *tetr*-, and so on indicate the number of carbon atoms in the chain. The prefix *aldo*- indicates an aldehyde, and the prefix *keto*- indicates a ketone.
- In a **Fischer Projection** of a monosaccharide, we write the carbon chain vertically with the most highly oxidized carbon toward the top. Horizontal lines represent groups projecting above the plane of the page; vertical lines represent groups projecting behind the plane of the page.
- The penultimate carbon of a monosaccharide is the next-to-last carbon of a fischer projection.
- A monosaccharide that has the same configuration at the penultimate carbon as D-glyceraldehyde is called **D-monosaccharide**; one that has the same configuration at the penultimate carbon as L-glyceraldehyde is called an **L-glyceraldehyde**.
- Monosaccharides exist primarily as cyclic hemiacetals.
- A six-membered cyclic hemiacetal is a **pyranose**; a five-membered cyclic hemiacetal is a **furanose**.

Students will be able to:

- Classify, formulate, predict, identify, categorize
- Identify monosaccharides.
- Analyze the names of monosaccharides to determine the number of carbons and functional group present.
- Predict the structures of fischer projections based on the names of monosaccharides.
- Predict the names of monosaccharides based on the fischer projections.
- Differentiate between D- and L-monosaccharides.
- Identify monosaccharides as D- and L-.
- Draw and identify pyranose and furanose monosaccharides.
- Identify the anomeric carbon in hemiacetal monosaccharides.
- Identify hemiacetal monosaccharides as β or α .
- Draw Haworth Projections for furanoses and pyranoses.
- Draw chair conformations for pyranoses.

- The new stereocenter resulting from hemiacetal formation is called an **anomeric carbon**, and the stereoisomers formed in this way are called **anomers**.
- The symbol β - indicates that the $-\text{OH}$ group on the anomeric carbon lies on the same side of the ring as the terminal $-\text{CH}_2\text{OH}$.
- The symbol α - indicates that the $-\text{OH}$ group on the anomeric carbon lies on the opposite side of the ring from the terminal $-\text{CH}_2\text{OH}$.
- Furanoses and pyranoses can be drawn as **Haworth Projections**.
- Pyranoses can also be drawn as **chair conformations**.
- **Mutarotation** is the change in specific rotation that accompanies formation of an equilibrium mixture of α and β anomers in aqueous solution.
- A **disaccharide** contains two monosaccharide units joined by a glycosidic bond.
- Terms applied to carbohydrates containing larger numbers of monosaccharides are **trisaccharide, tetrasaccharide, oligosaccharide, and polysaccharide**.
- **Sucrose** is a disaccharide consisting of D-glucose joined to D-fructose by an α -1,2-glycosidic bond.
- **Lactose** is a disaccharide consisting D-galactose.
- **Maltose** is a disaccharide of two molecules of D-glucose joined by an α -1,4-glycosidic bond.
- **Starch** can be separated into fractions: amylose and amylopectin.
- **Amylose** is a linear polysaccharide of as many as 4,000 units of D-glucopyranose joined by α -glycosidic bonds.
- **Amylopectin** is a highly branched polysaccharide of D-glucose joined by α -1,4-glycosidic bonds, and at branch points by β -1,4-glycosidic bonds.
- The carboxyl and sulfate groups of **acidic polysaccharides** are ionized to $-\text{COO}^-$ and $-\text{SO}_3^-$ at the pH of body fluids, which gives these polysaccharides net negative charges.