REVIEW

Chemistry, Water, Carbon, and Molecules

Chapters 2&3 - Biology in Focus
Chapters 2-5 - Campbell

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Brookings Biology

http://www.yellowtang.org/images/structure_of_nucleo_c_la_784.jpg

Macromolecule made by joining nucleotide subunits together

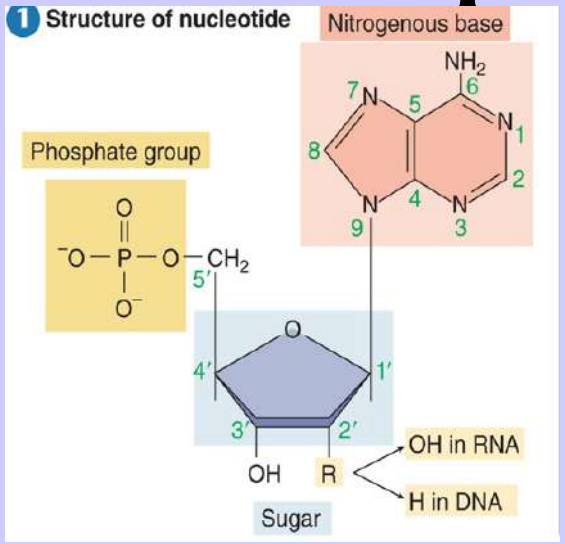
Nucleic acid (DNA & RNA)

Name the 3 components that make up a nucleotide

5 carbon sugar,

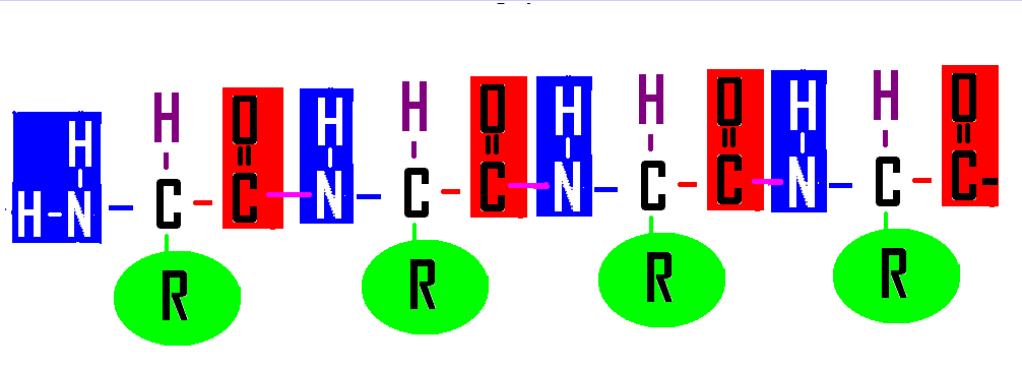
nitrogenous base,

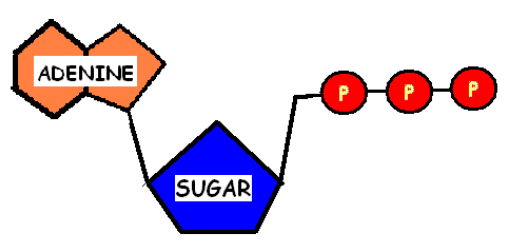
Phosphate group

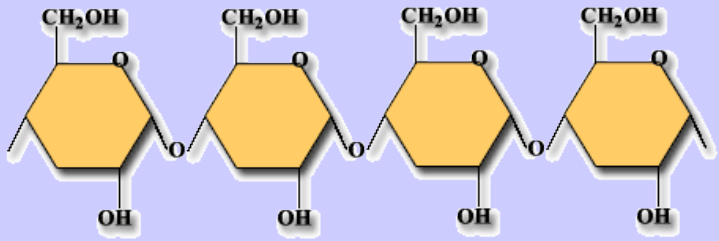


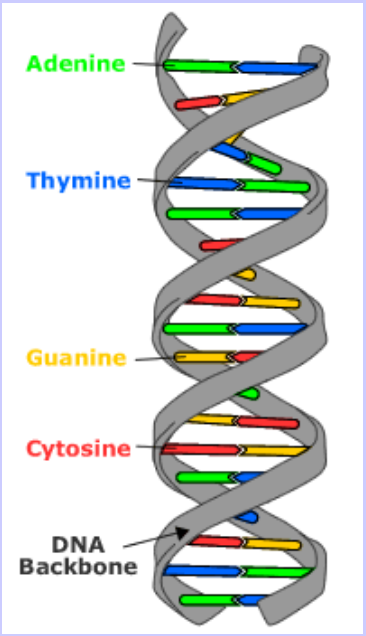
Essential knowledge 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.
b. DNA and RNA molecules have structural similarities and differences that define function. [See also **4.A.1**]
Evidence of student learning is a demonstrated understanding of each of the following:

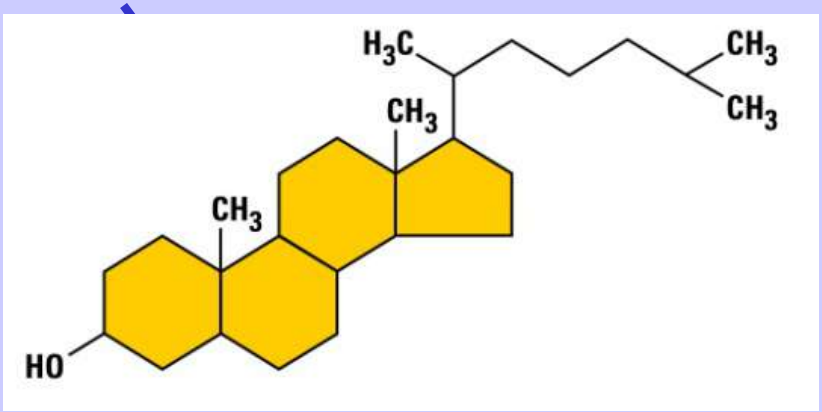
Which of these molecules is a steroid?











Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

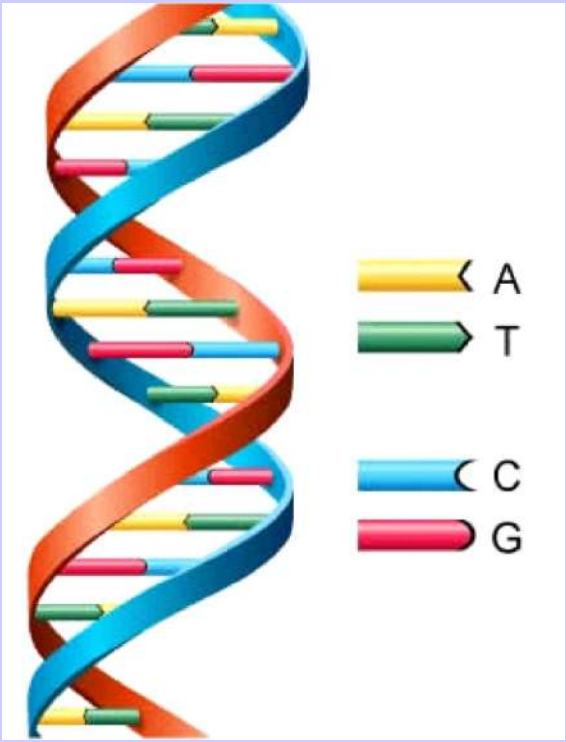
Image from: http://www.astrochem.org/sci_img/dna.jpg

Which type of bonds are found where?

HYDROGEN BONDS COVALENT BONDS

Bonds between nitrogen bases that hold the 2 DNA strands together. Hydrogen bonds

Bonds between sugars and phosphate groups in the DNA backbone. Covalent



Essential knowledge 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.

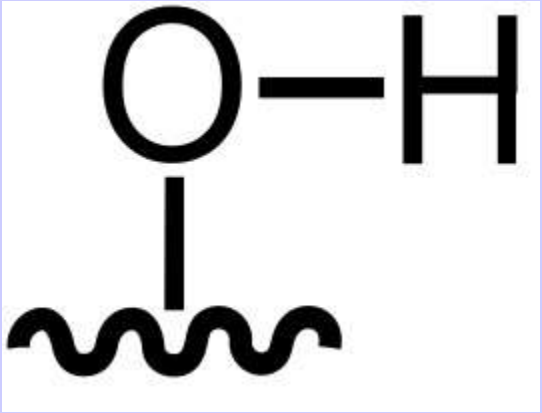
b. DNA and RNA molecules have structural similarities and differences that define function. [See also **4.A.1**]

Evidence of student learning is a demonstrated understanding of each of the following:

1. Both have three components — sugar, phosphate and a nitrogenous base — which form nucleotide units that are connected by covalent bonds to form a linear molecule with 3' and 5' ends, with the nitrogenous bases perpendicular to the sugar-phosphate backbone.

Image from: https://upload.wikimedia.org/wikipedia/commons/0/0b/Hydroxyl_group.svg

Name this functional group



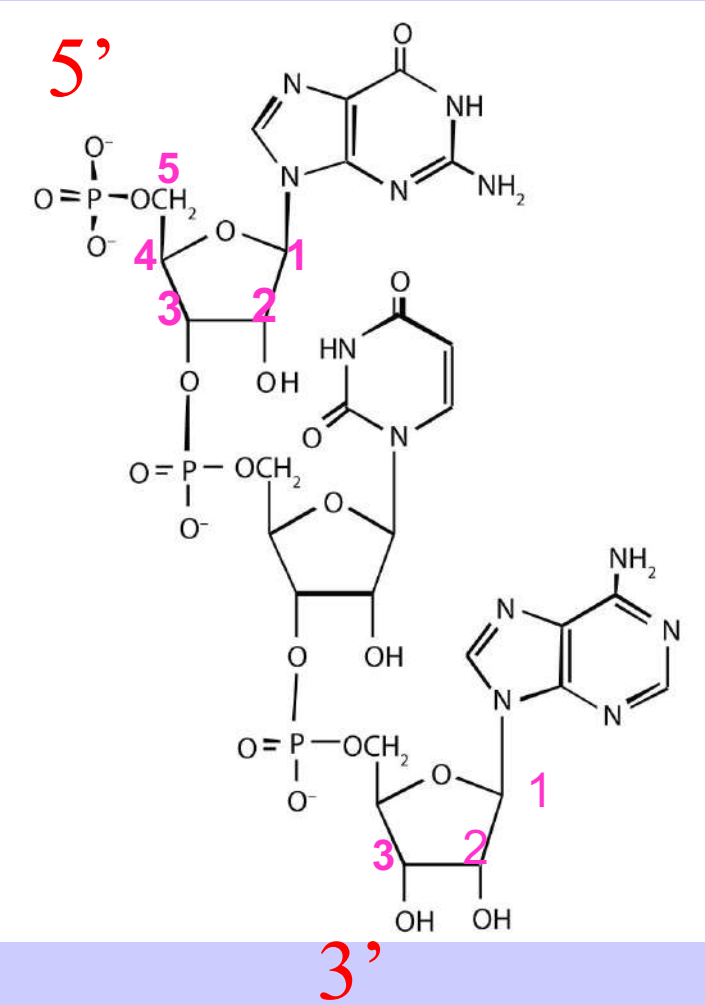
hydroxyl

How does adding this group change an organic molecule?

Makes it more polar
Makes it an alcohol

Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

http://2012books.lardbucket.org/books/introduction-to-chemistry-general-organic-and-biological/section_22/a7fb0b8d8bd87a23d5e3d86f5452a2dc.jpg



Label the 3’ and 5’ ends of this strand of DNA

Direction is determined by the carbon closest to that end

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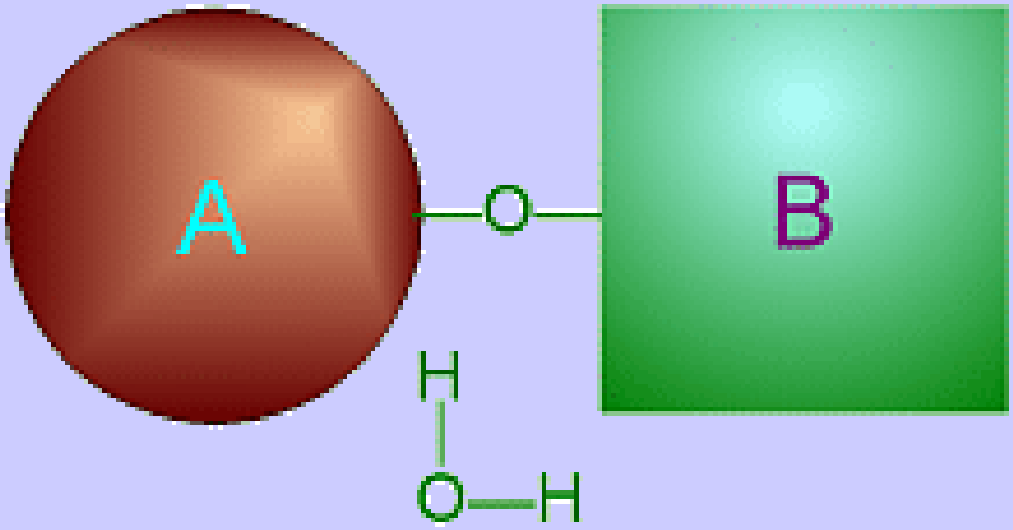
Animation from: http://biologyclermont.info/wwwroot/graphics/lect1/carbon/hydrolysis%20anim.gif

Chemical reaction in which a molecule is broken apart by the addition of the H and OH from a water molecule

hydrolysis



2.A.2.b.1. Heterotrophs may metabolize carbohydrates, lipids, and proteins by hydrolysis as sources of free energy..

Image from: http://scitechdaily.com/images/Four-stranded-quadruple-helix-DNA-structurein-human-cells.jpg

Which part of a nucleotide makes up the rungs of the ladder" in a DNA molecule?

Nitrogen bases

Essential knowledge 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.
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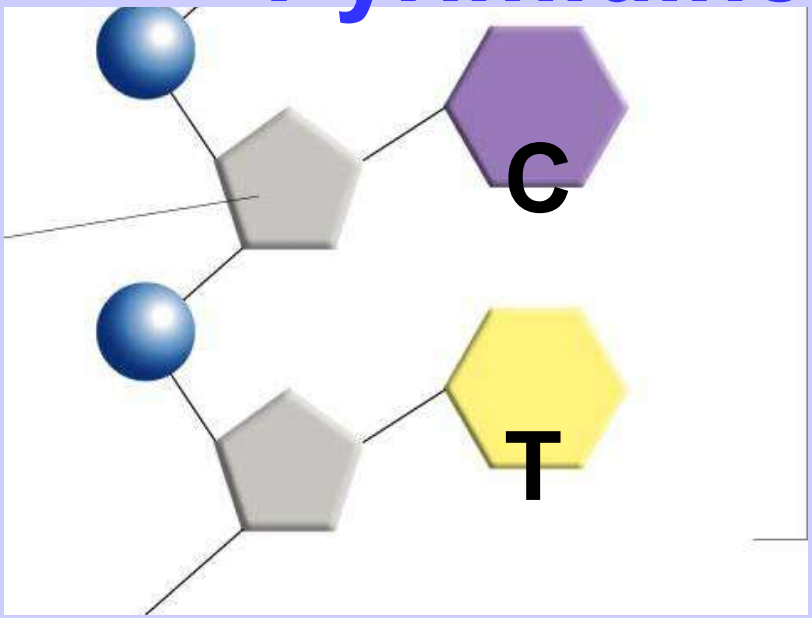
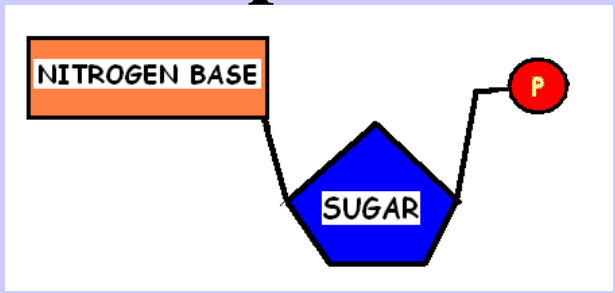
1. Both have three components — sugar, phosphate and a nitrogenous base — which form nucleotide units that are connected by covalent bonds to form a linear molecule with 3' and 5' ends, with the nitrogenous bases perpendicular to the sugar-phosphate backbone.

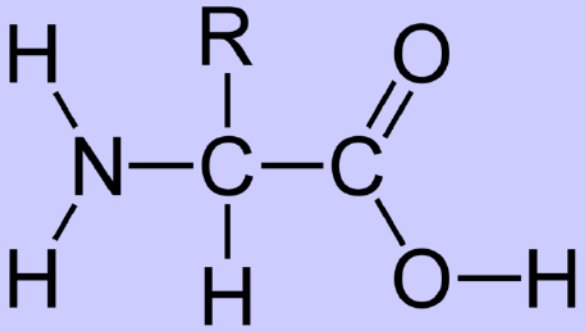
Nitrogen bases with 1 ring are called ~~Pyrimidines~~

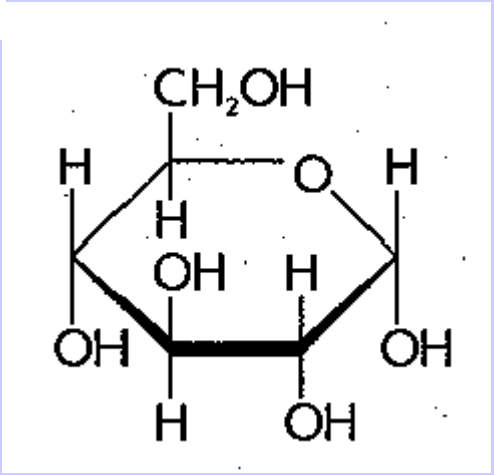


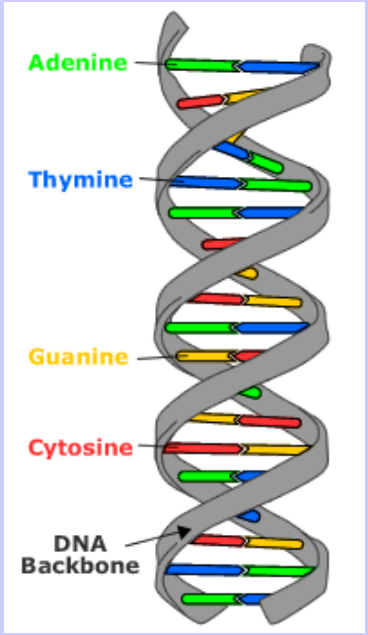
3.A.1.b. 3. Both DNA and RNA exhibit specific nucleotide base pairing that is conserved through evolution: adenine pairs with thymine or uracil (A-T or A-U and cytosine pairs with guanine (C-G)
ii. Pyrimidines (C, T and U) have a single ring structure.

Which of these molecules along with proteins is the major component in cell membranes?





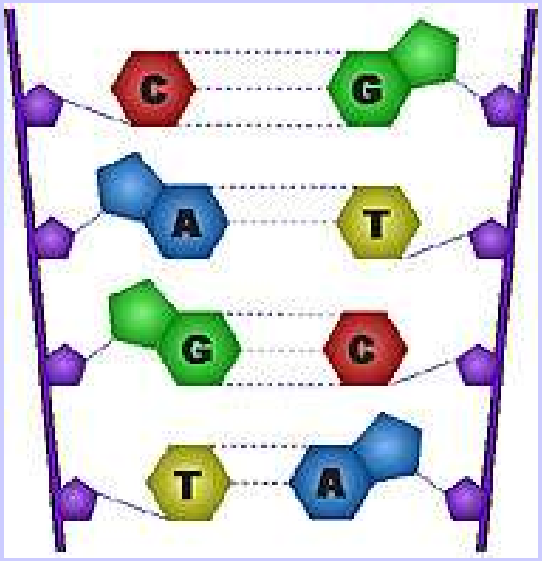




Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

Image from: http://www.tokyo-med.ac.jp/genet/picts/dna.jpg

Which molecules make up the backbone (sides of ladder) in a DNA molecule?



Sugar (deoxyribose) and phosphates

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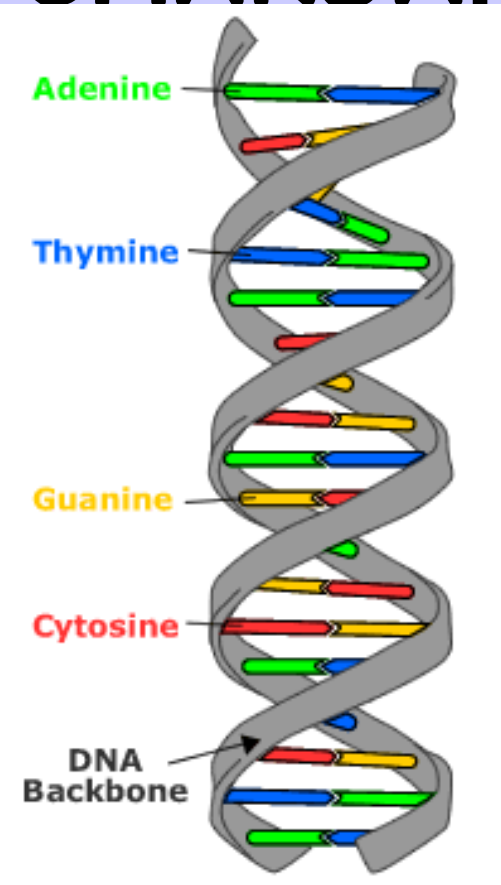
CHARGAFF'S RULES say that ?



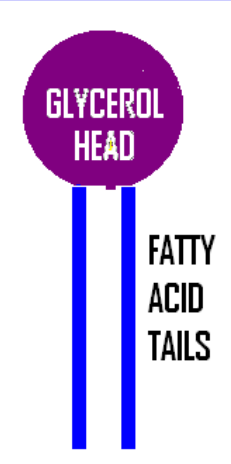
A = T G = C

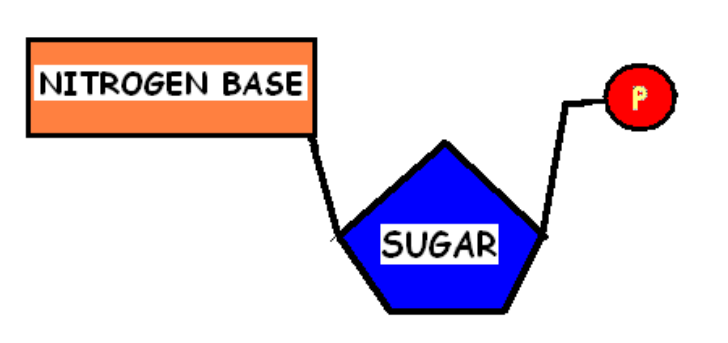
3.A.1. 3. Both DNA and RNA exhibit specific nucleotide base pairing that is conserved through evolution: adenine pairs with thymine or uracil (A-T or A-U) and cytosine pairs with guanine (C-G)

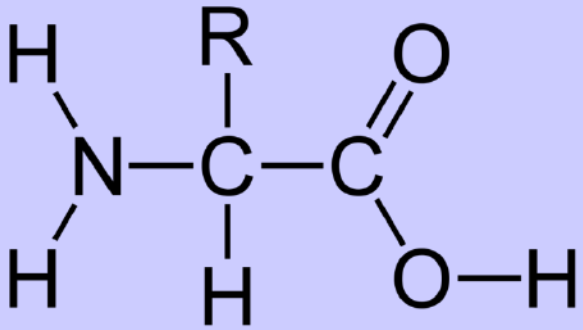
i. Purines (G and A) have a double ring structure.

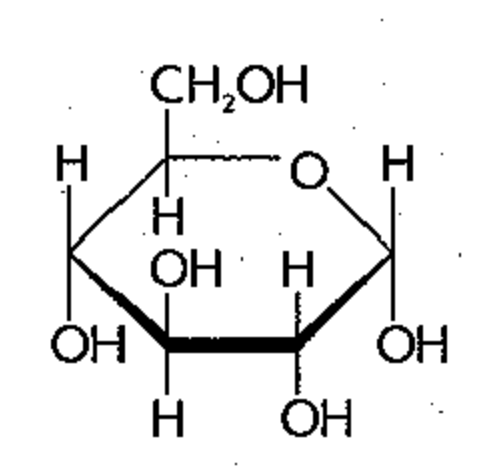
Image from: http://evolution.berkeley.edu/evosite/evo101/images/dna_bases.gif

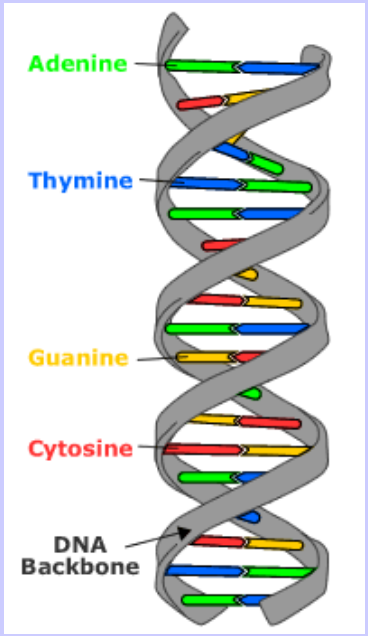
Which of these molecules is a carbohydrate?











Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

Name the molecule(s) that carry the genetic code found in all living things.

Nucleic acids

DNA or RNA

Which of these is found in retroviruses

RNA

Essential knowledge 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.

a. Genetic information is transmitted from one generation to the next through DNA or RNA.

Evidence of student learning is a demonstrated understanding of each of the following:

1. Genetic information is stored in and passed to subsequent generations through DNA molecules and, in some cases, RNA molecules.

Which of the following is true:

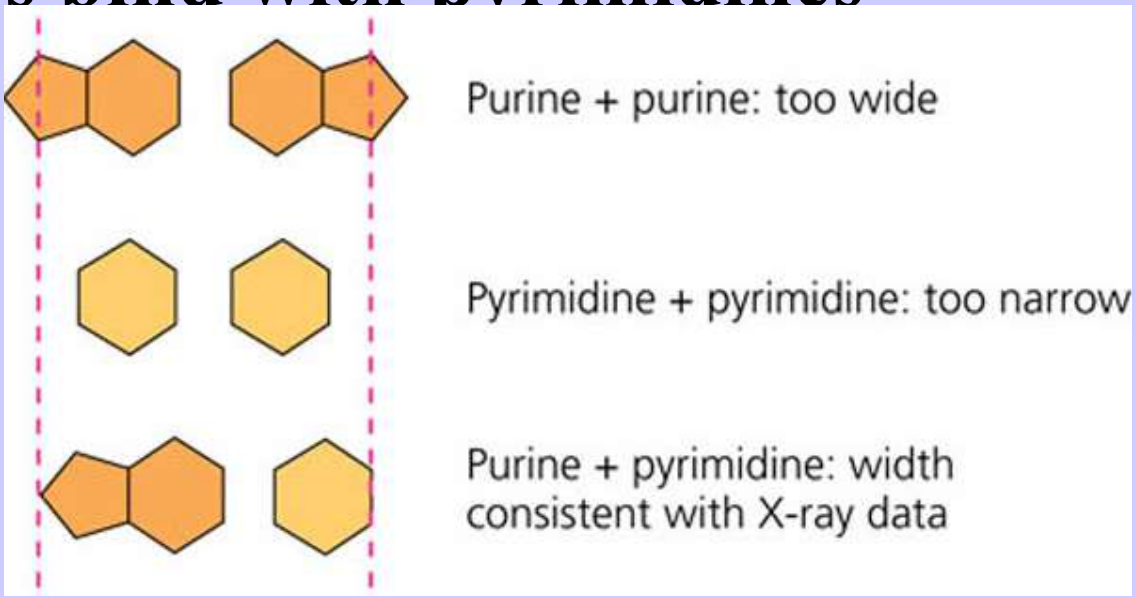
In a DNA molecule

A. purines always bind with purines

B. pyrimidines always bind with pyrimidines

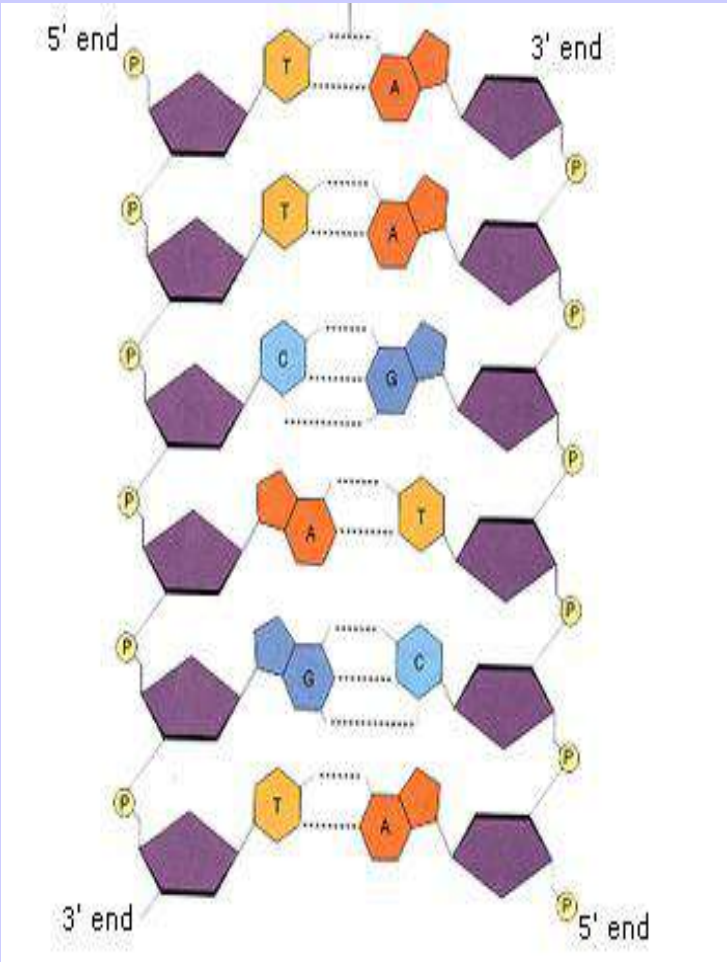
C. Purines always bind with pyrimidines

C.



3.A.1. 3. Both DNA and RNA exhibit specific nucleotide base pairing that is conserved through evolution: adenine pairs with thymine or uracil (A-T or A-U) and cytosine pairs with guanine (C-G)

http://images.tutorvista.com/cms/images/123/dna-base-pairing-structure.jpeg



The two DNA strands are said to be

ANTIPARALLEL

because their 3′ and 5′ ends run in opposite directions.

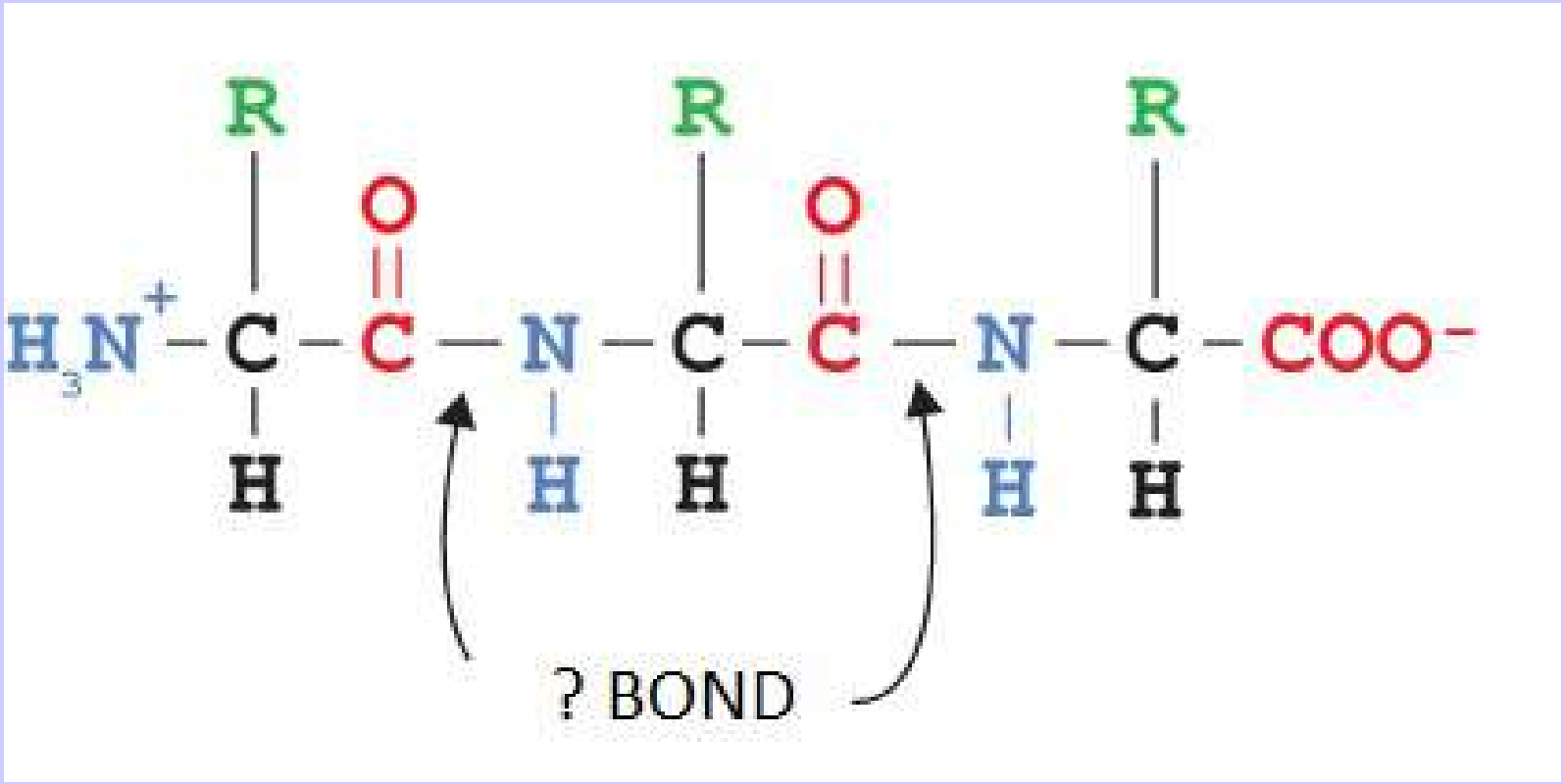
Essential knowledge 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.

b. DNA and RNA molecules have structural similarities and differences that define function. [See also **4.A.1**]

Evidence of student learning is a demonstrated understanding of each of the following:

2. The basic structural differences include:

iv. The two DNA strands in double-stranded DNA are antiparallel in directionality.

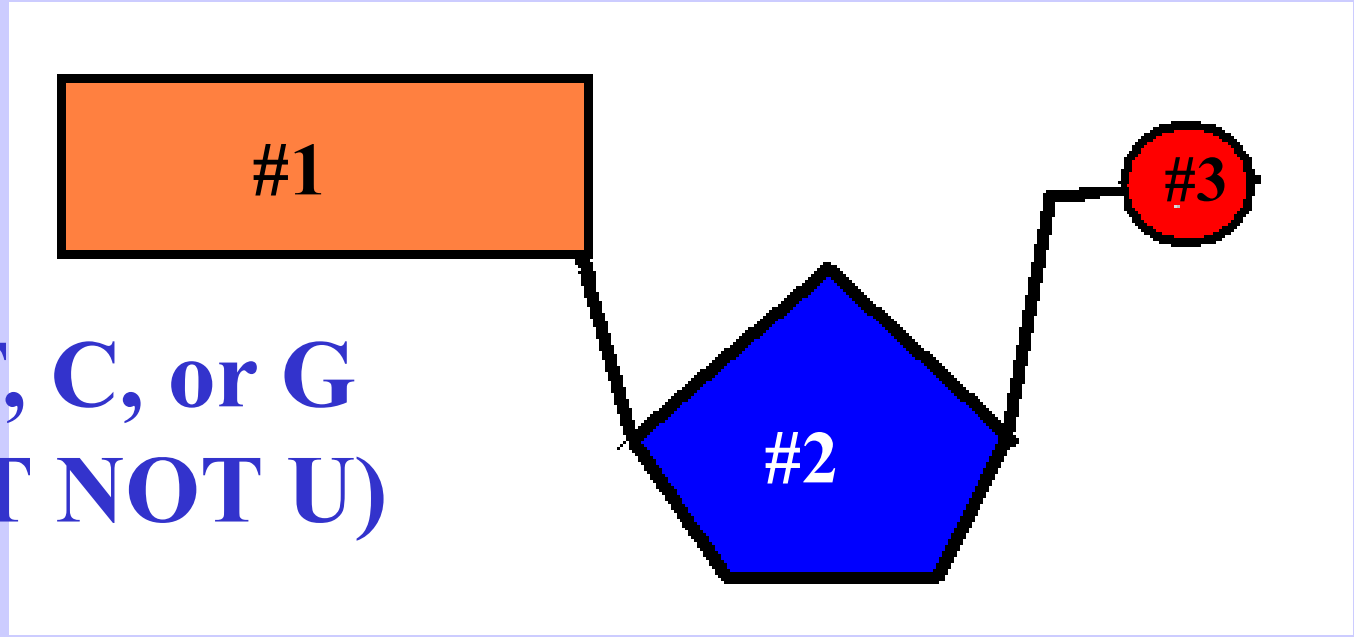


Name the bond that holds amino acid subunits together make a polypeptide

peptide bond

4.A.a.b.2 Proteins have an amino (NH_3) end and a carboxyl COOH) end, and consist of a linear sequence of amino acids connected by the formation of peptide bonds by dehydration synthesis between the amino and carboxyl groups of adjacent monomers.

If you want to make DNA which nitrogen bases CAN BE used in the #1 spot?



A, T, C, or G (BUT NOT U)

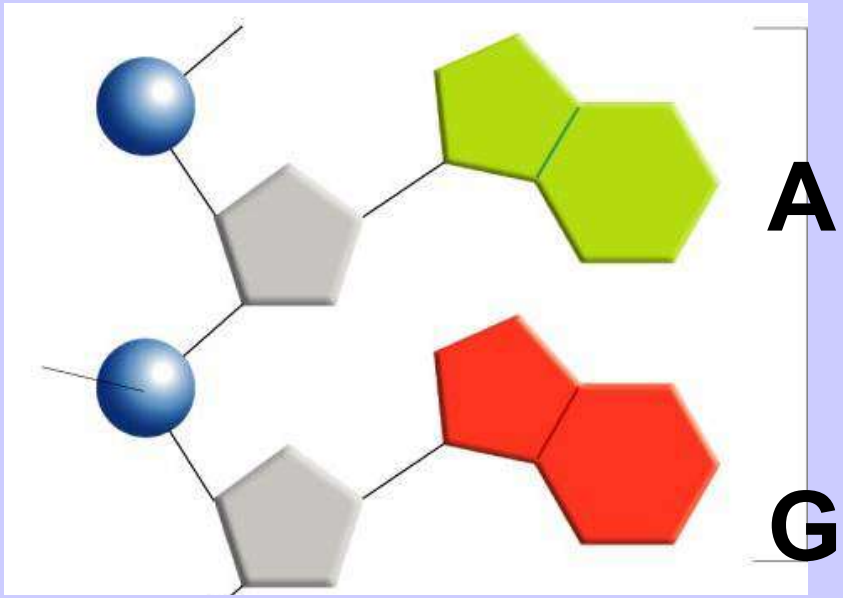
3.A.1.b DNA and RNA molecules have structural similarities and differences that define function.
2. The basic structural differences include:
ii. RNA contains uracil in lieu of thymine in DNA

Name some functions of carbohydrates in cells.

Burned for energy in cells (glucose)
Store energy for later (glycogen, starch)
Structural (cellulose, chitin)
Cell ID (part of glycoproteins)

Essential knowledge 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization.
a. Molecules and atoms from the environment are necessary to build new molecules.
Evidence of student learning is a demonstrated understanding of each of the following:
1. Carbon moves from the environment to organisms where it is used to build carbohydrates, proteins, lipids or nucleic acids. Carbon is used in storage compounds and cell formation in all organisms.

Nitrogen bases with 2 rings are called ~~Purines~~



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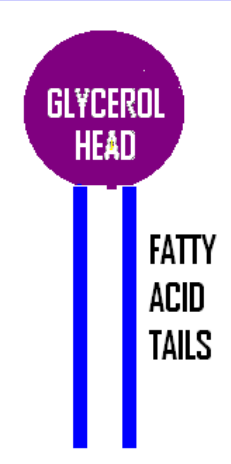
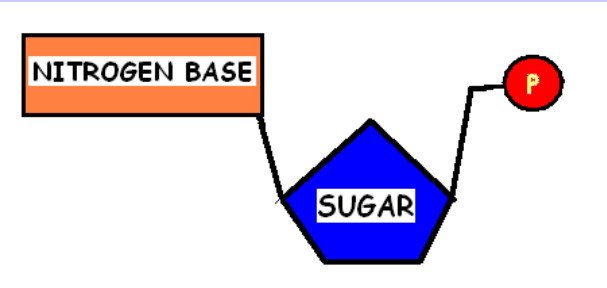
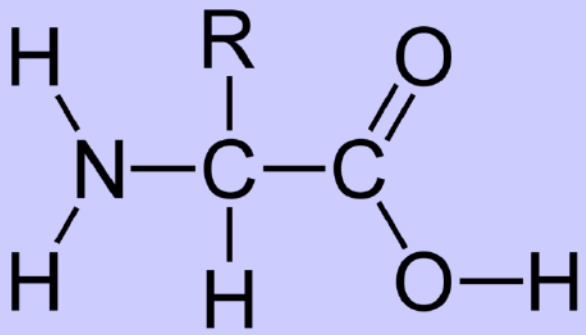
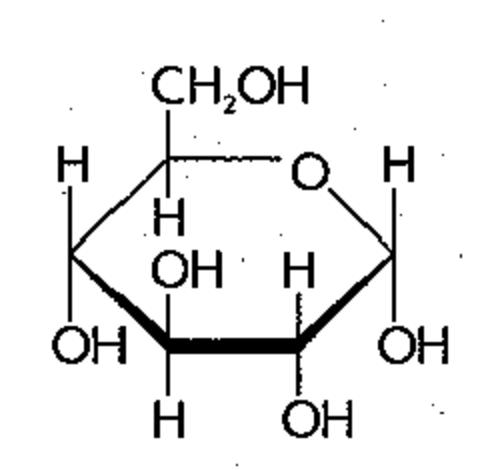
i. Purines (G and A) have a double ring structure.

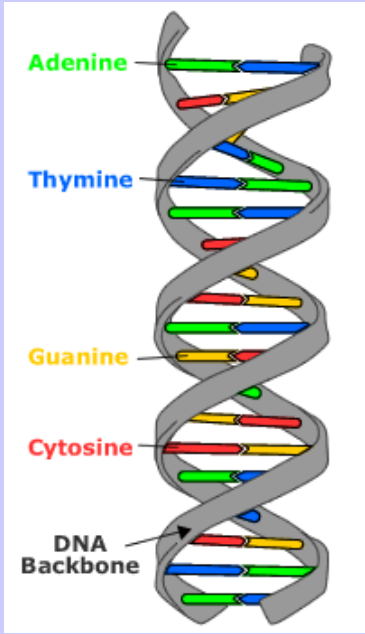
Which of these molecules is a nucleic acid?











Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

Tell some ways DNA is different from RNA

DNARNA

Double strandedsingle stranded

Contains A,T,C,GContains A,U,C,G

No Uno T

sugar = deoxyribosesugar = ribosose

Stores genetic info transfers info from DNA to cell

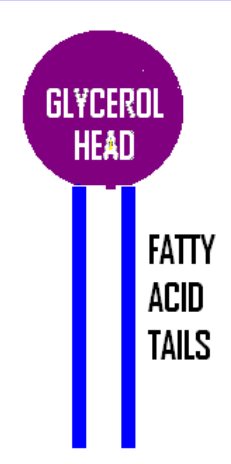
helps with protein

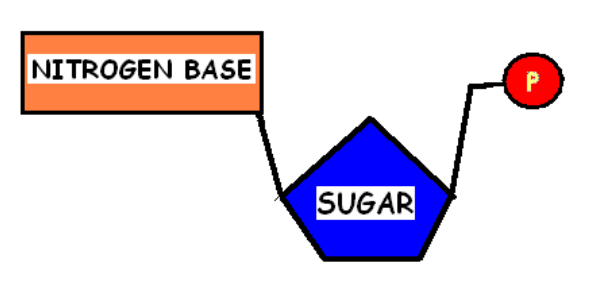
synthesis

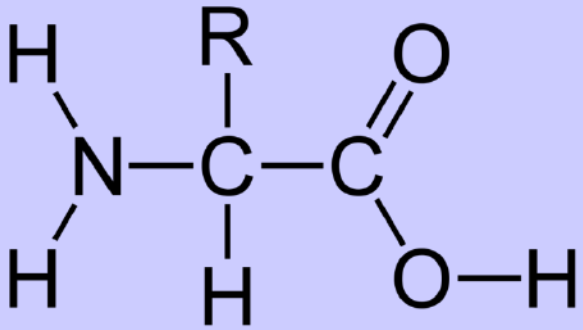
3.A.1.b DNA and RNA molecules have structural similarities and differences that define function.

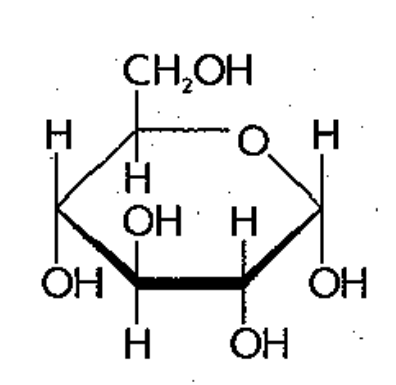
2. The basic structural differences include:
   i. DNA contains deoxyribose (RNA contains ribose)
   ii. RNA contains uracil in lieu of thymine in DNA
   iii. DNA is usually double stranded. RNA is usually single stranded.

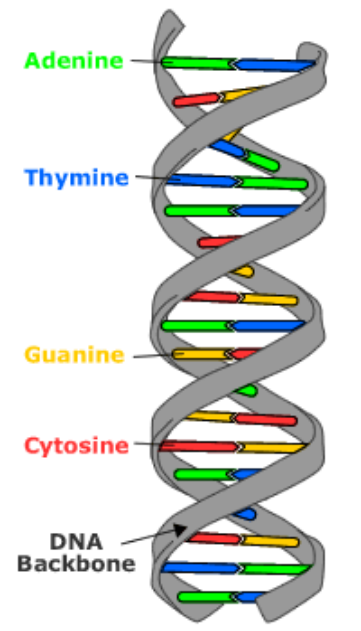
Which of these molecules stores genetic info?



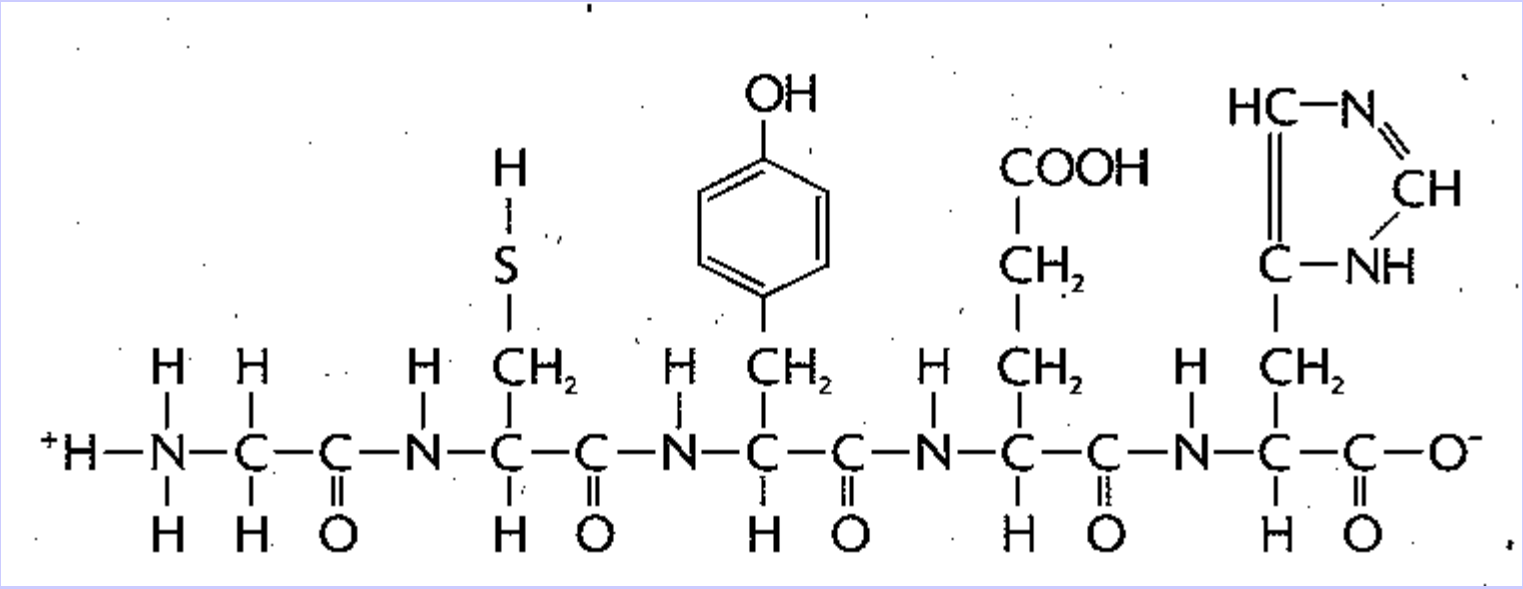








Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

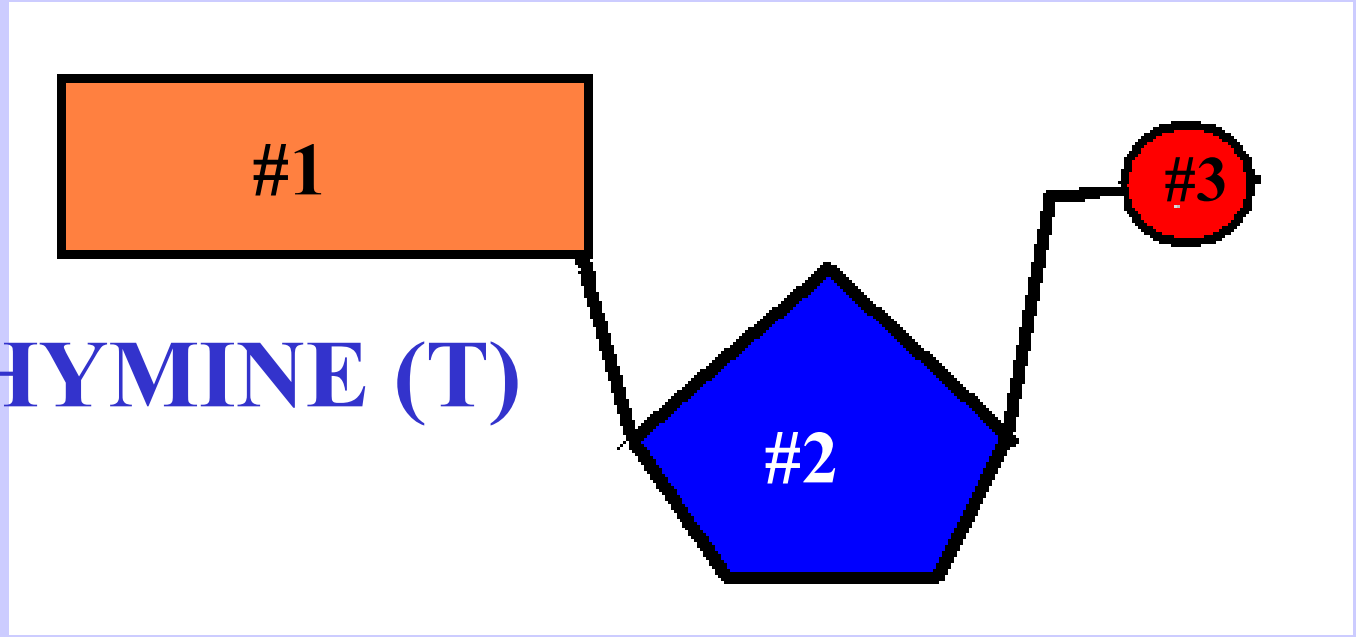


How many amino acids are shown in this polypeptide chain?

5

4.A.a.b.2 Proteins have an amino (NH_3) end and a carboxyl (COOH) end, and consist of a linear sequence of amino acids connected by the formation of peptide bonds by dehydration synthesis between the amino and carboxyl groups of adjacent monomers.

If you want to make RNA which nitrogen bases CAN'T be used in the #1 spot?



NO THYMINE (T)

3.A.1.b DNA and RNA molecules have structural similarities and differences that define function.
2. The basic structural differences include:
ii. RNA contains uracil in lieu of thymine in DNA

The interactions between the amino and carboxyl groups on different amino acids in a polypeptide chain make up its SECONDARY structure.

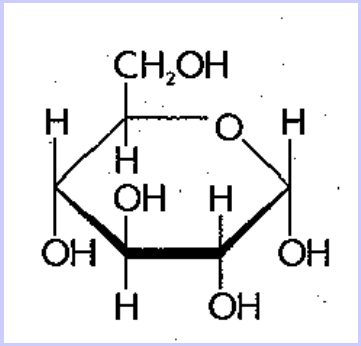
primary secondary tertiary quaternary

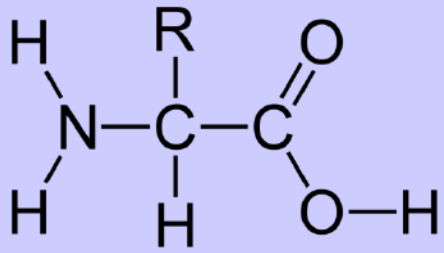
Name the kind of bonds/interactions that hold these together

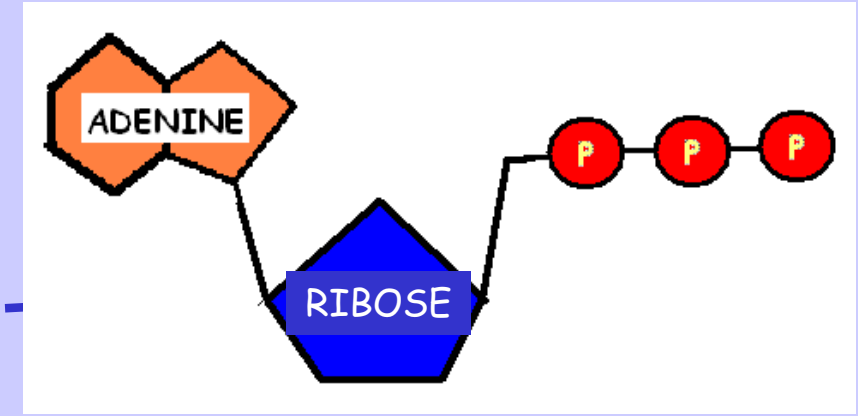
Hydrogen bonds

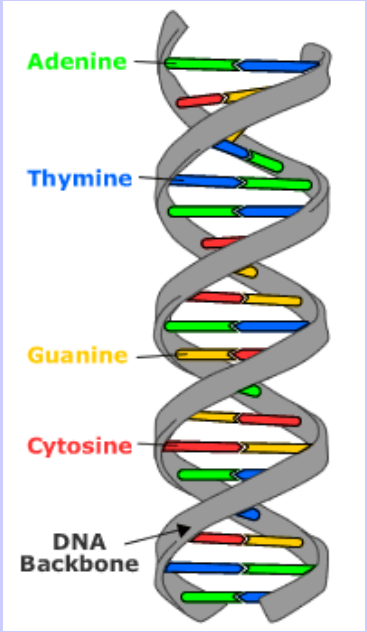
Essential knowledge 4.A.1.a. 2
In proteins, the specific order of amino acids in a polypeptide (primary structure) interacts with the environment to determine the overall shape of the protein, which also involves secondary tertiary and quaternary structure and, thus, its function.
✘ ✘ *The molecu7lar structure of specific amino acids is beyond the scope of the course and the AP Exam*

Which of these molecules is used by cells to store and transport energy?



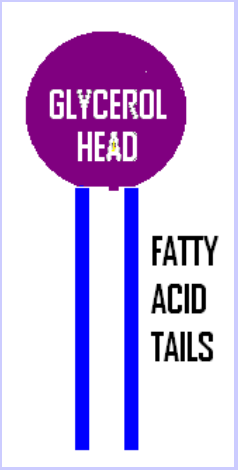


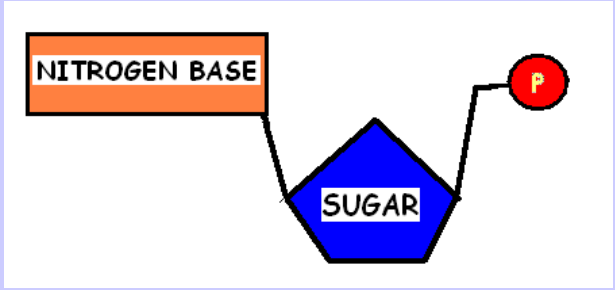


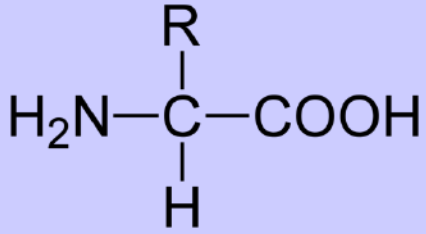


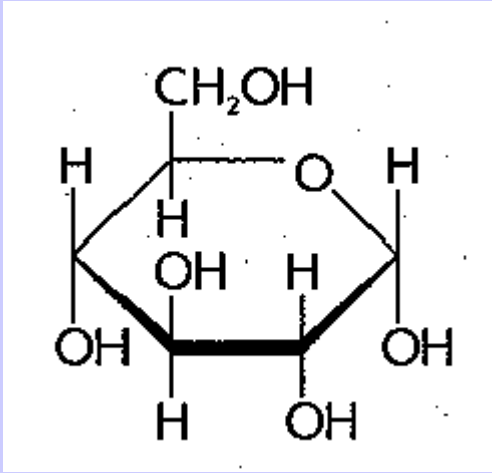
Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

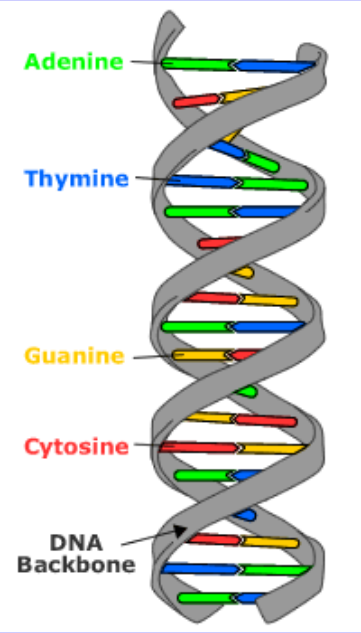
Which of these molecules could be used to make an RNA molecule?





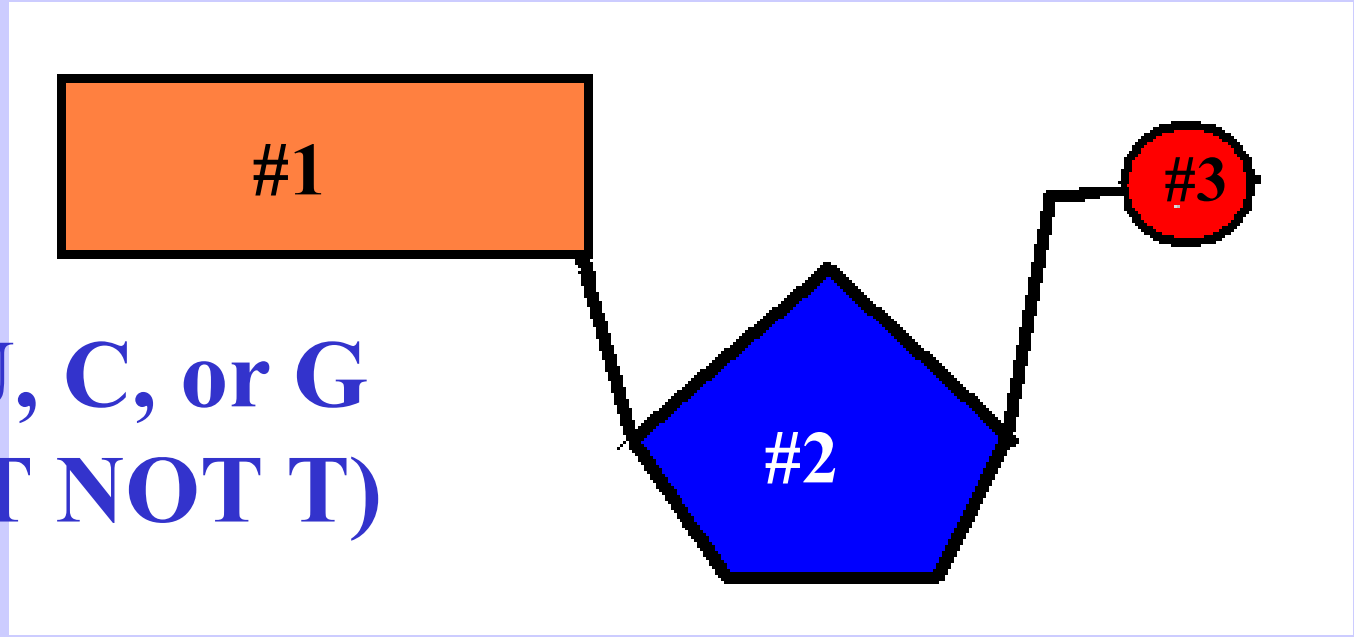






Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

If you want to make RNA which nitrogen bases CAN BE used in the #1 spot?



A, U, C, or G (BUT NOT T)

3.A.1.b. DNA and RNA molecules have structural similarities and differences that define function. [See also **4.A.1**]
2. The basic structural differences include:
ii. RNA contains uracil in lieu of thymine in DNA.

The interactions between R groups on amino acids in a polypeptide chain makes up its TERTIARY structure.

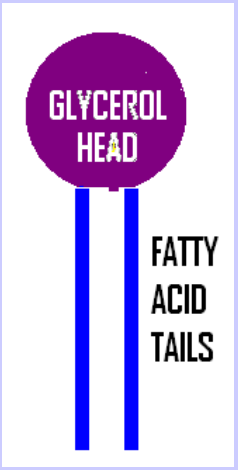
primary secondary tertiary quaternary

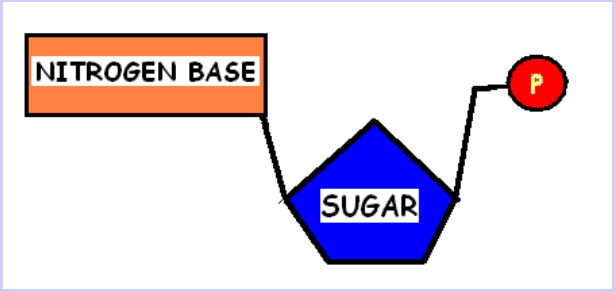
Name some of the kinds of bonds/interactions that hold these together

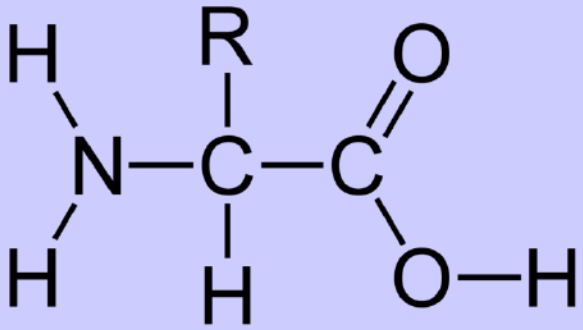
Hydrogen bonds
Van der waals interactions
Ionic interactions
Hydrophobic/hydrophilic interactions
Disulfide bridges (covalent)

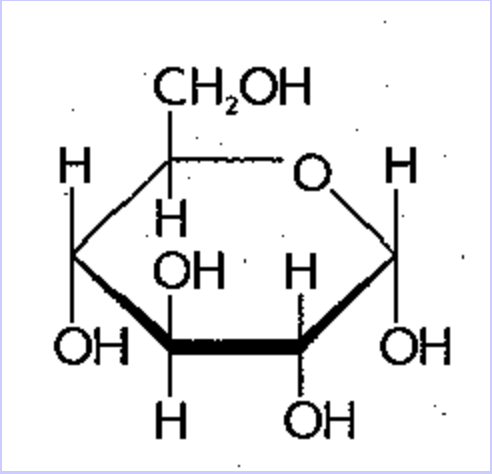
Essential knowledge 4.A.1.a. 2
In proteins, the specific order of amino acids in a polypeptide (primary structure) interacts with the environment to determine the overall shape of the protein, which also involves secondary tertiary and quaternary structure and, thus, its function. The R group of an amino acid can be categorized by chemical properties (hydrophobic, hydrophilic and ionic), and the interactions of these R groups determine structure and function of that region of the protein. ✘ ✘ *The molecular structure of specific amino acids is beyond the scope of the course and the AP Exam*

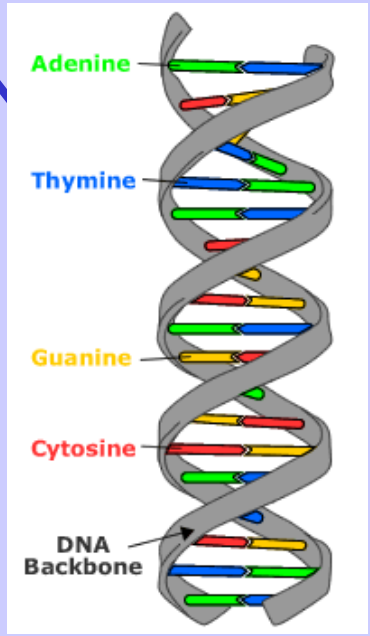
Which of these molecules is a nucleotide?











Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

Compare & Contrast

Cohesion

Attraction between individual water molecules

Adhesion

Attraction between water molecules and other surfaces

BOTH DUE TO HYDROGEN BONDING

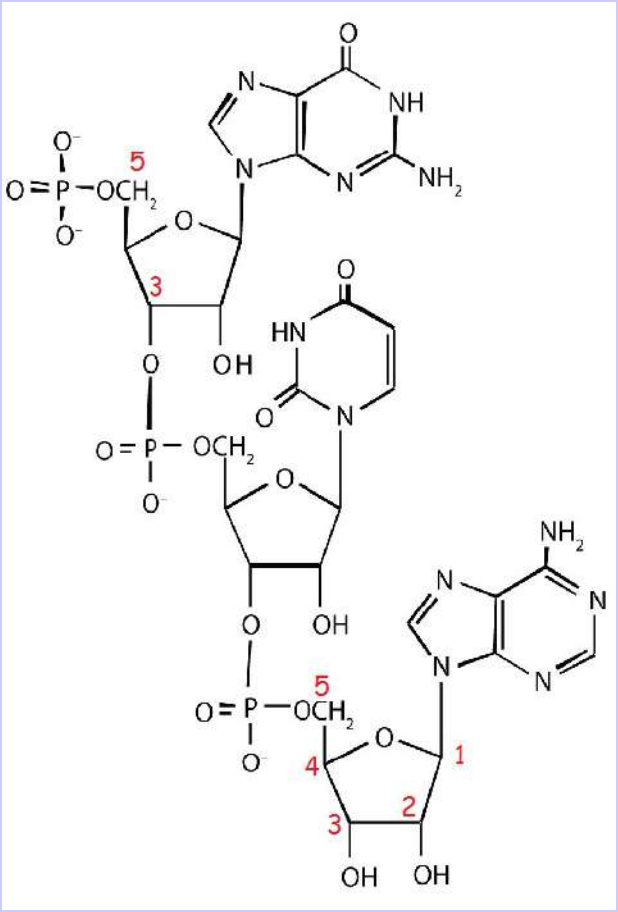
Essential knowledge 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization.

3. Living systems depend on properties of water that result from its polarity and hydrogen bonding.

T*o foster student understanding of this concept, instructors can choose an illustrative example such as:*

- Cohesion
- Adhesion

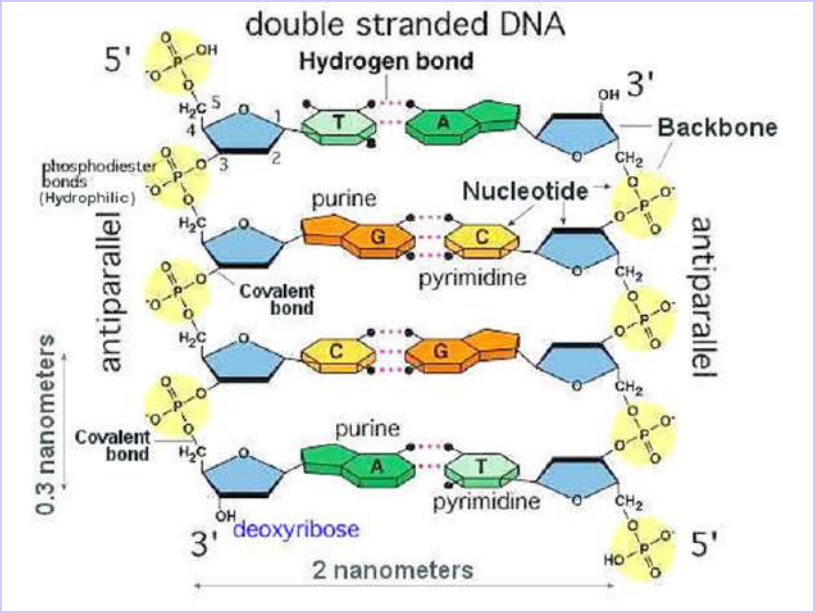
Explain what the term 3′ and 5′ ends means when referring to a DNA molecule



The 2 strands in a DNA molecule run in opposit directions (antiparallel) and are identified by numbering the carbons of the ribose sugar in the backbone.

The #3 carbon is closest to the 3’ end.

The #5 carbon is closest to the 5’ end.



Essential knowledge 4.A.1. b. Directionality influences structure and function of the polymer.

1. Nucleic acids have ends, defined by the 3’and 5' carbons of the sugar in the nucleotide, that determine the direction in which complementary nucleotides are added during DNA synthesis and the direction in which transcription occurs (from 5' to 3’).

The sequence of amino acids in a polypeptide chain makes up its PRIMARY structure.

primary secondary tertiary quaternary

The bond that holds 2 amino acids together in a chain is a(n) COVALENT bond

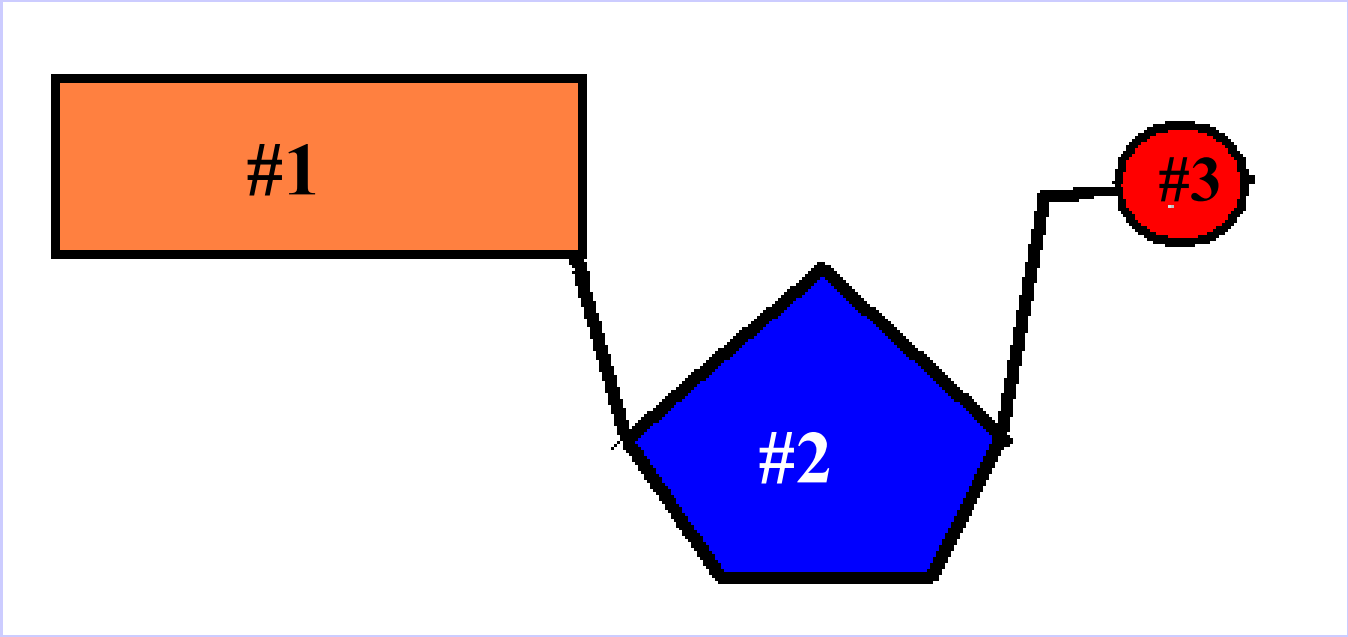
ionic covalent hydrogen

Essential knowledge 4.A.1.a. 2

In proteins, the specific order of amino acids in a polypeptide (primary structure) interacts with the environment to determine the overall shape of the protein, which also involves secondary tertiary and quaternary structure and, thus, its function.

✘✘ *The molecular structure of specific amino acids is beyond the scope of the course and the AP Exam*

If you want to make RNA which sugar CAN BE used in the #2 spot?



ribose

3.A.1.b. DNA and RNA molecules have structural similarities and differences that define function. [See also **4.A.1**]
i. DNA contains deoxyribose (RNA contains ribose).

One way to identify specific molecules that are too small to be seen is to "tag" them with radioactive isotopes.

Name some kinds of macromolecules that would be labeled by the addition of ^{14}C

Carbon is found in carbohydrates, proteins, nucleic acids and lipids.

Essential knowledge 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization.

a. Molecules and atoms from the environment are necessary to build new molecules.

Evidence of student learning is a demonstrated understanding of each of the following:

1. Carbon moves from the environment to organisms where it is used to build carbohydrates, proteins, lipids or nucleic acids. Carbon is used in storage compounds and cell formation in all organisms.

A protein like hemoglobin made up of multiple polypeptide chains shows QUATERNARY structure.

primary secondary tertiary quaternary

TRUE or FALSE

This type of structure is found in all proteins.

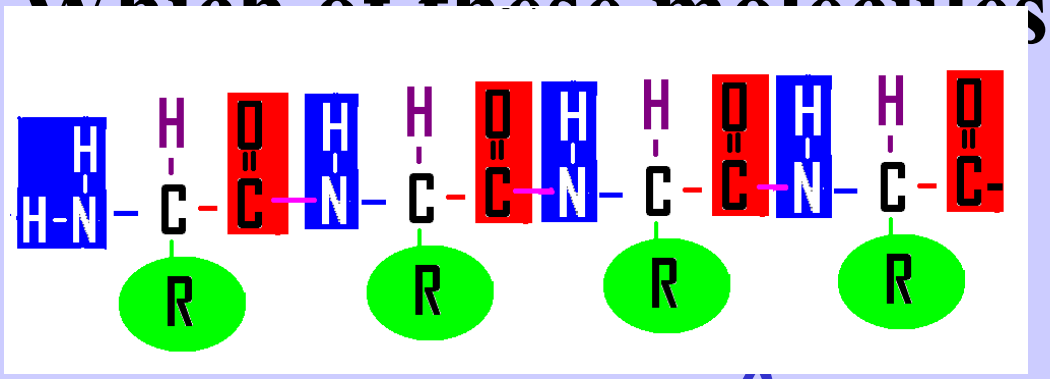
All proteins have primary, secondary, tertiary structure, but only some have quaternary structure.

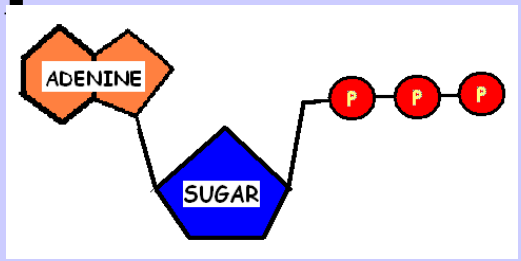
Essential knowledge 4.A.1.a. 2

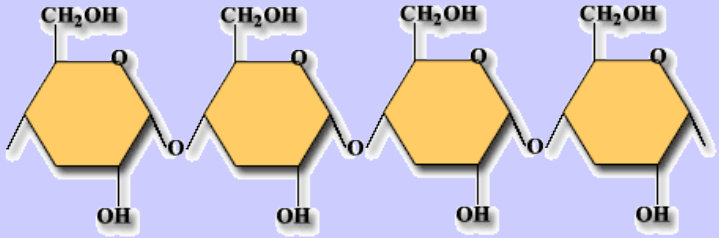
In proteins, the specific order of amino acids in a polypeptide (primary structure) interacts with the environment to determine the overall shape of the protein, which also involves secondary tertiary and quaternary structure and, thus, its function.

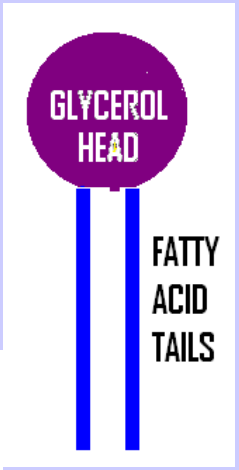
✘✘ *The molecular structure of specific amino acids is beyond the scope of the course and the AP Exam*

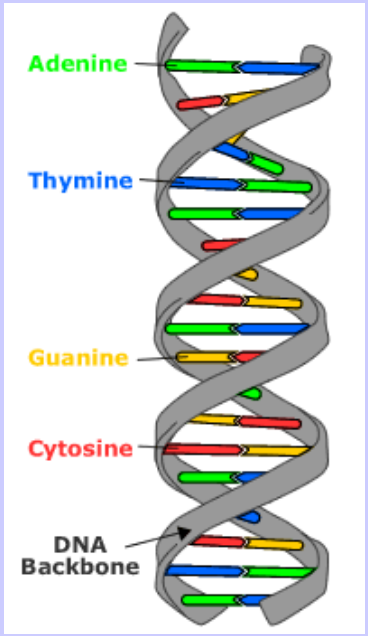
Which of these molecules is a protein?

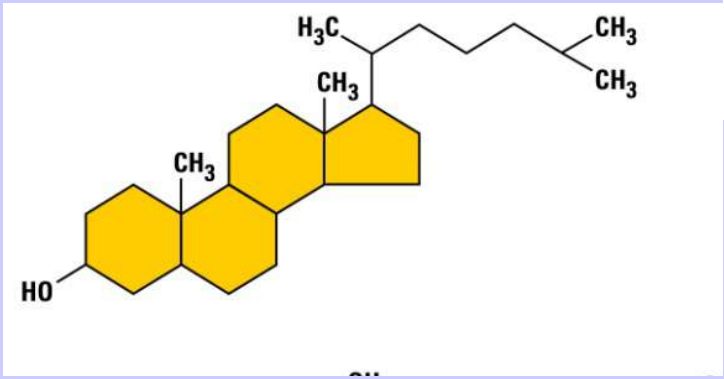








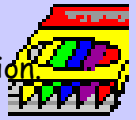




Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

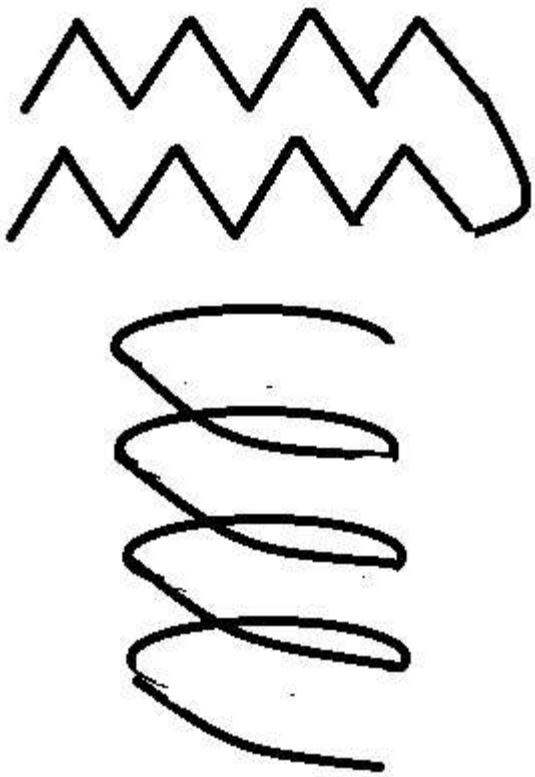
Draw the 2 kinds of shapes found in the secondary structure of proteins.

What kinds of groups are involved in holding this shape in position?



https://s3.amazonaws.com/classconnection/448/flashcards/2303448/jpg/secondary_structure_proteins-14D1C8071264EA0F0FC.jpg

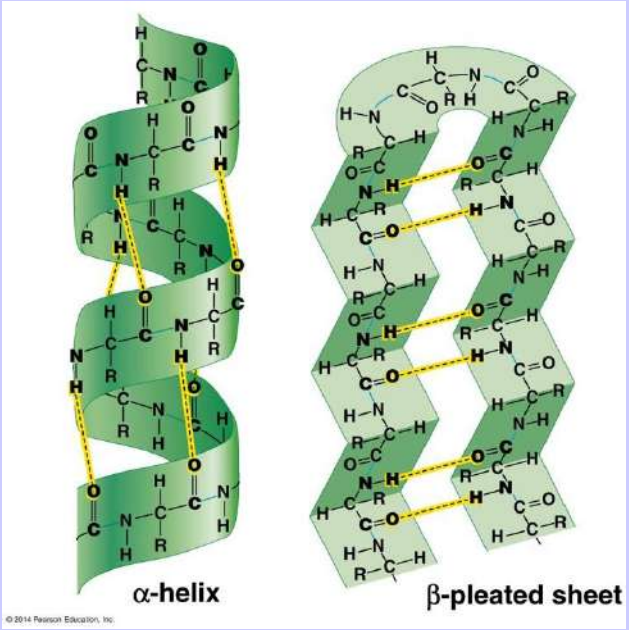
Beta pleated sheet



Alpha helix

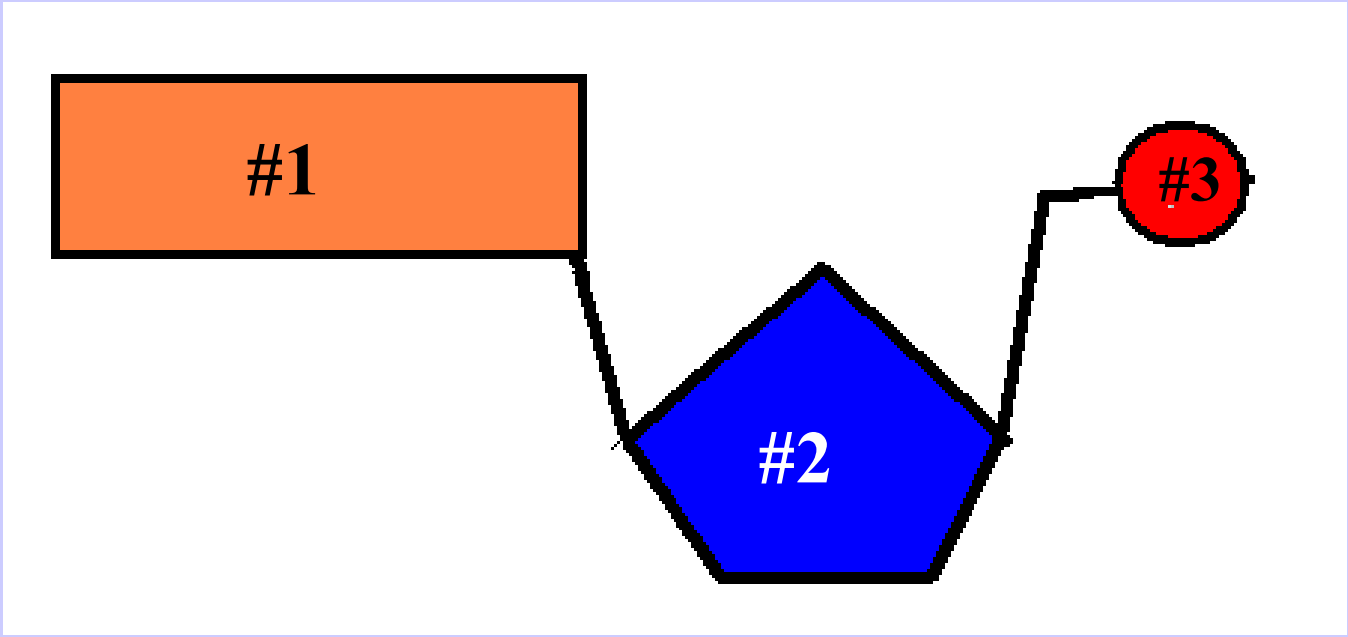
Hydrogen bonds between C=O on one amino acid and the N-H on another amino acid

R-groups NOT involved!



4.A.1.a. 2 In proteins, the specific order of amino acids in a polypeptide (primary structure) interacts with the environment to determine the overall shape of the protein, which also involves secondary, tertiary, and quaternary structure, and thus, its function.

If you want to make DNA which sugar CAN BE used in the #2 spot?



deoxyribose

Essential knowledge 4.A.1

a. Structure and function of polymers are derived from the way their monomers are assembled.

1. In nucleic acids, biological information is encoded in sequences of nucleotide monomers. Each nucleotide has structural components: a five-carbon sugar (deoxyribose or ribose), a phosphate and a nitrogen base (adenine, thymine, guanine, cytosine or uracil). DNA and RNA differ in function and differ slightly in structure, and these structural differences account for the differing functions.

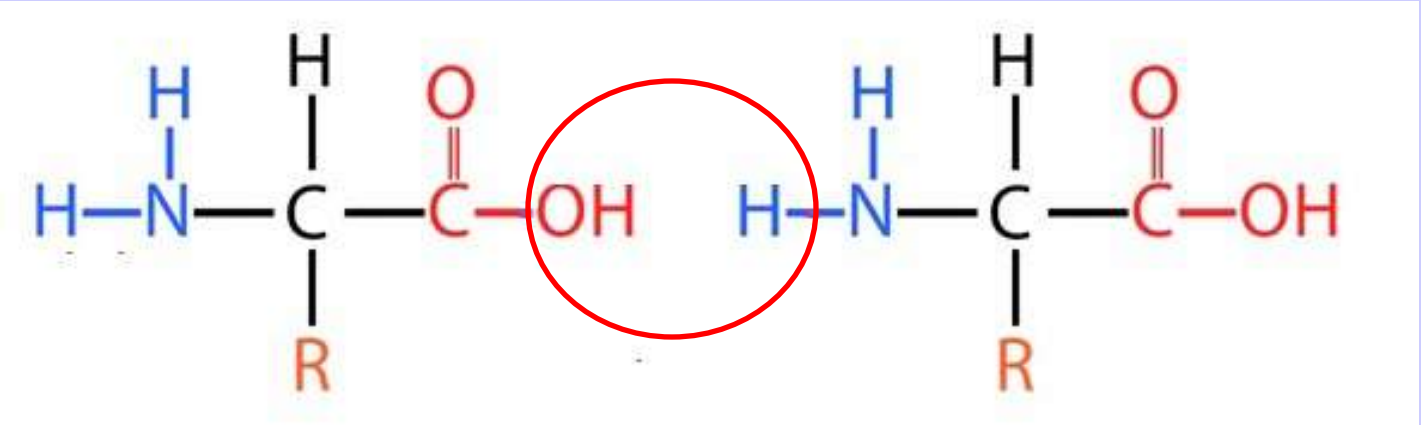
✘✘ *The molecular structure of specific nucleotides is beyond the scope of the course and the AP Exam*

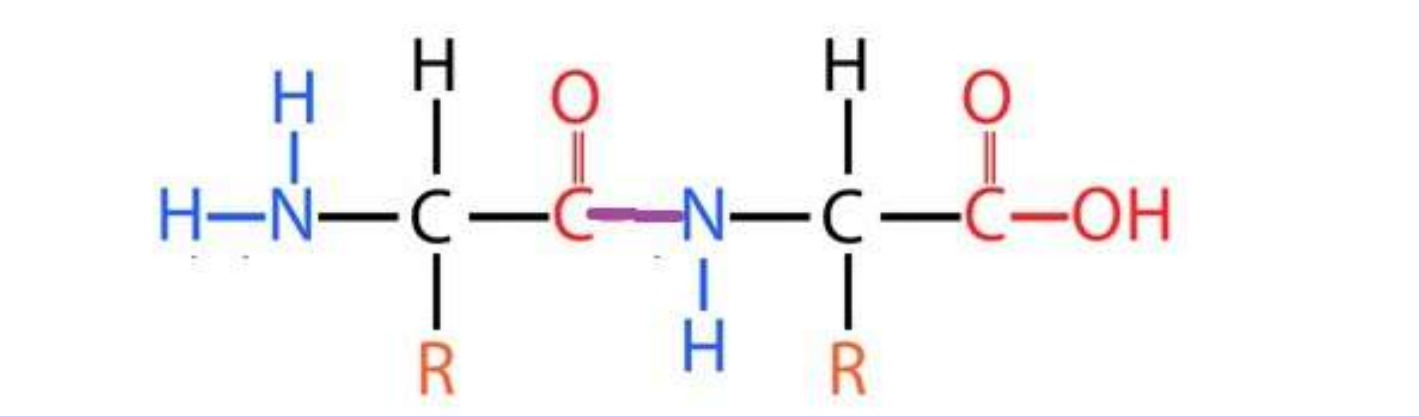
Draw a picture of an amino acid

Show how 2 amino acids could be joined together.

Identify this process and the type of bond formed

4.A.1.b. 2. Proteins have an amino (NH_2) end and a carboxyl (COOH) end, and consist of a linear sequence of amino acids connected by the formation of peptide bonds by dehydration synthesis between the amino and carboxyl groups of adjacent monomers.

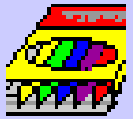




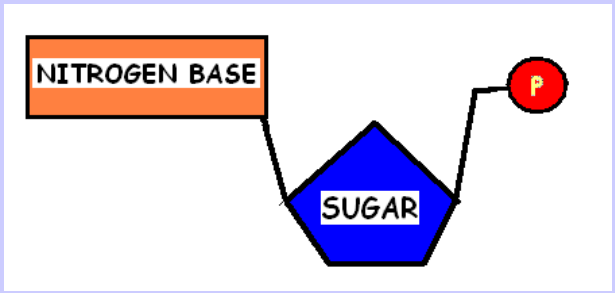
DEHYDRATION SYNTHESIS(CONDENSATION) REACTION

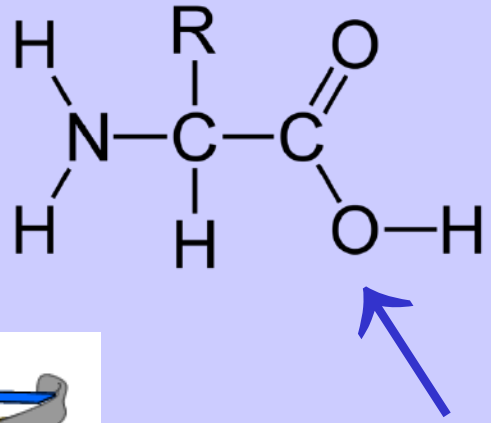
Remove H_2O

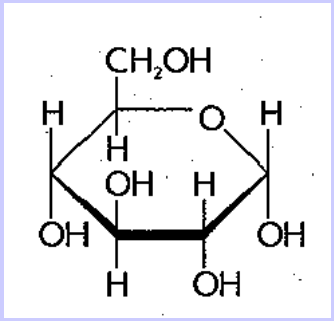
MAKES A PEPTIDE BOND

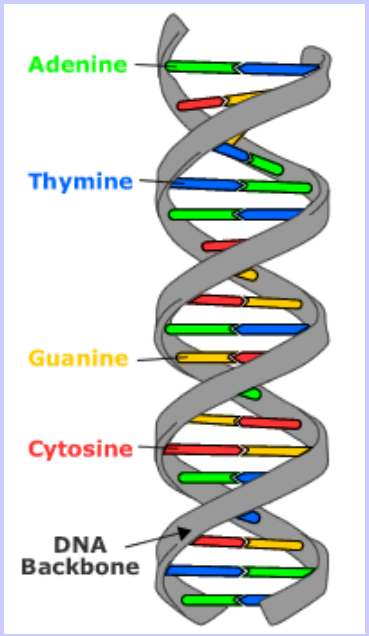


Which of these molecules is an amino acid?









Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

Monosaccharides (simple sugars) all have the same 1C:2H:1O ratio.
EX: Glucose = $C_6H_{12}O_6$ and Ribose = $C_5H_{10}O_5$

DISSACHARIDES like lactose and sucrose vary a little from this ratio. EX: Sucrose = $C_{12}H_{22}O_{11}$

Use what you learned about chemical reactions that join molecules and the numbers of sugar molecules found in different kinds of carbohydrates to explain why disaccharides seem to have a "few atoms missing".

Watch video

Joining of monosaccharide subunits by dehydration synthesis removes a water molecule. So for each subunit added the resulting "saccharide" has 2 fewer H's and 1 less O than starting subunits.

4.A.1.a. 4. Carbohydrates are composed of sugar monomers whose structures ad bonding with each other by dehydration synthesis determine the properties and functions of the molecules. Illustrative examples include: cellulose vs starch

Draw a picture of the subunit used to make nucleic acids.

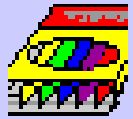
Circle the parts of this subunit that make the backbone of a DNA molecule

Which nitrogen bases could be found in the nitrogen base spot if this were used to make DNA?

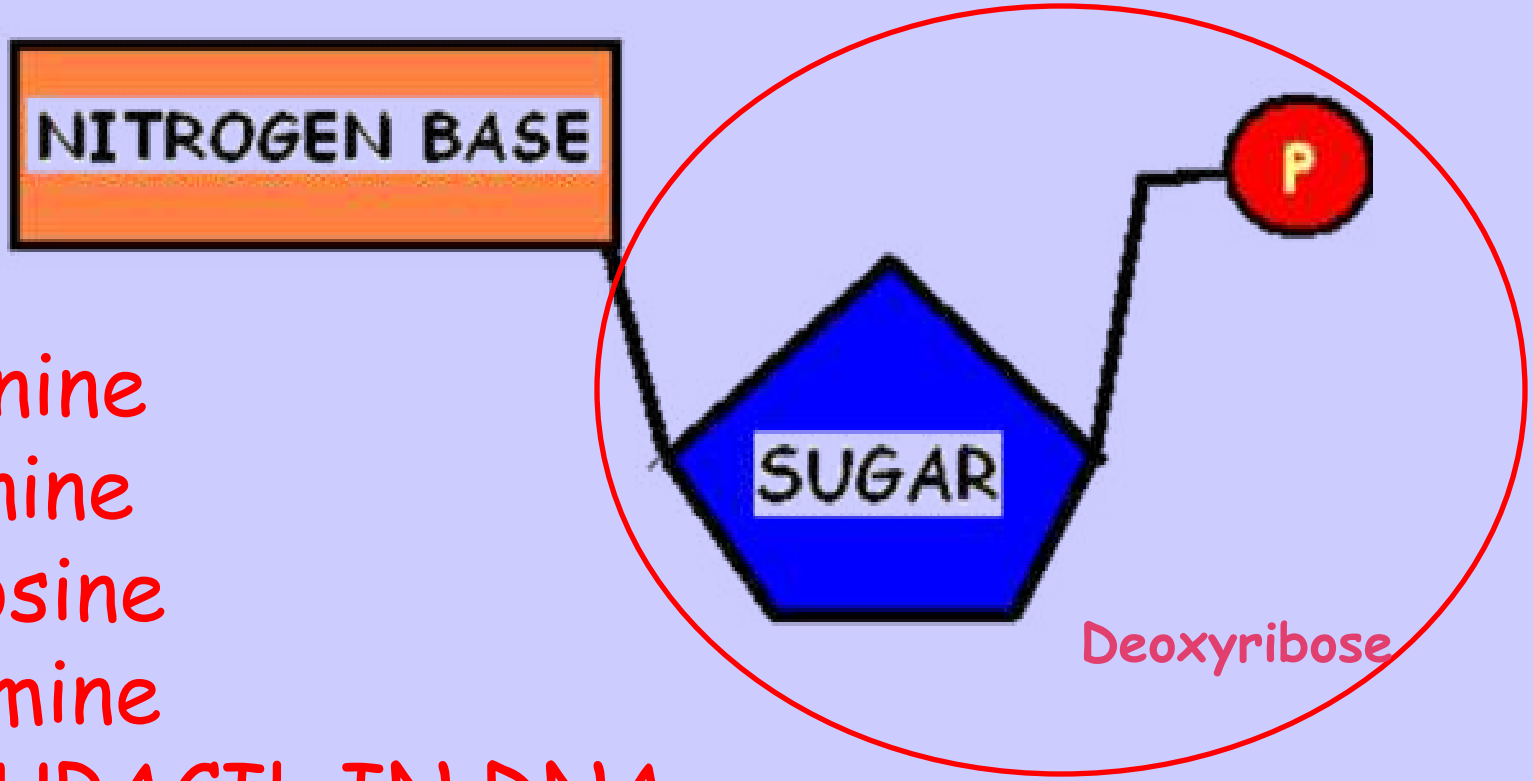
Which sugar can be found in the sugar spot?

4.A.1.a. 1. In nucleic acids, biological information is encoded in sequences of nucleotide monomers. Each nucleotide has structural components: a five-carbon sugar (deoxyribose or ribose), a phosphate and a nitrogen base (adenine, thymine, guanine cytosine, or uracil).
DNA and RNA differ in function and differ slightly in structure, and these structural difference account for the differing functions.
3.A.1.b DNA and RNA molecules have structural similarities and differences that define function.

2. The basic structural differences include:
   i. DNA contains deoxyribose (RNA contains ribose)
   ii. RNA contains uracil in lieu of thymine in DNA



NUCLEOTIDE



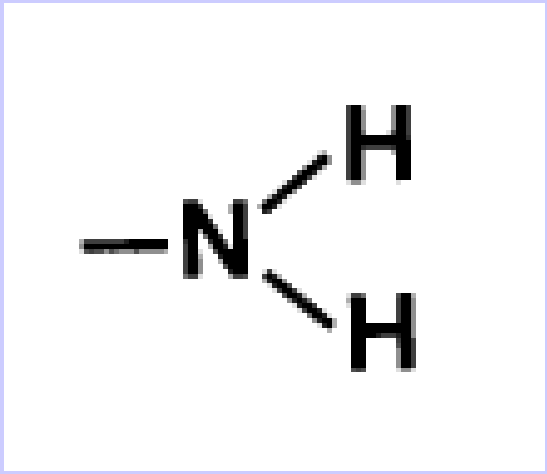
Adenine
Guanine
Cytosine
Thymine
NO URACIL IN DNA

3.A.1.b. DNA and RNA molecules have structural similarities and differences that define function. [See also **4.A.1**]
1. Both have three components — sugar, phosphate and a nitrogenous base — which form nucleotide units that are connected by covalent bonds to form a linear molecule with and ends, with the nitrogenous bases perpendicular to the sugar-phosphate backbone.
2. The basic structural differences include:
i. DNA contains deoxyribose (RNA contains ribose).
ii. RNA contains uracil in lieu of thymine in DNA.

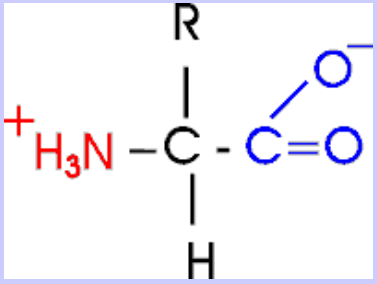
Image from: http://www.biology-pages.info/G/Groups_5.gif
http://ccnmtl.columbia.edu/projects/biology/lecture4/images/aacharched.3.gif

Name this functional group

amino



How does adding this group change an organic molecule?



Makes it more polar

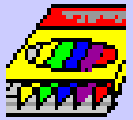
Makes it more basic (can pick up a H^+ ion) which gives it a slight positive charge

Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

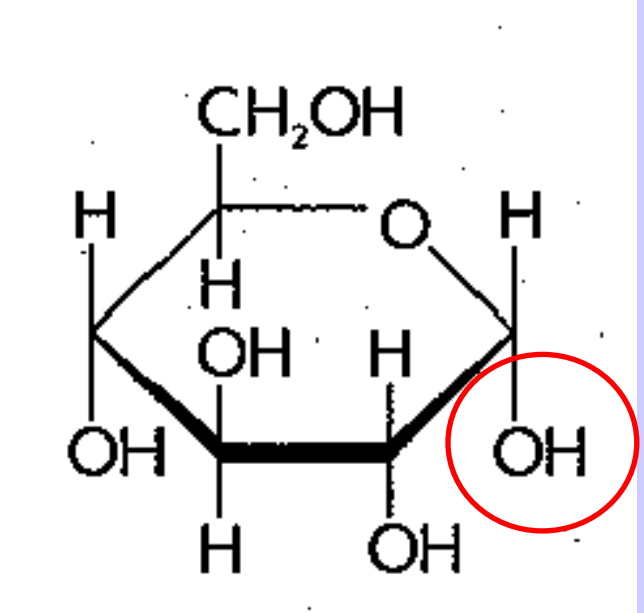
Show how alpha and beta glucose are different.

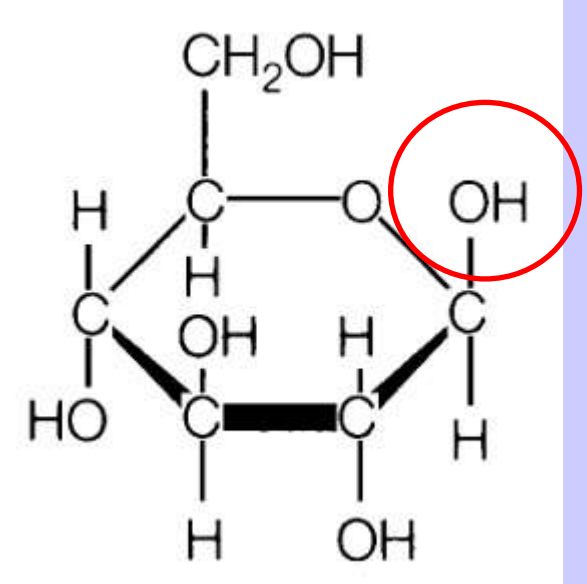
Give examples of polysaccharides made with each of these.

Which of these polysaccharide are humans and other animals unable to digest?



4.A.1.a. 4. Carbohydrates are composed of sugar monomers whose structures ad bonding with each other by dehydration synthesis determine the properties and functions of the molecules. Illustrative examples include: cellulose vs starch
4.A.1.b.3. The nature of the bonding between carbohydrate subunits determines their relative orientation in the carbohydrate, which then determines the secondary structure of the carbohydrate.



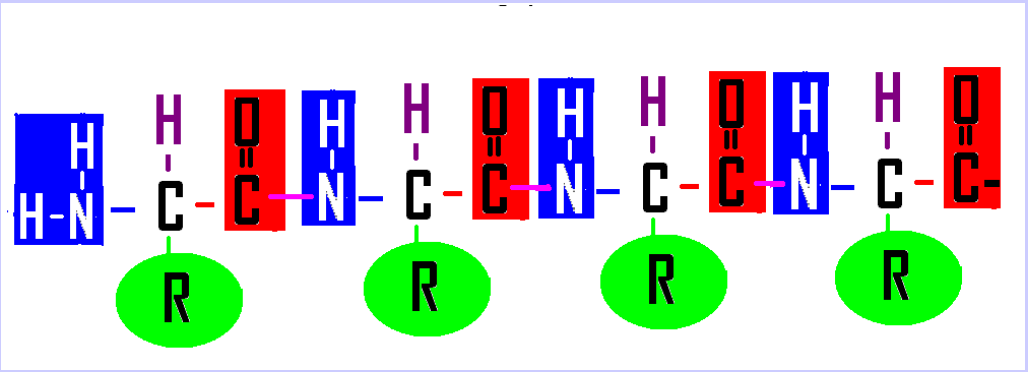


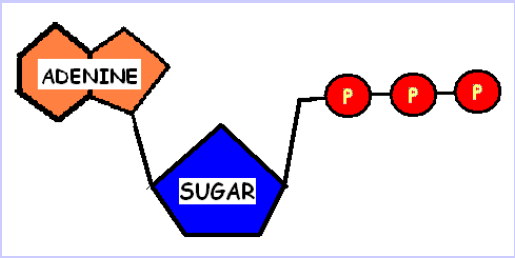
Alpha (α)glucose
glycogen & starch

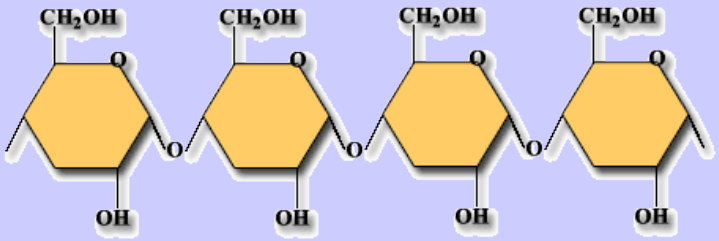
Beta (β) glucose
cellulose & chitin

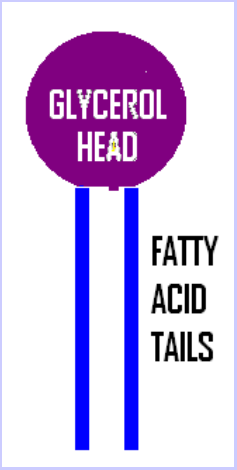
Humans and other animals are unable to break polysaccharides with β linkages

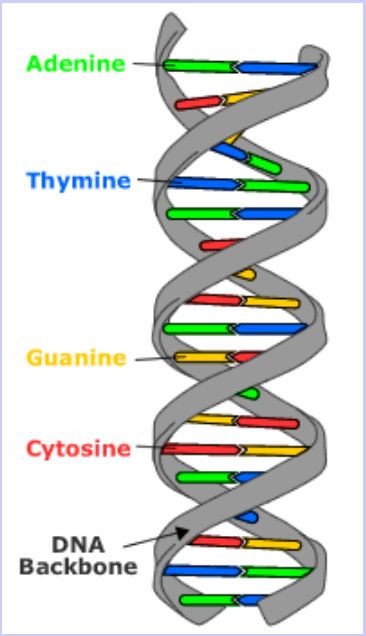
Which of these molecules is a carbohydrate?

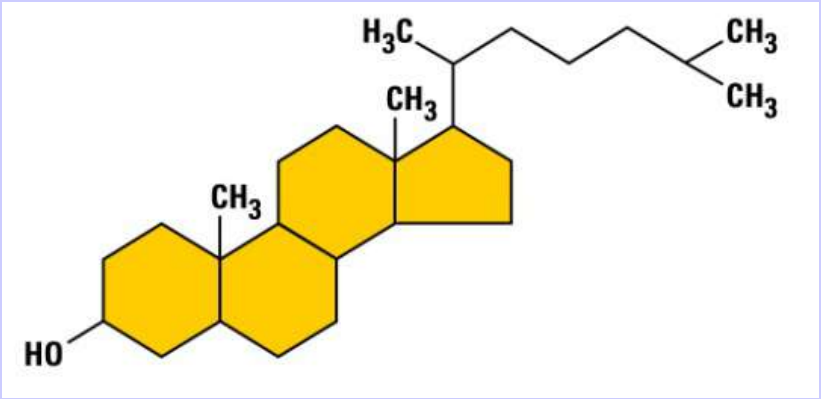












Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

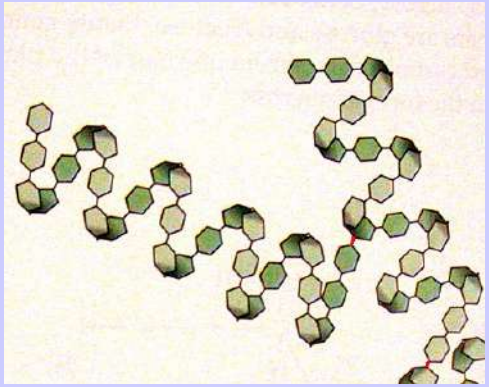
http://www.msu.edu/course/lbs/145/smith/s02/graphics/campbell_5.6.gif

Polysaccharide used by plant cells to store glucose for later

cellulose

Polysaccharide used by animal cells to store glucose for later

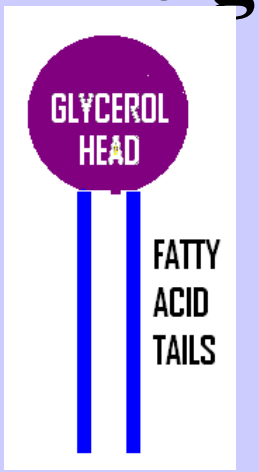
glycogen

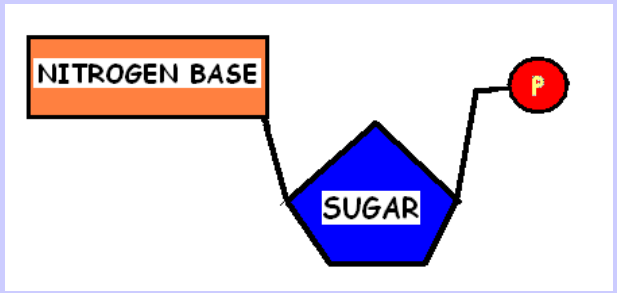


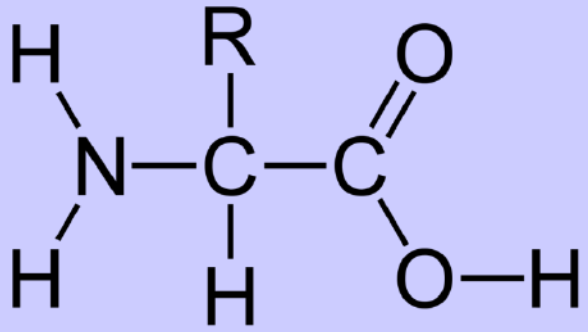
4.A.1.a. 4. Carbohydrates are composed of sugar monomers whose structures ad bonding with each other by dehydration synthesis determine the properties and functions of the molecules. Illustrative examples include: cellulose vs starch

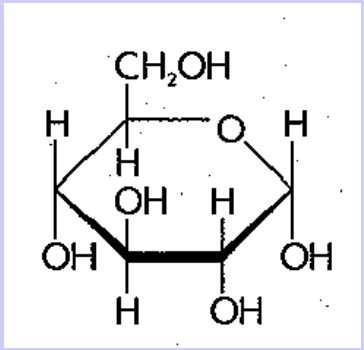
4.A.1.b.3. The nature of the bonding between carbohydrate subunits determines their relative orientation in the carbohydrate, which then determines the secondary structure of the carbohydrate.

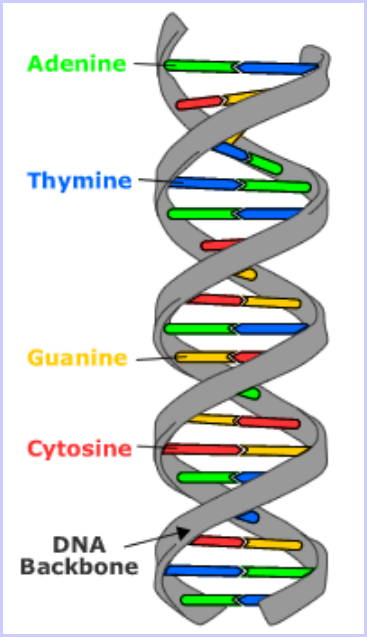
Which of these molecules could be used to make glycogen or starch?











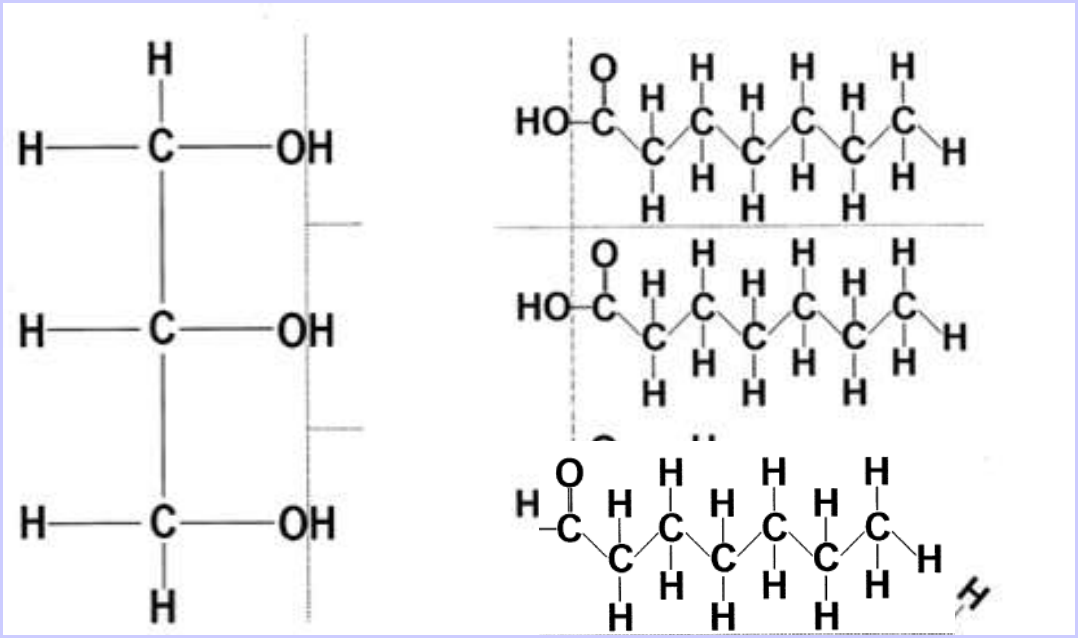
Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

Draw a picture showing the components used to make a FAT molecule. What kind of reaction joins the "pieces"?

How is a fat different than a phospholipid?

How does adding unsaturated fatty acid tails change whether the fat is solid or liquid at room temperature?

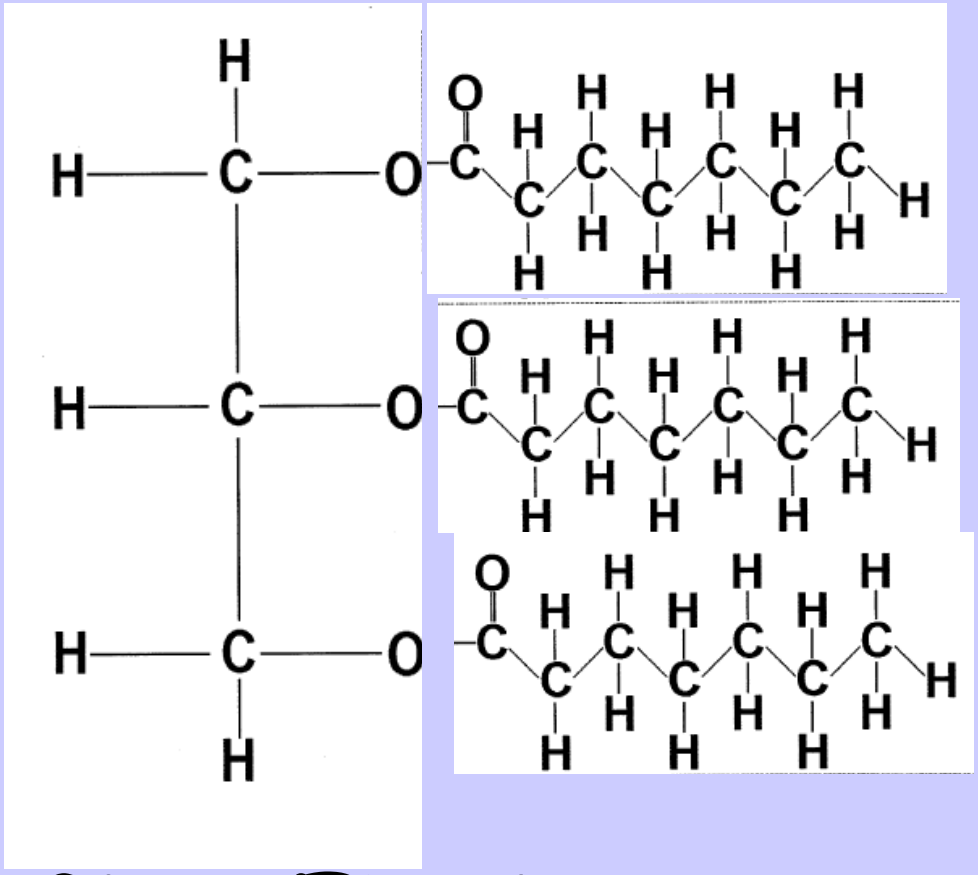
4.A.1.a.3. In general, lipids are nonpolar; however phospholipids exhibit structural properties , with polar regions that interact with other polar molecules such as water, and with nonpolar regions where differences in saturation determine the structure and function of lipids



FAT = 1 glycerol + 3 fatty acid tails
Joined by dehydration synthesis

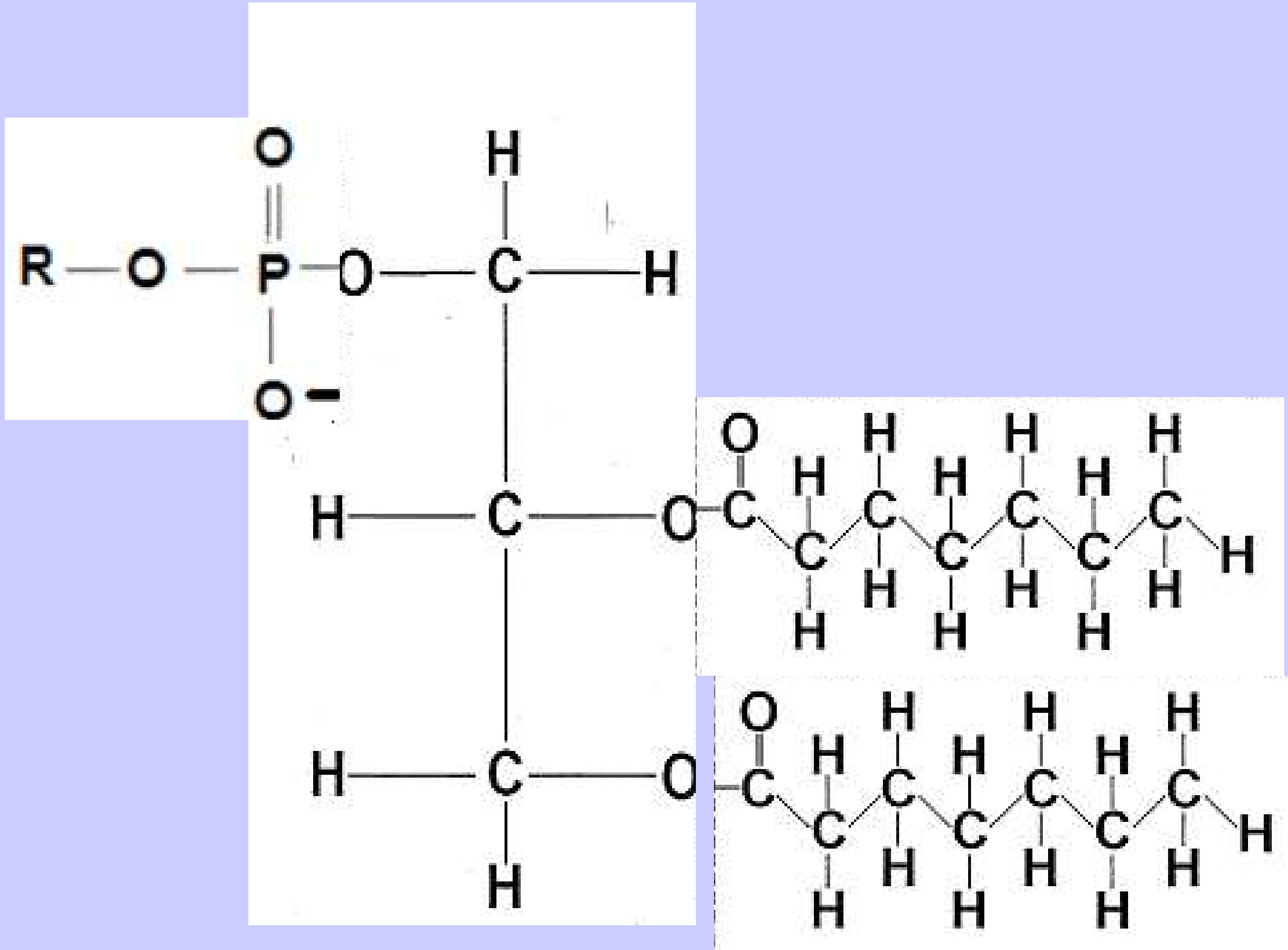
Phospholipid = 1 glycerol + 2 fatty acid tails
+ 1 phosphate group

MAKE A FAT

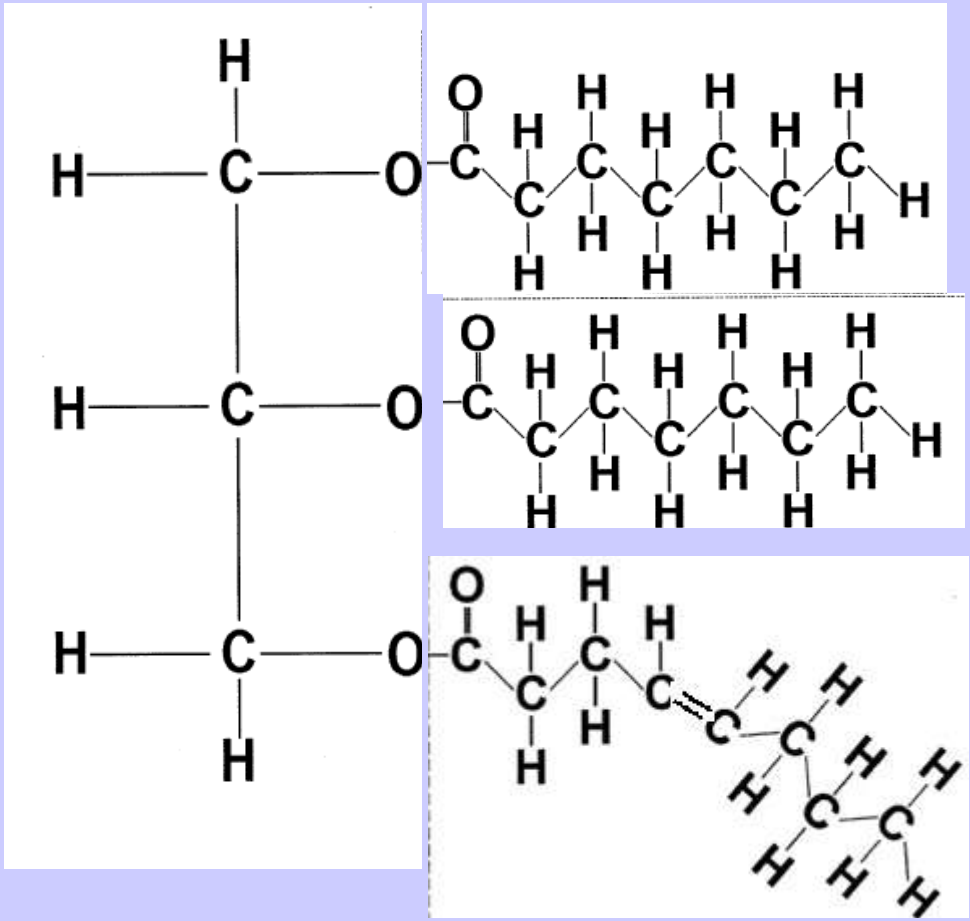


GLYCEROL 3 FATTY ACIDS

PHOSPHOLIPID



STRUCTURE/FUNCTION!



UNSATURATED FA's put "kinks" in tails

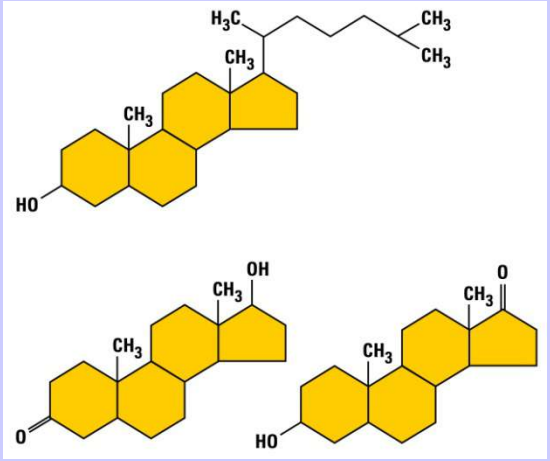
Can't pack as tightly.

UNSATURATED Fats = liquid at room temperature.
Saturated fats = solid at room temperature.

Image from: http://**media.pearsoncmg.com/bc/bc_campbell_essentials_2/cipl/03/HTML/source/03-16-steroids-nl.htm**

Name the kind of lipid joined in rings instead of chains made mainly from carbon and hydrogen that can be found in animal cell membranes and can act as hormones

steroids



Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

Draw a picture of the subunit used to make nucleic acids.

Which nitrogen bases could be found in the nitrogen base spot if this were used to make RNA?

Which sugar can be found in the sugar spot?

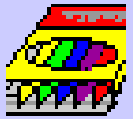
4.A.1.a. 1. In nucleic acids, biological information is encoded in sequences of nucleotide monomers. Each nucleotide has structural components: a five-carbon sugar (deoxyribose or ribose), a phosphate and a nitrogen base (adenine, thymine, guanine cytosine, or uracil). DNA and RNA differ in function and differ slightly in structure, and these structural difference account for the differing functions.

3.A.1.b DNA and RNA molecules have structural similarities and differences that define function.

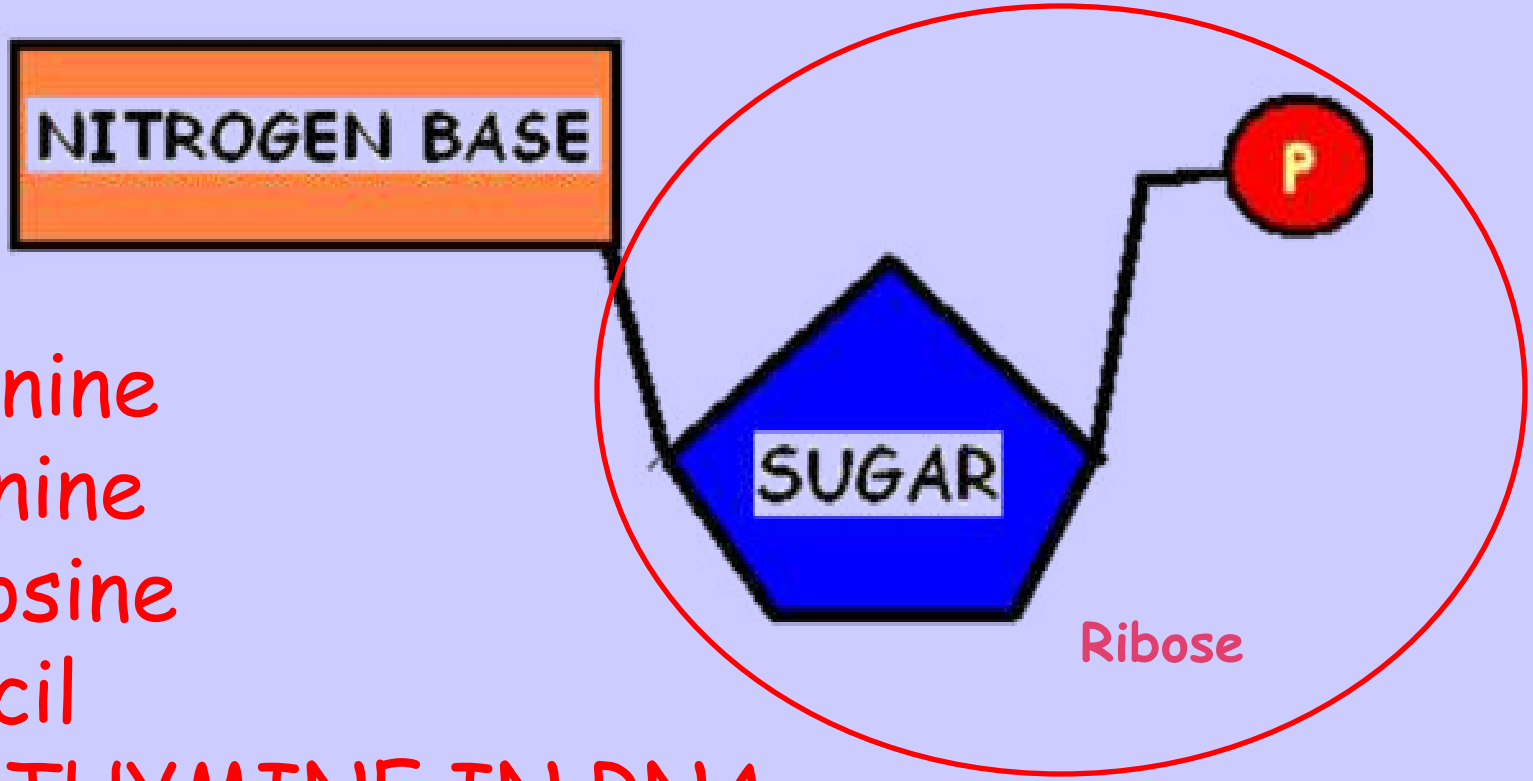
2. The basic structural differences include:

I DNA contains deoxyribose (RNA contains ribose)

Ii RNA contains uracil in lieu of thymine in DNA



NUCLEOTIDE

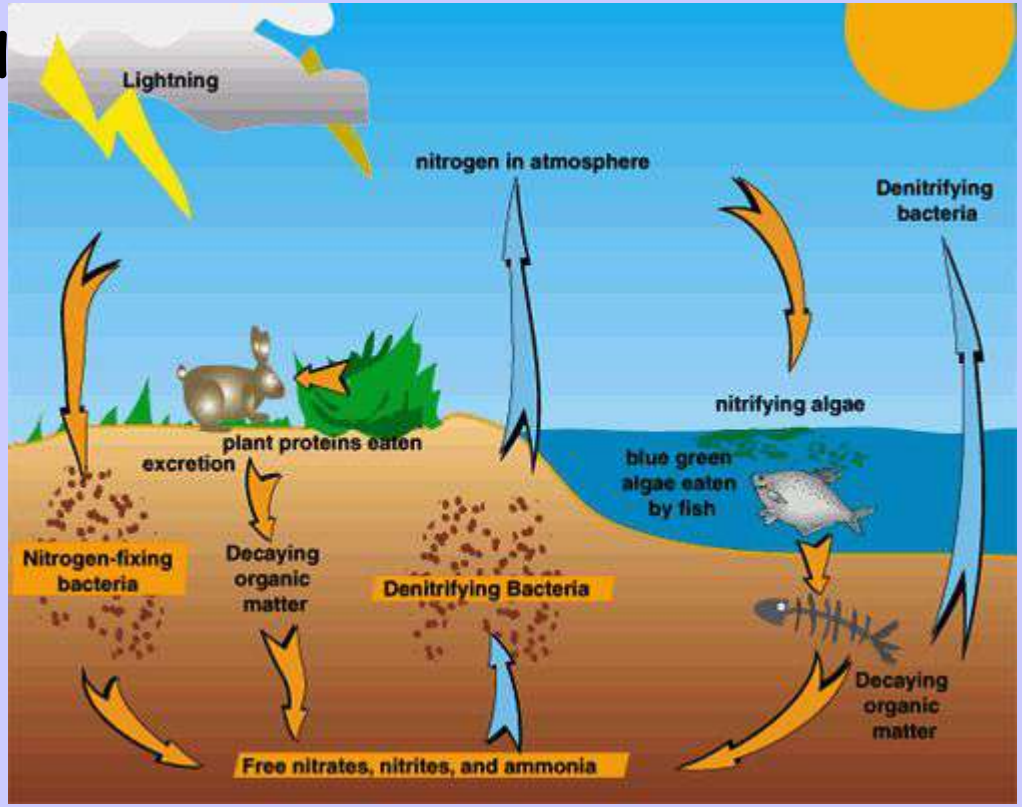


Adenine
Guanine
Cytosine
Uracil
NO THYMINE IN RNA

3.A.1.b. DNA and RNA molecules have structural similarities and differences that define function. [See also **4.A.1**]
1. Both have three components — sugar, phosphate and a nitrogenous base — which form nucleotide units that are connected by covalent bonds to form a linear molecule with and ends, with the nitrogenous bases perpendicular to the sugar-phosphate backbone.
2. The basic structural differences include:
i. DNA contains deoxyribose (RNA contains ribose).
ii. RNA contains uracil in lieu of thymine in DNA.

The Earth's atmosphere is approximately 78% nitrogen gas, but most organisms (including humans) are unable to obtain nitrogen to build their molecules by breathing. How do hu
nitrogen?

From food we eat



SP 7. The student is able to connect and relate knowledge across various scales, concepts, and representations in and across domains.
Essential knowledge 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization.
a. Molecules and atoms from the environment are necessary to build new molecules.
Evidence of student learning is a demonstrated understanding of each of the following:
2. Nitrogen moves from the environment to organisms where it is used in building proteins and nucleic acids.

One way to identify specific molecules that are too small to be seen is to "tag" them with radioactive isotopes.

Name some kinds of macromolecules that would be labeled by the addition of ^{13}N

Nitrogen is found in proteins and nucleic acids .

Essential knowledge 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization.

a. Molecules and atoms from the environment are necessary to build new molecules.

Evidence of student learning is a demonstrated understanding of each of the following:

2. Nitrogen moves from the environment to organisms where it is used in building proteins and nucleic acids.

One way to identify specific molecules that are too small to be seen is to "tag" them with radioactive isotopes.

Name some kinds of macromolecules that would be labeled by the addition of ^{32}P

Nucleic acids (DNA, RNA)
phospholipids
ATP

See a video

Essential knowledge 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization.

a. Molecules and atoms from the environment are necessary to build new molecules.

Evidence of student learning is a demonstrated understanding of each of the following:

2. Phosphorus moves from the environment to organisms where it is used in nucleic acids and certain lipids.

One way to identify specific molecules that are too small to be seen is to "tag" them with radioactive isotopes.

Name some kinds of macromolecules that would be labeled by the addition of ^{35}S

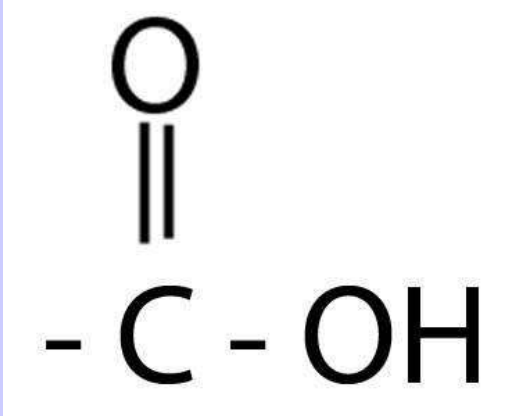
Proteins (due to disulfide bridges)

See a video

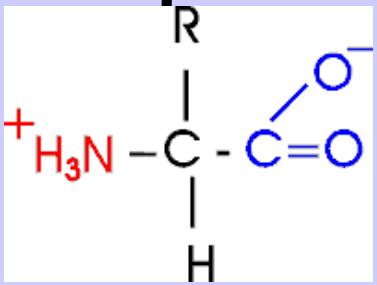
Images from: http://classconnection.s3.amazonaws.com/1522/flashcards/716539/jpg/carboxyl-functional-group.jp
http://ccnmtl.columbia.edu/projects/biology/lecture4/images/aacharched.3.gif

Name this functional group

carboxyl



How does adding this group change an organic molecule?



Makes it more polar

Makes it more acidic (can lose H^+ ion)

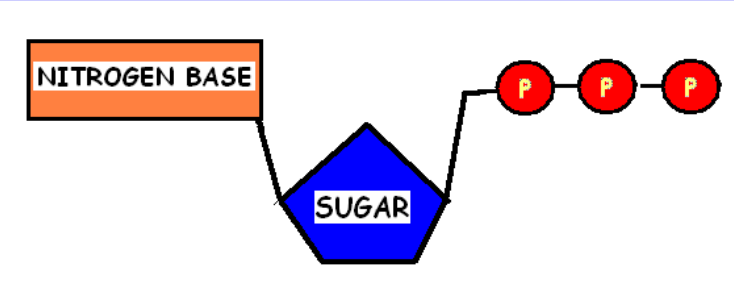
which gives it a slight negative charge

Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

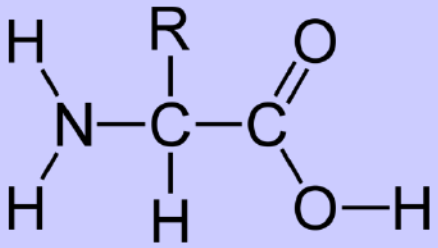
Match the building block with the molecule it makes.

proteins **nucleic acids** **lipids** **carbohydrates**

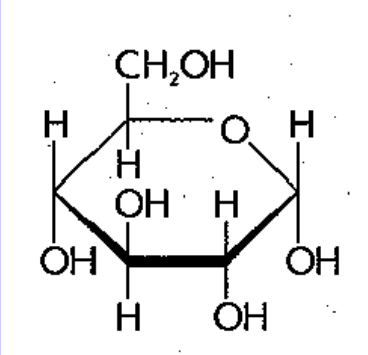
Nucleotide and amino acid images by Riedell



Nucleic acids



Proteins



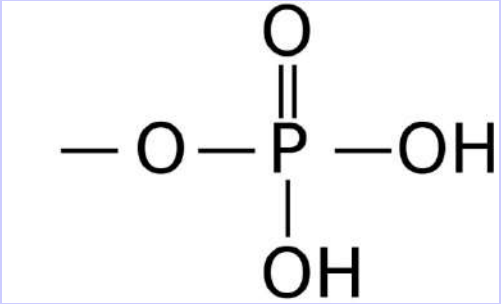
Carbohydrates

Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

Images from: https://commons.wikimedia.org/wiki/File:Phosphate_Group.svg
https://s3.amazonaws.com/classconnection/220/flashcards/1019220/png/phosphate_group-15257F313A80BBCEDAC.png

Name this functional group

phosphate

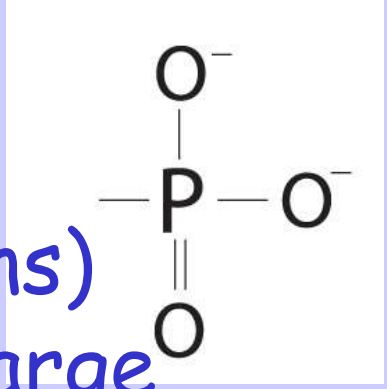


How does adding this group change an organic molecule?

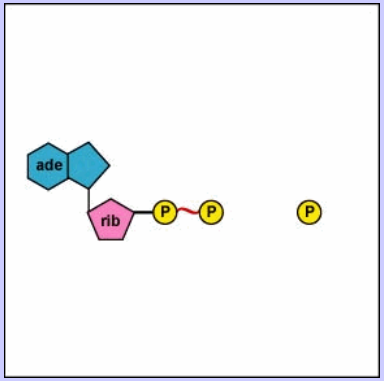
Makes it more polar

Makes it more acidic (can lose H^+ ions)

which gives it a slight negative charge

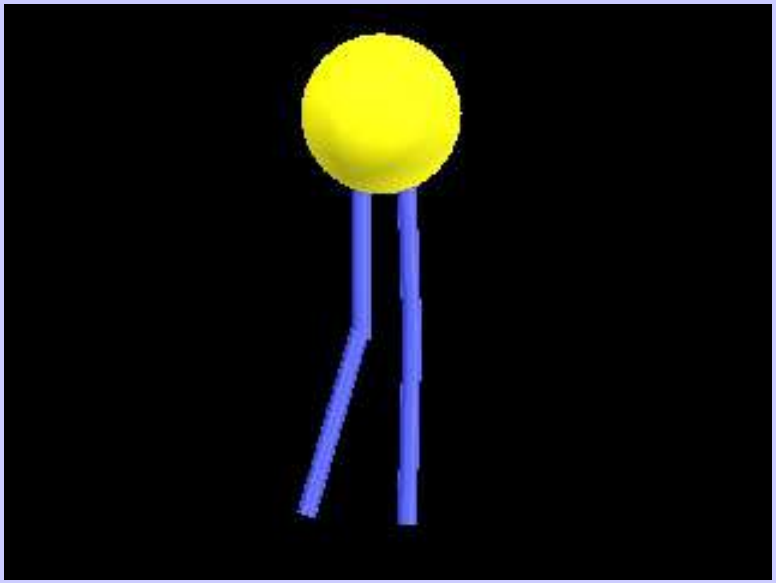


Adding a phosphate group to ADP stores energy as ATP



Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

The blue part of this phospholipid molecule is Non-polar



polar **non-polar**

The tails on this molecule are hydrophobic

hydrophilic **hydrophobic**

Vocab

The carbohydrate molecule that cells burn to release energy is _____glucose_____.

Give an example of a monosaccharide

Glucose, galactose, fructose, ribose, deoxyribose,

Not all but many carbohydrate names share the suffix -OSE

Not all but many enzyme names share the suffix -ASE

Describes molecules that try to stay away from water or other polar molecules

Hydrophobic; non-polar

Scale used to measure acidity

pH

Disaccharides are carbohydrates made from 2 sugar molecules

Give an example of a disaccharide you learned about

Sucrose (table sugar)
Lactose (milk sugar)

Vocab

Name the 2 kinds of nucleic acids you learned about.

DNA and RNA

Give an example of a polysaccharide

Cellulose, glycogen, starch

Name the structural polysaccharide used to make plants sturdy

cellulose

Special kind of nucleotide used by cells to store the energy released from burning glucose.

ATP

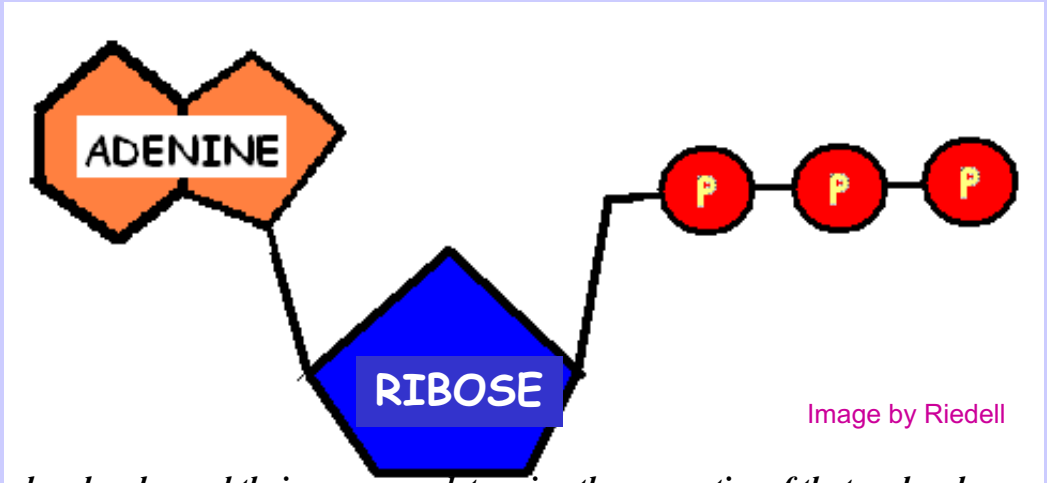


Image by Riedell

Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

Carbohydrates made from 2-10 sugar molecules like those found in glycoproteins are called **oligosaccharides**

Lactose and sucrose are examples of **di** **saccharides**

mono di oligo poly

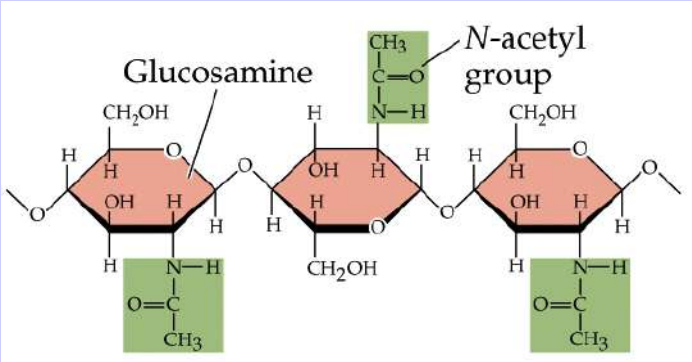
Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

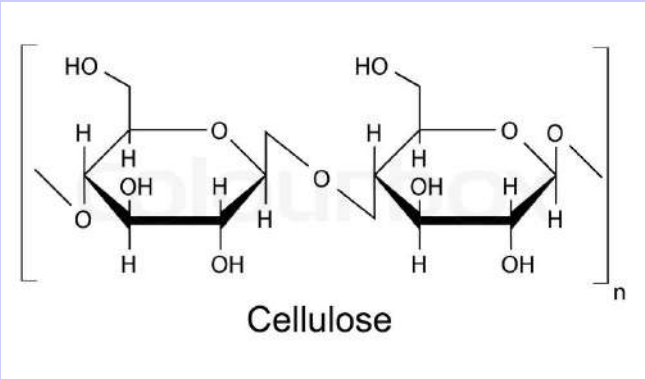
Images from: https://www.colourbox.com/preview/9746487-the-structural-formula-of-cellulose-polymer.jpg
http://www.blc.arizona.edu/courses/schaffer/182/ModCarb-c.jpeg

Compare and contrast CHITIN and CELLULOSE

Both are structural polysaccharides made from β-glucose monomers

Chitin has nitrogen groups attached to its β-glucose monomers.





Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

Images from: https://www.colourbox.com/preview/9746487-the-structural-formula-of-cellulose-polymer.jpg
http://www.blc.arizona.edu/courses/schaffer/182/ModCarb-c.jpeg

Compare and contrast GLYCOGEN and STARCH

Both are energy storage polysaccharides made from α-glucose monomers

Starch is made by plants; glycogen is made by animals

Images from: https://www.colourbox.com/preview/9746487-the-structural-formula-of-cellulose-polymer.jpg
http://www.blc.arizona.edu/courses/schaffer/182/ModCarb-c.jpeg

Compare and contrast CELLULOSE and STARCH

Both are plant polysaccharides made from glucose monomers

Cellulose is structural, made from β-glucose subunits, non-digestable by animals; STARCH is for energy storage, is made from α-glucose subunits, is digestable by animals.

Images from: http://www.brl.org/chemistry/gifs/53115.gif

Does this molecule have an asymmetric carbon? If so, identify which one(s) is/are asymmetric.

Carbon #2 and #3
are asymmetric
(have 4 different groups attached)

Would you expect this molecule to exist as enantiomer isomers?

YES, molecules with asymmetric carbons can form enantiomer isomers

What ratio of carbon, hydrogen, and oxygen atoms is seen in carbohydrates?

1:2:1; 1 carbon:2 hydrogen:1 oxygen

What is the chemical formula for water?

H_2O

Vocab

A carbohydrate made by joining TWO sugar molecules

disaccharide

A short DNA segment that gives the instructions for a protein

gene

Name the 4 main macromolecules that are important for all living things

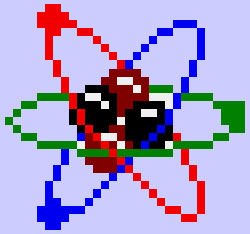
Proteins, carbohydrates, lipids, nucleic acids

Lipids that are made of many carbon and hydrogen atoms are **Non polar**

Polar **non-polar**

Vocab

Electrons orbit the nucleus of an atom at very high speeds in different energy levels.



Protons **neutrons** **electrons**

What kind of electric charge do electrons have?

negative

MOLECULES that have an uneven pattern of electric charge (more + on one side; more – on the other) are called polar.

ATOMS that have gained or lost electrons so that they have an electric charge are called ions.

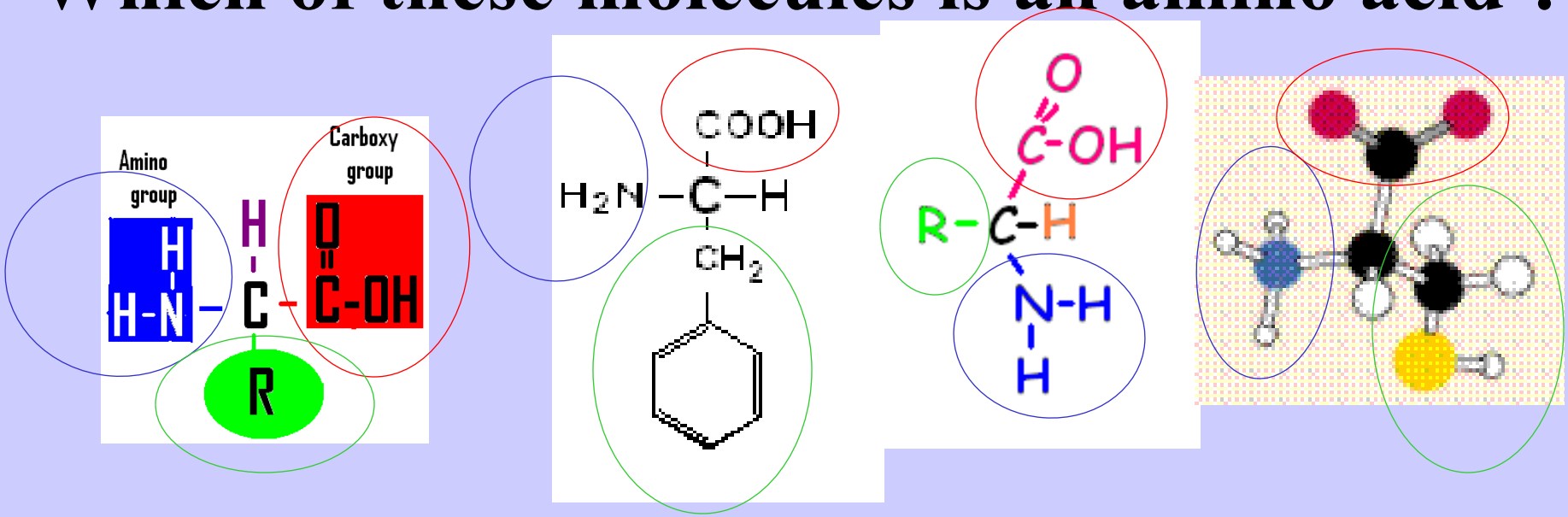
HEMOGLOBIN that carries oxygen in your blood, INSULIN that helps cells store sugar, and DIGESTIVE ENZYMES are all proteins.

Proteins **carbohydrates** **nucleic acids** **lipids**

Glucose is a carbohydrate.

Protein **carbohydrate** **nucleic acid** **lipid**

Which of these molecules is an amino acid ?



Look closely! They all are.
Look for the groups
on the center carbon: Amino, carboxyl, R

Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

Which of the following is TRUE?

Simple sugars are made of polysaccharides.

F Simple sugars are monosaccharides.
Polysaccharides are complex carbo's made of many sugars.

RNA molecules are made of nucleotides.

TRUE

Amino acids are made of proteins.

F Proteins are made of amino acids

TRUE

Glycogen, starch, and cellulose are made of glucose.

In polymerization, complex molecules are formed by the joining together of

D. monomers

A. macromolecules

B. carbohydrates

C. polymers

D. monomers

Give a function for nucleic acids in cells

- Store genetic info (DNA)
- transfer info from DNA to cell (RNA)
- protein synthesis (RNA)

Name an ion that's important in living cells.

- Sodium (Na^+)
- Calcium (Ca^{++})
- Potassium (K^+)
- Chloride (Cl^-)
- Hydrogen (H^+)

Name some ways DNA and RNA are different

DNARNA

double stranded **single stranded**

deoxyribose sugar **ribose sugar**

A,T, G, C **A, U, G, C**

No uracil **No thymine**

stores genetic info **carries info**

to ribosomes;

protein synthesis

Essential knowledge 4.A.1

a. Structure and function of polymers are derived from the way their monomers are assembled.

1. In nucleic acids, biological information is encoded in sequences of nucleotide monomers. Each nucleotide has structural components: a five-carbon sugar (deoxyribose or ribose), a phosphate and a nitrogen base (adenine, thymine, guanine, cytosine or uracil). DNA and RNA differ in function and differ slightly in structure, and these structural differences account for the differing functions. [See also **1.D.1, 2.A.3, 3.A.1**]

✘✘ *The molecular structure of specific nucleotides is beyond the scope of the course and the AP Exam*

The subunits that make nucleic acids are called _____

nucleotides

Glucose, sucrose, glycogen, and starch are all examples of _____.

carbohydrates

Carbon is an important atom to living things because it can form bonds with 4 other atoms at once to make chains, rings, and many different kinds of molecules.

Name 4 of the 6 atoms important for making molecules used in cells.

CHNOPS-

Carbon, hydrogen, nitrogen, oxygen, phosphorus, OR sulfur

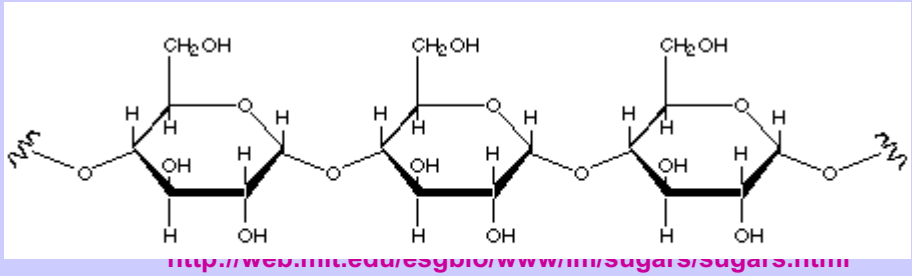
Essential knowledge 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization.

a. Molecules and atoms from the environment are necessary to build new molecules.

Evidence of student learning is a demonstrated understanding of each of the following:

1. Carbon moves from the environment to organisms where it is used to build carbohydrates, proteins, lipids or nucleic acids.

Double stranded nucleic acid molecule containing A, T, C, G nitrogen bases found in chromosomes that stores genetic information **DNA**



Macromolecule made by joining MANY sugar molecules together in a chain **polysaccharide**

Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

Amino acid subunits join together to make proteins

Lipids carbohydrates nucleic acids proteins

Adenine, Thymine, Cytosine, Guanine, and Uracil are used to make Nucleotides

polysaccharides amino acids nucleotides lipids

Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

Name 3 of the many functions of proteins that you learned about

Act as enzymes
Transport (Help move substances in & out of cells)
Help synthesize other proteins (part of ribosomes)
Movement (make up cytoskeleton, cilia, flagella)
Act as hormones (insulin)
Help cells recognize self (glycoproteins)
Structural (make cell membranes)
Fight germs (antibodies)
carry oxygen in blood cells (hemoglobin)
control blood sugar (insulin)

Give an example of a molecule that might have oligosaccharides attached

glycoprotein

Give an example of a disaccharide sugar

Table sugar(sucrose)

Lactose (milk sugar)

Name an atom found in DNA but not carbohydrates and lipids

Nitrogen OR phosphorus

Kind of chemical reaction used to join subunits when making polysaccharides, proteins, and nucleic acids

Dehydration synthesis

Vocab

Name the only kind of macromolecule that is not a polymer.

lipids

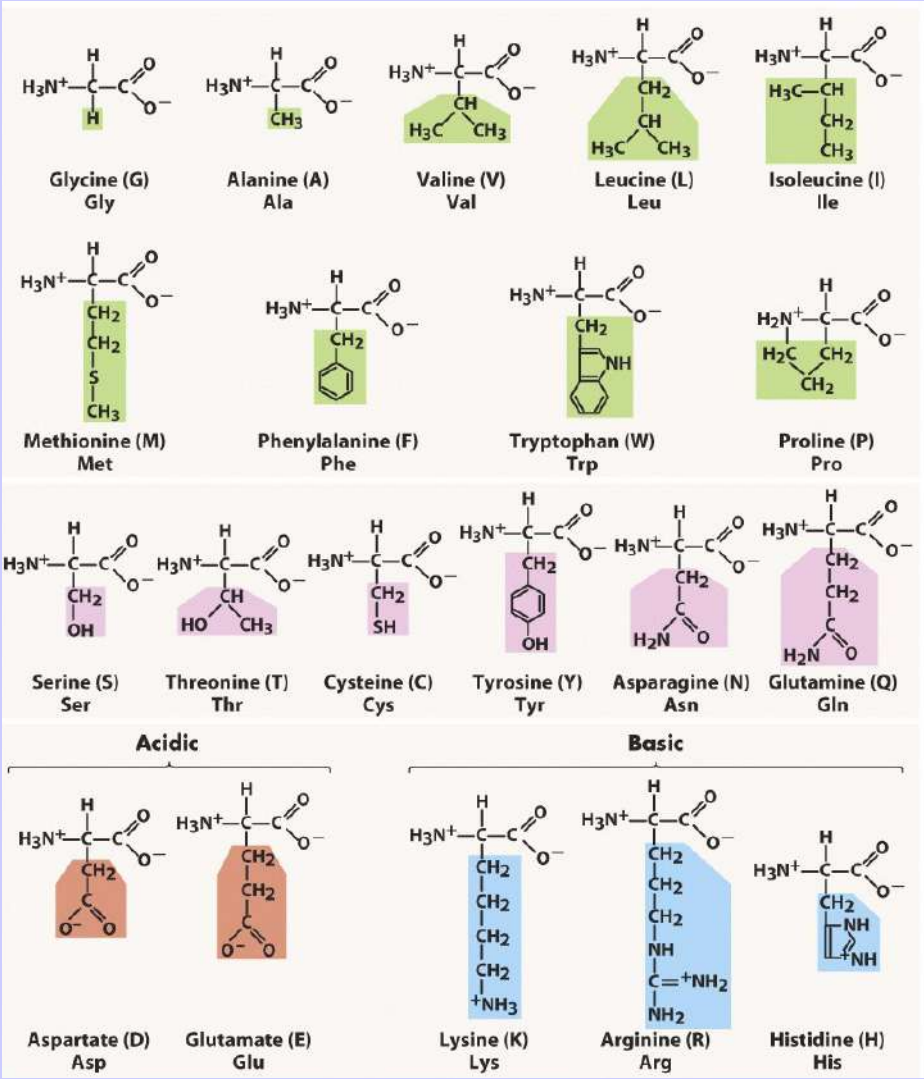


Image from: http://bio100.class.uic.edu/lectures/aminoacids01.jpg

Mutations can change the amino acid sequence in a protein. How might replacing lysine with arginine affect the secondary structure of a protein?

Impact probably would be minimal. Their shapes and charges are similar and R groups are not involved in secondary structure. Amino and carboxyl groups in the backbone are responsible for 2° structure.

*4.A. 1.a.*2. In proteins, the specific order of amino acids in a polypeptide (primary structure) interacts with the environment to determine the overall shape of the protein, which also involves secondary tertiary and quaternary structure and, thus, its function. The R group of an amino acid can be categorized by chemical properties (hydrophobic, hydrophilic and ionic), and the interactions of these R groups determine structure and function of that region of the protein.

LO 4.1 The student is able to explain the connection between the sequence and the subcomponents of a biological polymer and its properties. [See **SP 7.1**]

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Images from: http://ppt.wz51z.com/PMP2/Science.To.WebText/animations/science/chemistry_physics/vp_beaker_bubbles_steam.htm
http://nobel.scas.bcit.ca/debeck_pt/science/images/blue_bubbling_liquid.gif

Which is more basic?
How much more?
EXPLAIN YOUR ANSWER

pH 8

A

pH 12

B

B-

pH greater than 7 is basic ; so both are basic

each unit difference = 10 times more

pH 12 is 10,000 times more basic than pH 8

The process of changing from a stem cell to different looking cells with different functions

differentiation

Name the 4 main macromolecules used to make living things

Carbohydrates, lipids, proteins, & nucleic acids

VOCAB

Carbohydrate molecule like glucose that is made from only ONE sugar molecule

monosaccharide

Which ion is the pH scale used to measure?

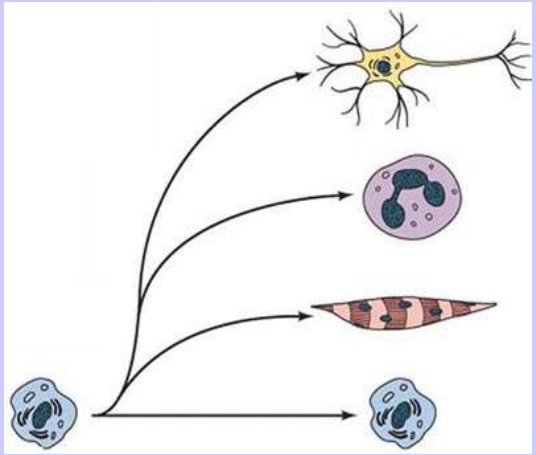
H^+ ions

Vocab

The basic unit of life is the cell.

The process in which cells change as they grow and develop to become specialized with different functions

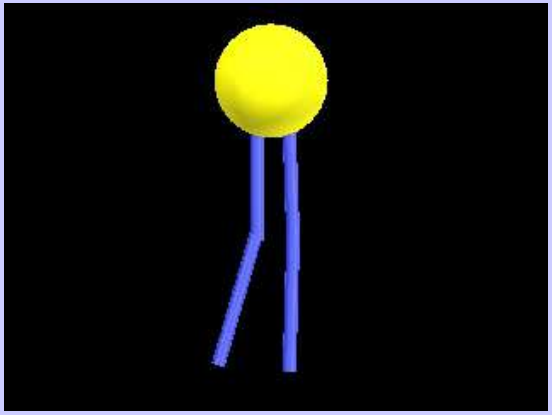
differentiation



http://www.ncu.edu.tw/~ls/graph/faculty_pictures/whole_time/SLC/SLC_lab-1.jpg

Phospholipids that make up cell membranes have a polar _____.

head



head tail

Nucleic acid molecule that is single stranded

RNA

VOCAB

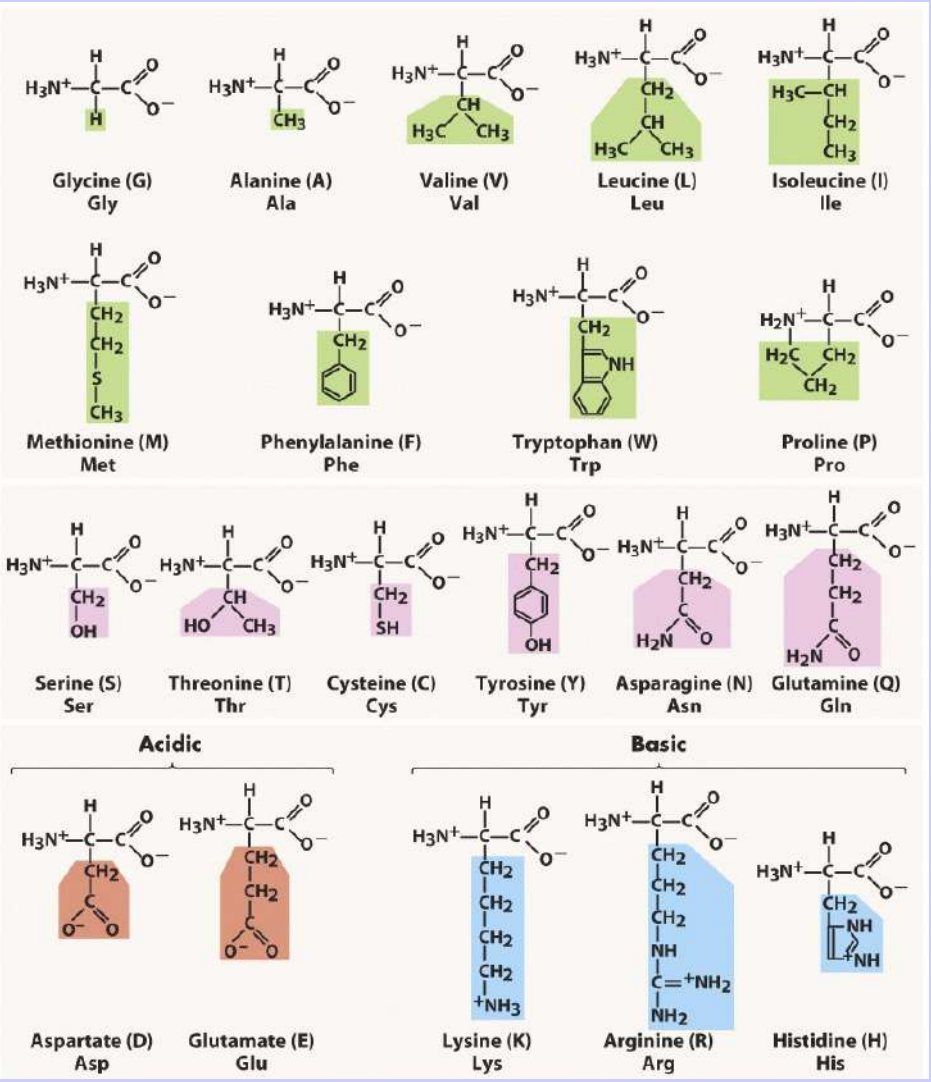


Image from: http://bio100.class.uic.edu/lectures/aminoacids01.jpg

Which of these amino acids have non-polar side chains?

Glycine, alanine, valine, leucine, isoleucine, methionine, phenylalanine, tryptophan, proline have phobic side chains.

Which R groups would be hydrophilic?

Serine, threonine, cysteine, tyrosine, asparagine, glutamine, aspartate, glutamate, lysine, arginine, histidine

*4.A. 1.a.*2. In proteins, the specific order of amino acids in a polypeptide (primary structure) interacts with the environment to determine the overall shape of the protein, which also involves secondary tertiary and quaternary structure and, thus, its function. The R group of an amino acid can be categorized by chemical properties (hydrophobic, hydrophilic and ionic), and the interactions of these R groups determine structure and function of that region of the protein.

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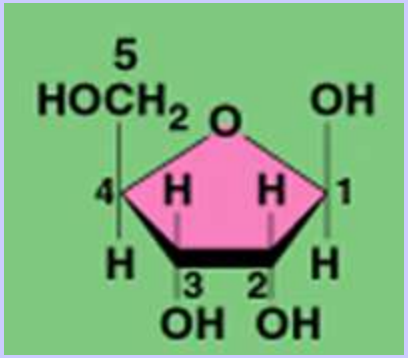
http://fig.cox.miami.edu/~cmallery/150/chemistry/fig5x27b.jpg

5 carbon sugar used to make RNA



ribose

Macromolecule made of a polar glycerol phosphate head and non- polar tails used to make cell membranes

phospholipid

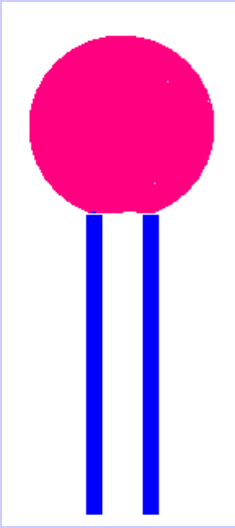
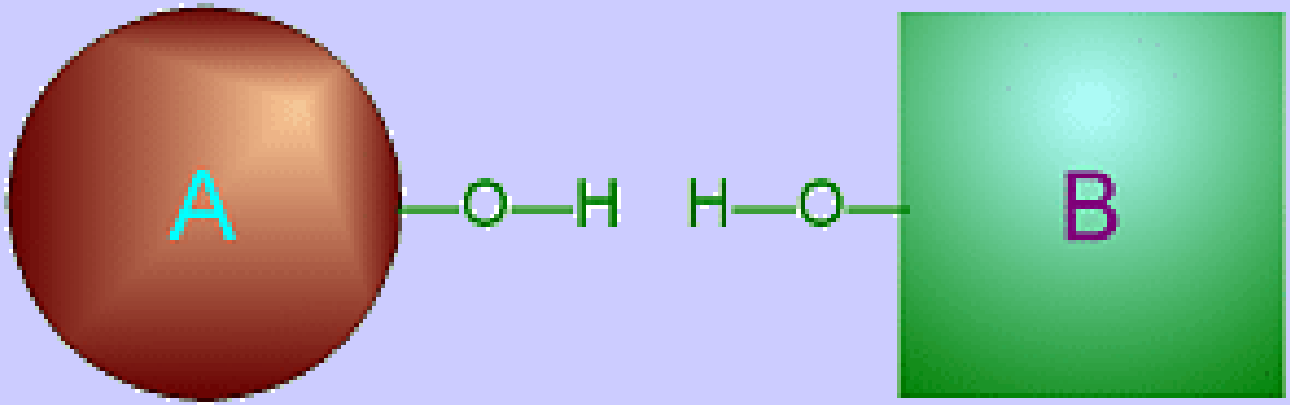


Image by Riedell

Vocab

Animation from: http://biologyclermont.info/wwwroot/graphics/lect1/carbon/dehydration%20anim.gif

Chemical reaction used by cells to join molecules together by removing an H and OH to make a water molecule



Dehydration synthesis

4.A.1.a. 4. Carbohydrates are composed of sugar monomers whose structures ad bonding with each other by dehydration synthesis determine the properties and functions of the molecules.
4.A.1.b.2. Proteins . . . consist of a linear sequence of amino acids connected by the formation of peptide bonds by dehydration synthesis . .

Describes a polar molecule that mixes easily with water; means "water loving"

hydrophilic

Small unit that can join together with other small units to form polymers

monomer

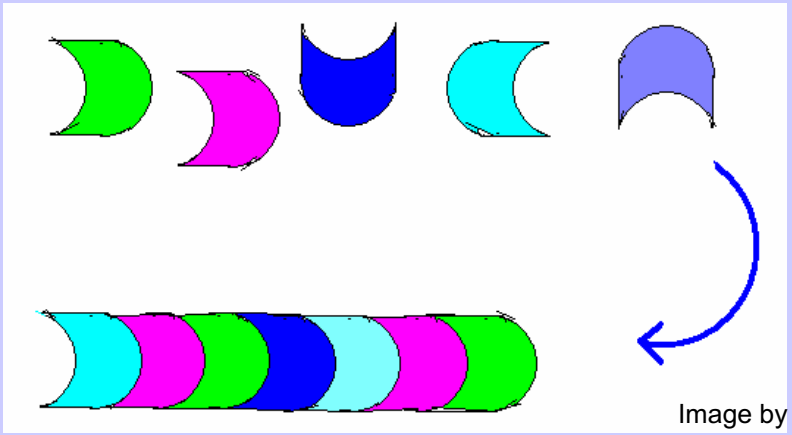
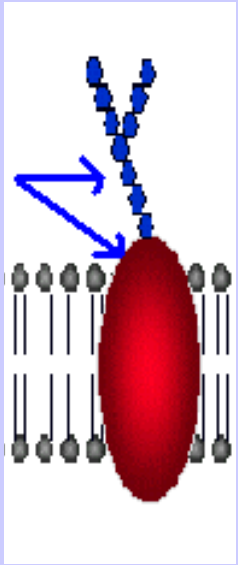


Image by Riedell

http://faculty.clintoncc.suny.edu/faculty/Michael.Gregory/files/Bio%20101/Bio%20101%20Lectures/Membranes/membrane.htm

Molecule made of a protein with carbohydrates attached found in cell membranes that helps in cell identification

glycoprotein



Protein hormone, missing in people with diabetes, that tells cells to store glucose as glycogen

insulin

vocab

Images from: http://ppt.wz51z.com/PMP2/Science.To.WebText/animations/science/chemistry_physics/vp_beaker_bubbles_steam.htm
http://nobel.scas.bcit.ca/debeck_pt/science/images/blue_bubbling_liquid.gif

Which is more acidic?
How much more?
EXPLAIN YOUR ANSWER

pH 5
A

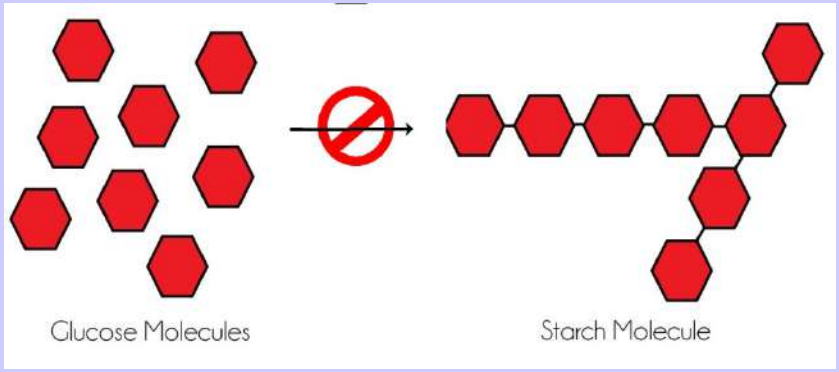
pH 7
B

A-
Smaller pH number = more acidic;
each unit difference = 10 times more
pH 5 is 100 times more acidic than pH 7

Images from:
http://nourishednutrition.co.nz/wp-content/uploads/2014/05/Starch-glucose.jpg
http://www.gurneys.com/product/kandy_korn_se_sweet_corn/vegetables

"Candy Corn" is a variety of sweet corn that has been modified by geneticists to taste sweeter than other varieties because Candy Corn lacks an enzyme that "field" corn plants have. What do you think the function of this missing enzyme is in other corn plants? EXPLAIN YOUR ANSWER

"Candy corn" lacks the enzyme that joins glucose subunits to make starch. If glucose in corn is not converted to starch, it tastes sweeter.



SP 7 The student is able to connect and relate knowledge across various scales, concepts, And representations in and across domains.
LO 4.1 The student is able to explain the connection between the sequence and the subcomponents of a biological polymer and its properties. [See **SP 7.1**]
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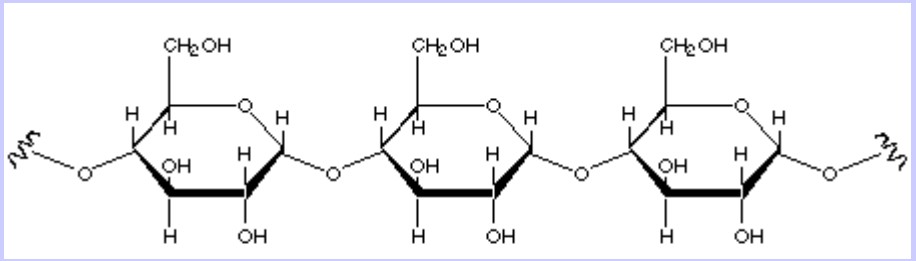
Double stranded nucleic acid molecule containing A, T, C, G nitrogen bases found in chromosomes that stores genetic information

DNA



http://web.mit.edu/esgbio/www/lm/sugars/sugars.html

Macromolecule made by joining a FEW (3-10) sugar molecules together in a chain

oligosaccharide

vocab

vocab

Protein that acts as a biological catalyst in living things to help chemical reactions happen faster

enzyme

Attraction between oppositely charged regions of nearby molecules involving the hydrogen atoms of one molecule and the partially negatively charged atoms in another molecule

Hydrogen bonds

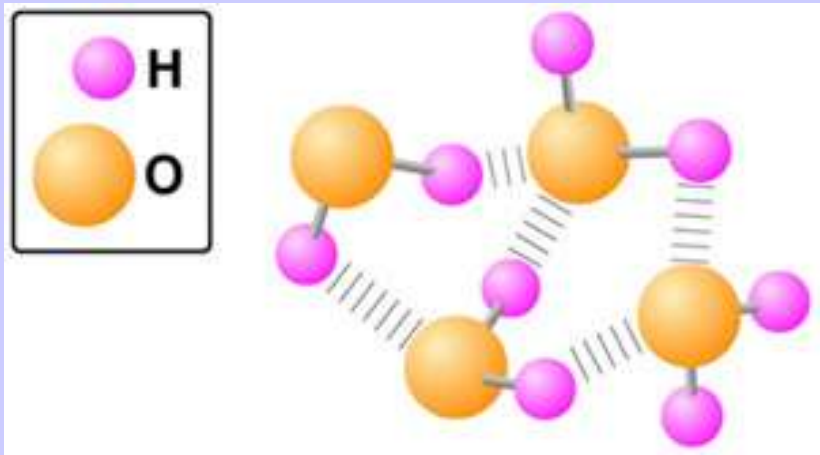


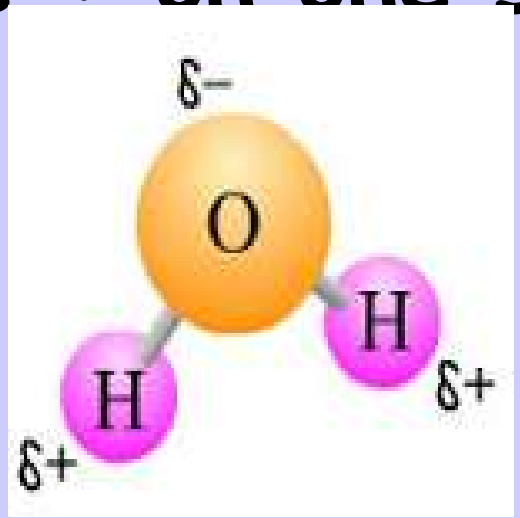
Image from: http://www.estrellamountain.edu/faculty/farabee/biobk/BioBookCHEM2.html

Macromolecule that contains carbon, hydrogen, oxygen, and nitrogen, made by joining amino acid subunits

protein

Molecule with an uneven pattern of electric charges; More + on one side/ more – on the other

polar



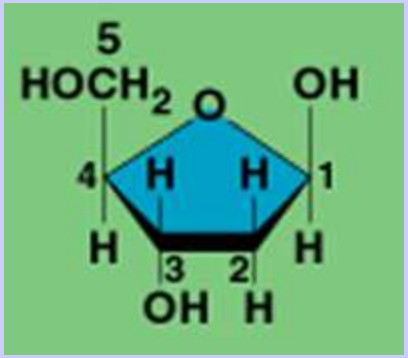
vocab

Image from: http://www.estrellamountain.edu/faculty/farabee/biobk/BioBookCHEM2.html

Image from: http://fig.cox.miami.edu/~cmallery/150/chemistry/fig5x27b.jpg

5 carbon sugar used to make DNA

deoxyribose



An atom that has gained or lost electrons so it has an electric charge

ion

Substances on the left side of a chemical equation which react

reactants

Describes a non-polar molecule that tries to stay away from water; means "water fearing"

hydrophobic

One of the components (including adenine, thymine, guanine, cytosine, or uracil) that make up nucleotides

Nitrogen bases

Compound made up of carbon, hydrogen, and oxygen atoms usually in a ratio of 1 C: 2 H: 1 O which is a major source of energy for the human body

carbohydrate

Large molecule made by joining smaller monomer subunits together

polymer

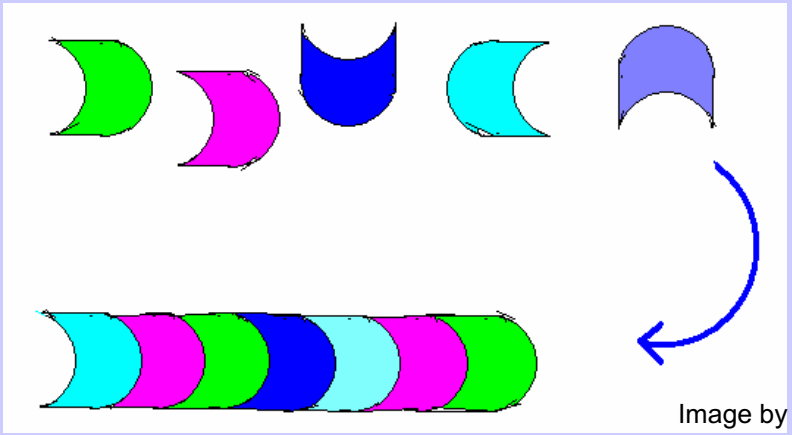


Image by Riedell

vocab

Macromolecules made mainly of carbon and hydrogen atoms; includes fats, oils, and waxes and steroids, which are generally hydrophobic **lipid**

Macromolecule made of nucleotide subunits containing carbon, hydrogen, oxygen, nitrogen, and phosphorus which stores and transports information in cells and helps in protein synthesis **nucleic acid**

Lipids are hydrophobic

hydrophobic hydrophilic

Lipids are non-polar

polar non-polar

Essential knowledge 4.A.1.a. 3. In general, lipids are nonpolar; however, phospholipids exhibit structural properties, with polar regions that interact with other polar molecules such as water, and with nonpolar regions where differences in saturation determine the structure and function of lipids. [See also **1.D.1, 2.A.3, 2. B.1**]

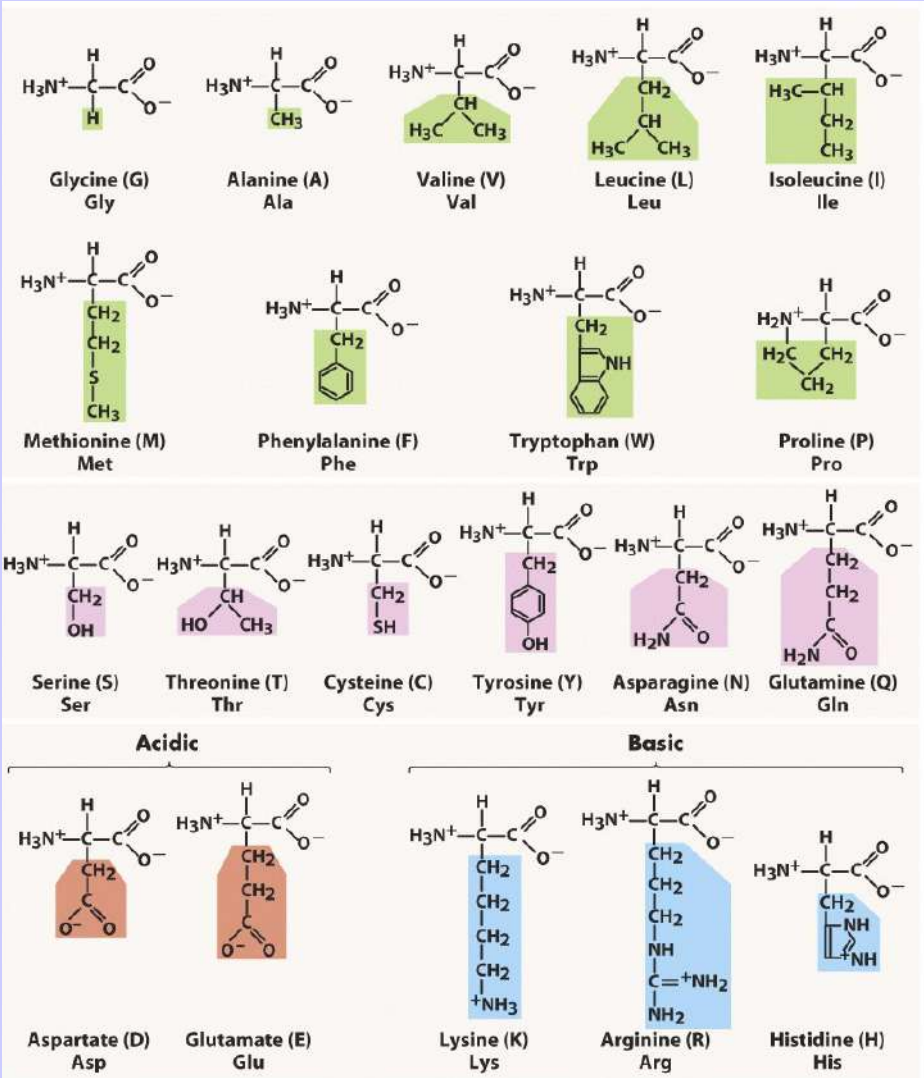


Image from: http://bio100.class.uic.edu/lectures/aminoacids01.jpg

Mutations can change the amino acid sequence in a protein. How might replacing cysteine with serine affect the tertiary structure of a protein?

Although these have similar polar R groups, cysteine can make a disulfide bridge with another cysteine which helps stabilize 3 structure. This mutation would impact the protein's 3D shape.

*4.A. 1.a.*2. In proteins, the specific order of amino acids in a polypeptide (primary structure) interacts with the environment to determine the overall shape of the protein, which also involves secondary tertiary and quaternary structure and, thus, its function. The R group of an amino acid can be categorized by chemical properties (hydrophobic, hydrophilic and ionic), and the interactions of these R groups determine structure and function of that region of the protein.

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Image from: https://thumbs.dreamstime.com/t/huge-cow-eating-field-illustration-53978774.jpg

Starch and cellulose are both polysaccharides made by plants. Many organisms including humans can digest starch but not cellulose. WHY?

They have enzymes to break α-glycosidic linkages (starch) but not β-glycosidic linkages (cellulose).

Explain how cows can survive on a diet of hay and grass if they can't digest cellulose in their food ?

Cows (and humans) have symbiotic bacteria that live in their gut which CAN break β inkages

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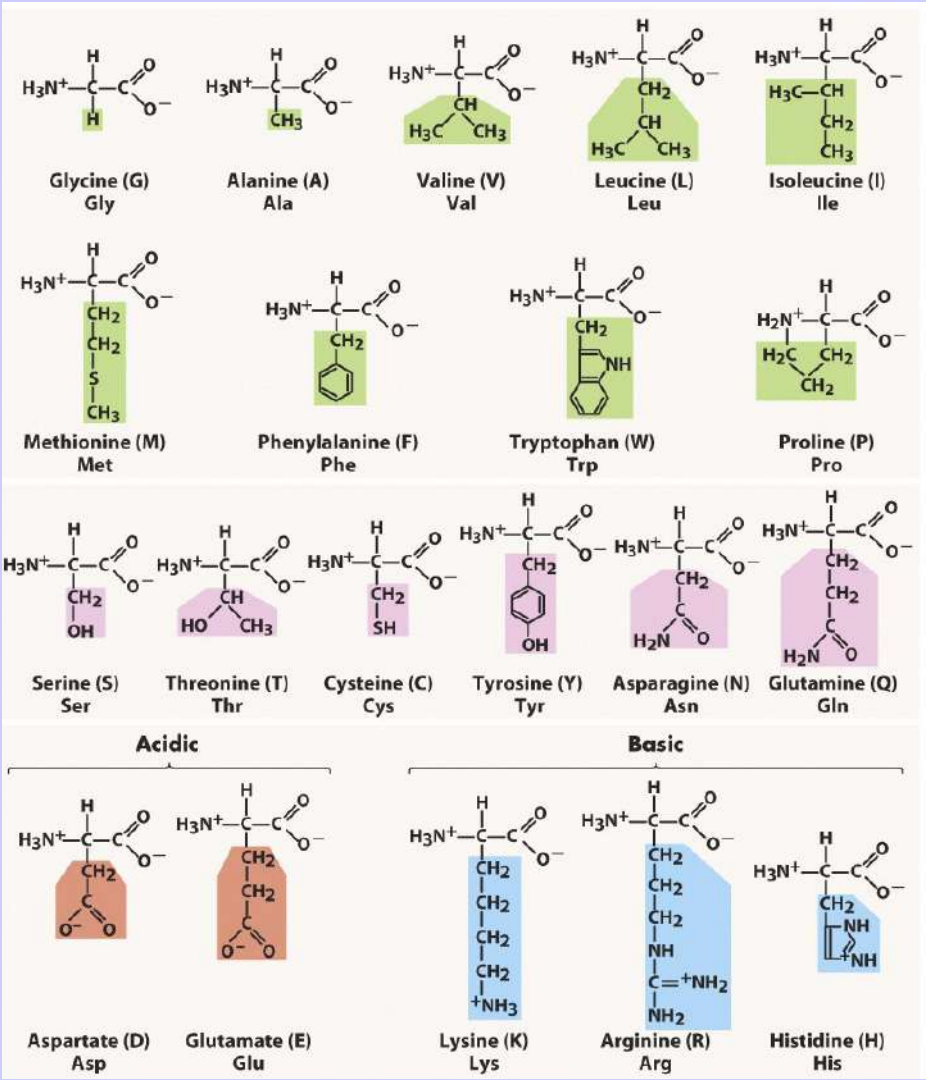

Image from: http://bio100.class.uic.edu/lectures/aminoacids01.jpg

Which of these amino acids have polar side chains?

Serine, threonine, cysteine, tyrosine, asparagine, glutamine

Which R groups would be hydrophobic?

Glycine, alanine, valine, leucine, isoleucine, methionine, phenylalanine, tryptophan, proline

*4.A. 1.a.*2. In proteins, the specific order of amino acids in a polypeptide (primary structure) interacts with the environment to determine the overall shape of the protein, which also involves secondary tertiary and quaternary structure and, thus, its function. The R group of an amino acid can be categorized by chemical properties (hydrophobic, hydrophilic and ionic), and the interactions of these R groups determine structure and function of that region of the protein.

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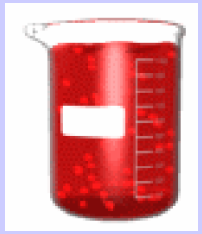
Images from: http://ppt.wz51z.com/PMP2/Science.To.WebText/animations/science/chemistry_physics/vp_beaker_bubbles_steam.htm
http://nobel.scas.bcit.ca/debeck_pt/science/images/blue_bubbling_liquid.gif
http://ps205.org/wp-content/uploads/2010/09/beaker_red_liquid_bubbling_sm_wht.gif

Which is basic?
EXPLAIN YOUR ANSWER

pH 4
A

pH 7
B

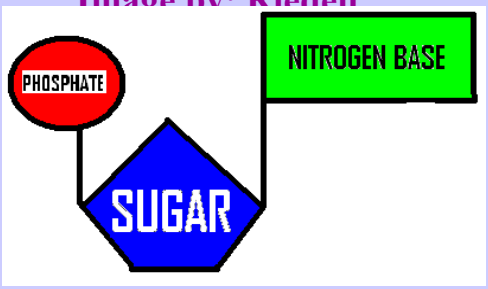


pH 9
C

C (pH 9)
pH < 7 is acidic
pH 7 = neutral
pH > & is basic

Image by: Riedell

Name this subunit used to build nucleic acids like DNA & RNA



NUCLEOTIDE

If this was going to make DNA what sugar would be used?

deoxyribose

Which nitrogen base could NOT be used?

URACIL

Essential knowledge 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.

b. DNA and RNA molecules have structural similarities and differences that define function. [See also **4.A.1**]

Evidence of student learning is a demonstrated understanding of each of the following:

1. Both have three components — sugar, phosphate and a nitrogenous base — which form nucleotide units that are connected by covalent bonds to form a linear molecule with 3' and 5' ends, with the nitrogenous bases perpendicular to the sugar-phosphate backbone.
2. The basic structural differences include:
   i. DNA contains deoxyribose (RNA contains ribose).
   ii. RNA contains uracil in lieu of thymine in DNA.

Our stomachs produce hydrochloric acid to kill germs and help break down the food we eat. Too much stomach acid can cause an upset stomach. Use what you learned about acids and bases to explain why people take antacids (like Maalox, Tums, or Rolaids) when they get heartburn.
(Hint: The chemical in Maalox is magnesium HYDROXIDE)

H^+ in stomach acid is neutralized by OH^- in antacid

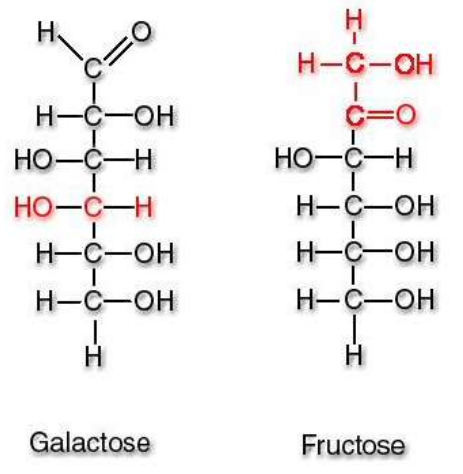
$$H^+ + OH^- \rightarrow H_2O$$

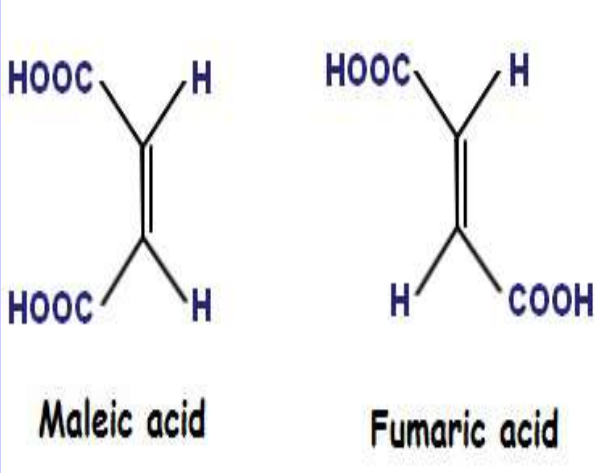
(Acid) (base) (Neutral)

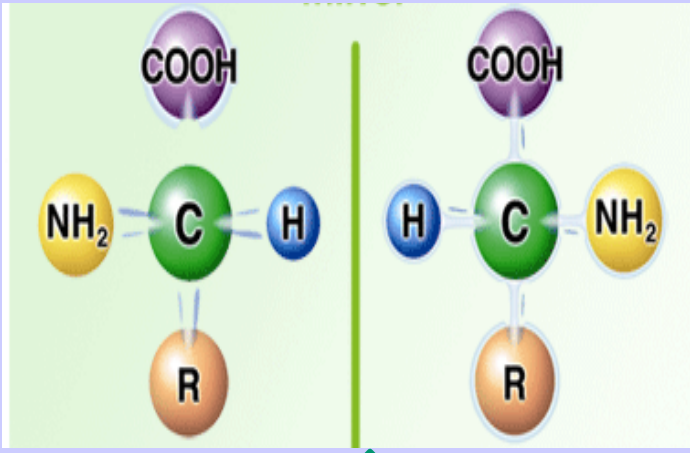
SP 7 The student is able to connect and relate knowledge across various scales, concepts, And representations in and across domains

Images from: http://www.brl.org/chemistry/gifs/53115.gif
http://www.chemistry.wustl.edu/~coursedev/Online%20tutorials/chem_forms/fumaricacid.gif
http://www.noticiasbioiberica.com/images/noticias_fisio/img_20_1_ing.gif

Which of these pairs of molecules represent enantiomer (stereo) isomers?

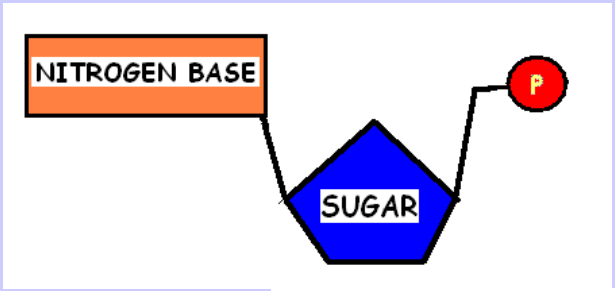


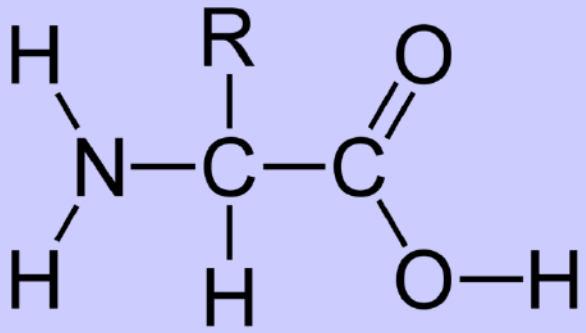


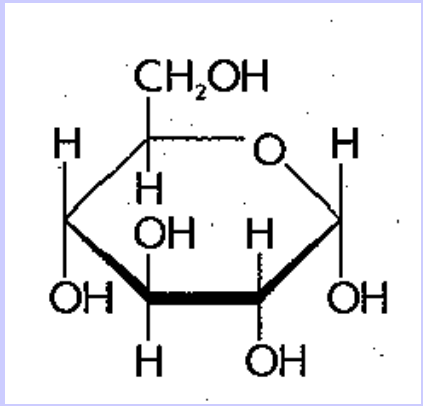


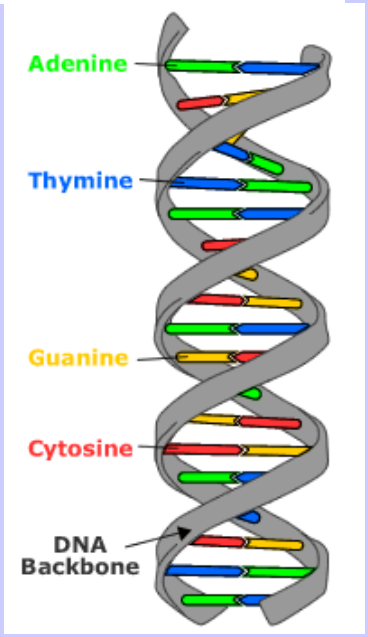
Mirror images
asymmetric carbon

Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule









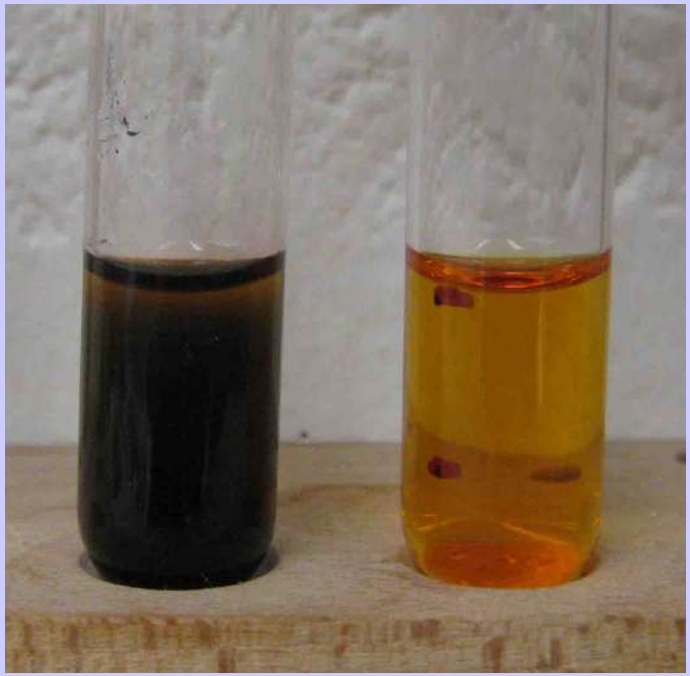
Which of these molecules is a phospholipid?

Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

http://emp.byui.edu/wellerg/Molecules%20of%20the%20Cell%20Lab/images/instructions/iodineboth.jpg

During the food lab in Honors Bio you used iodine to test for the presence of starch. You accidently spill IODINE on your lab paper and get it on your finger while cleaning up.

EXPLAIN WHY your lab paper turns black but your finger doesn't.



Iodine turns black in presence of starch

Paper comes from plants.
Plants store glucose as starch

Humans (animals) store glucose as glycogen (NO starch)

SP.7 The student is able to connect and relate knowledge across various scales, concepts, and representations in and across domains.

EXPLAIN how the properties of water result in its label as the "UNIVERSAL SOLVENT"

~ **Polarity of H_2O** molecules result in their ability to dissolve many ionic and polar molecules important for living things (carbohydrates, nucleic acids, proteins, ions) that are **HYDROPHILIC**.

~ Water is major component in cytoplasm so serves as a medium for all chemical reactions to happen in cells.

~ **Cohesion of water** allows it to flow (ex blood) to transport dissolved substances throughout the body.

SP 7 The student is able to connect and relate knowledge across various scales, concepts, And representations in and across domains
2.A.3..a..3 Living systems depend on properties of water that result from its polarity and hydrogen bonding.
Universal solvent supports reactions

Images from: http://ppt.wz51z.com/PMP2/Science.To.WebText/animations/science/chemistry_physics/vp_beaker_bubbles_steam.htm
http://nobel.scas.bcit.ca/debeck_pt/science/images/blue_bubbling_liquid.gif

Which contains more H^+ ions?
What is the $[H^+]$ in solution A and B?

pH 2

A

pH 8

B

pH = -log[H+]

pH 2 has 1 X 10^{-2} or 0.01 H^+ per liter (0.01 M)

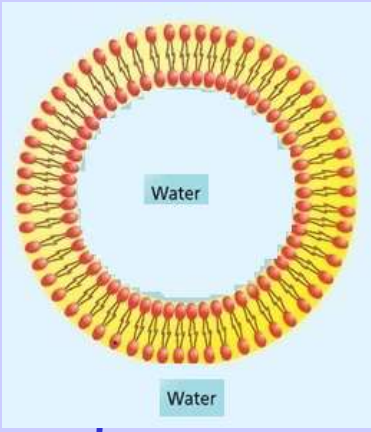
pH 8 has 1 X 10^{-8} or 0.00000001 H^+ per liter

A contains more H^+ ions

Images from:https://o.quizlet.com/UjH7VJTp7w1js70vvFKSRw_m.jpg
https://i.ytimg.com/vi/LTK8wFcglyg/maxresdefault.jpg

EXPLAIN how the polar properties of water result in cell membrane formation.

~ **Polarity of H_2O** molecules result in the insolubility of molecules that are HYDROPHOBIC (lipids)



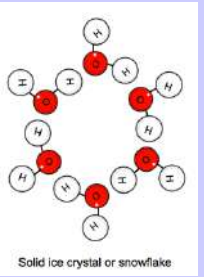
~ interaction with phospholipids results in the hydrophilic/polar heads orienting themselves in a bilayer with the polar/hydrophilic facing outward touching the mostly water cytoplasm/extracellular fluid and the hydrophobic/nonpolar tails facing inward away from water

~ allows cell membranes to form structure of cells and results in internal compartmentalization of chemical reactions in cells (ex: mitochondria, chloroplasts)

SP 7 The student is able to connect and relate knowledge across various scales, concepts, And representations in and across domains
2.A.3..a..3 Living systems depend on properties of water that result from its polarity and hydrogen bonding
2.B.1.a Cell membranes separate the internal environment of the cell from the external environment.
2. Phospholipids give the membrane both hydrophilic and hydrophobic properties. The hydrophilic phosphate portions of the phospholipids are oriented toward the aqueous external or internal environments, while the hydrophobic fatty acid portions face each other within the interior of the membrane itself.

Image from:https://bsciencecenter.files.wordpress.com/2013/02/screen-shot-2013-02-09-at-6-16-44-pm.png
http://www.pitara.com/wordpress/wp-content/uploads/2013/12/5wh-25_1.gif

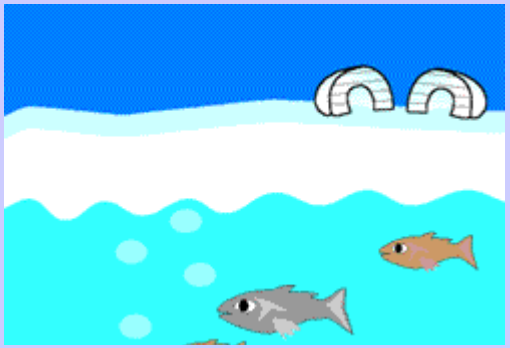
Water is ONLY substance that is LESS DENSE AS A SOLID THAN AS A LIQUID. Explain how this unique property of water allows aquatic life to survive when water freezes in winter.



When water changes from liquid to solid, the molecules form a lattice structure that causes the molecules to move farther apart.

Water expands as it freezes instead of contracting like most liquids. Since ice is less dense than liquid water lakes/ponds freeze from the top down instead of the bottom up.

Living things can survive under the surface of the ice during winter.



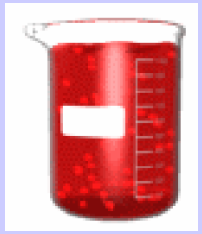
SP 7 The student is able to connect and relate knowledge across various scales, concepts, And representations in and across domains
2.A.3..a..3 Living systems depend on properties of water that result from its polarity and hydrogen bonding

Images from: http://ppt.wz51z.com/PMP2/Science.To.WebText/animations/science/chemistry_physics/vp_beaker_bubbles_steam.htm
http://nobel.scas.bcit.ca/debeck_pt/science/images/blue_bubbling_liquid.gif
http://ps205.org/wp-content/uploads/2010/09/beaker_red_liquid_bubbling_sm_wht.gif

Which is acidic?
EXPLAIN YOUR ANSWER

pH 4
A

pH 7
B



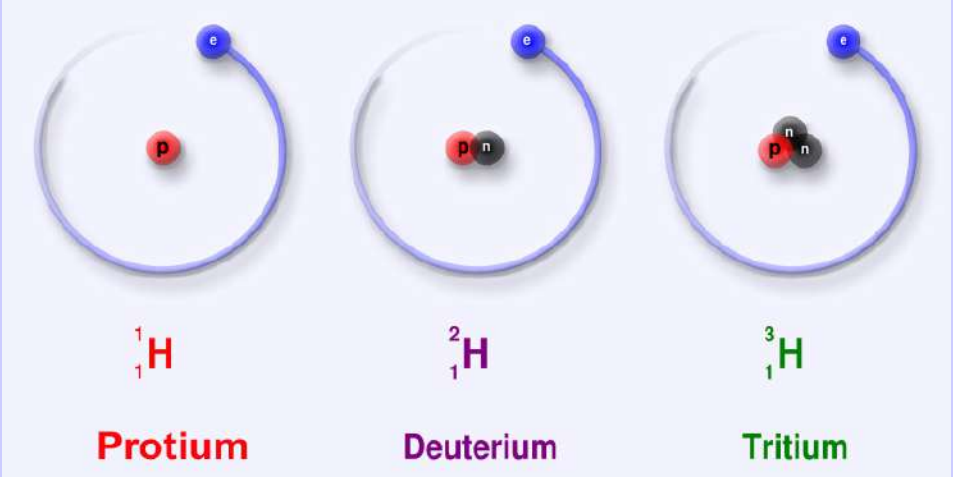
pH 9
C

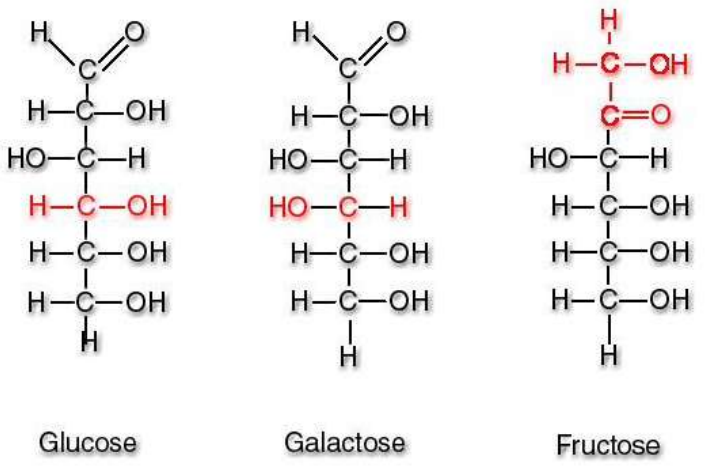
A (pH 4)
pH < 7 is acidic
pH 7 = neutral
pH > 7 is basic

Images from:
https://upload.wikimedia.org/wikipedia/commons/6/6c/Protium_deuterium_tritium.jpg
http://credit-help.biz/img/2551/monosaccharides1350254591202972.jpg

EXPLAIN the difference between an ISOTOPE and an ISOMER.

Isotopes are **ATOMS** that have the same number of protons & electrons but **different numbers of neutrons**





Isomers are **MOLECULES** that contain the same numbers and kinds of atoms **arranged in a different way**

VOCAB

Image from: http://water.usgs.gov/edu/pictures/meniscus-small.jpg:

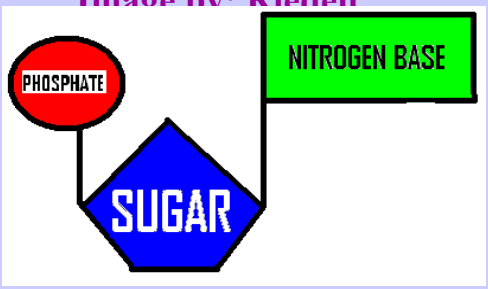
EXPLAIN why water in a glass graduated cylinder forms a meniscus.

Polarity of H_2O molecules results in ability of water molecules to **form hydrogen bonds** between water molecules (**cohesion**) and between water molecules and the surface of the glass (**adhesion**).

Because water is attracted to the glass, it moves up the sides of the graduated cylinder.

SP 7 The student is able to connect and relate knowledge across various scales, concepts, And representations in and across domains
2.A.3..a..3 Living systems depend on properties of water that result from its polarity and hydrogen bonding.
Cohesion
- **Adhesion**

Name this subunit used to build nucleic acids like DNA & RNA



NUCLEOTIDE

If this was going to make RNA what sugar would be used?

ribose

Which nitrogen base could NOT be used?

THYMINE

Essential knowledge 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.

b. DNA and RNA molecules have structural similarities and differences that define function. [See also **4.A.1**]

Evidence of student learning is a demonstrated understanding of each of the following:

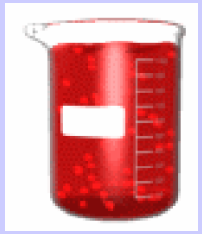
1. Both have three components — sugar, phosphate and a nitrogenous base — which form nucleotide units that are connected by covalent bonds to form a linear molecule with 3' and 5' ends, with the nitrogenous bases perpendicular to the sugar-phosphate backbone.
2. The basic structural differences include:
   i. DNA contains deoxyribose (RNA contains ribose).
   ii. RNA contains uracil in lieu of thymine in DNA.

Images from: http://ppt.wz51z.com/PMP2/Science.To.WebText/animations/science/chemistry_physics/vp_beaker_bubbles_steam.htm
http://nobel.scas.bcit.ca/debeck_pt/science/images/blue_bubbling_liquid.gif
http://ps205.org/wp-content/uploads/2010/09/beaker_red_liquid_bubbling_sm_wht.gif

Which is neutral?
EXPLAIN YOUR ANSWER

pH 4
A

pH 7
B



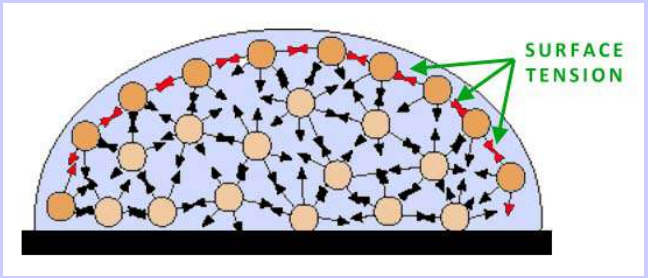
pH 9
C

B (pH 7)
pH < 7 is acidic
pH 7 = neutral
pH > & is basic

Image from: http://fusedglass.org/imgs/02_surface_tension.jpg
http://www.dailyrogers.com/wp-content/uploads/2015/08/water_strider_robot-1.jpg
http://cuntamination.tumblr.com/post/17029767902

Use the properties of water to EXPLAIN why water bugs can "walk on water".

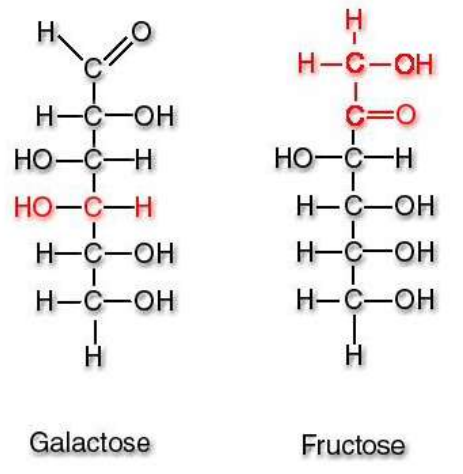
SURFACE TENSION is a measure of how difficult it is to stretch or break the surface of a liquid. There is an attraction between water molecules (COHESION) due to HYDROGEN bonds causing them to pull toward each other and gives water a very high surface tension which makes it behave as though it were coated with an invisible film. This is enough to provide the support to hold up some organisms.

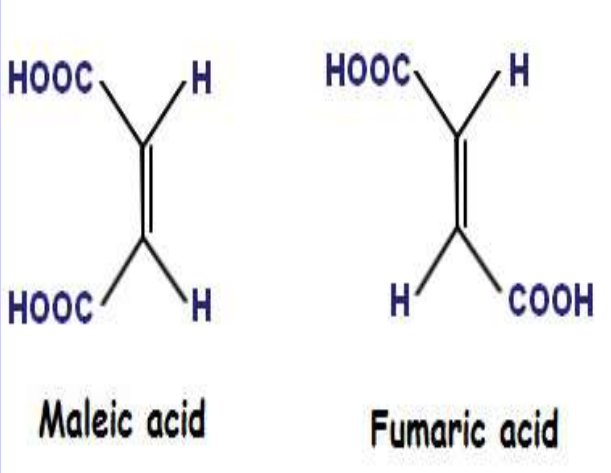


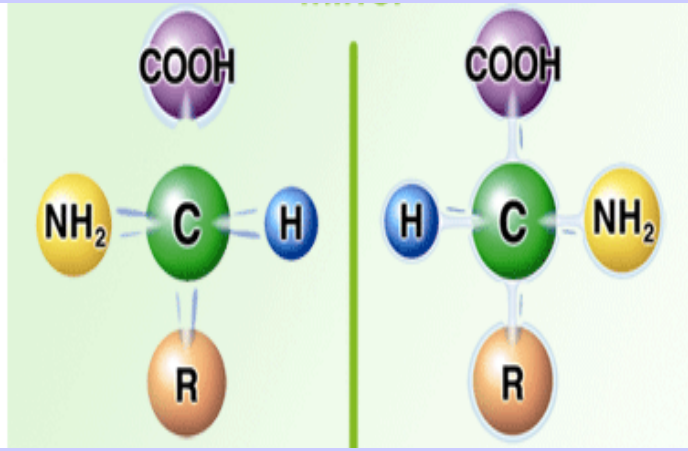
SP 7 The student is able to connect and relate knowledge across various scales, concepts, And representations in and across domains
2.A.3..a..3 Living systems depend on properties of water that result from its polarity and hydrogen bonding
Cohesion

Images from: http://www.brl.org/chemistry/gifs/53115.gif
http://www.chemistry.wustl.edu/~coursedev/Online%20tutorials/chem_forms/fumaricacid.gif
http://www.noticiasbioiberica.com/images/noticias_fisio/img_20_1_ing.gif

Which of these pairs of molecules represent geometric isomers?



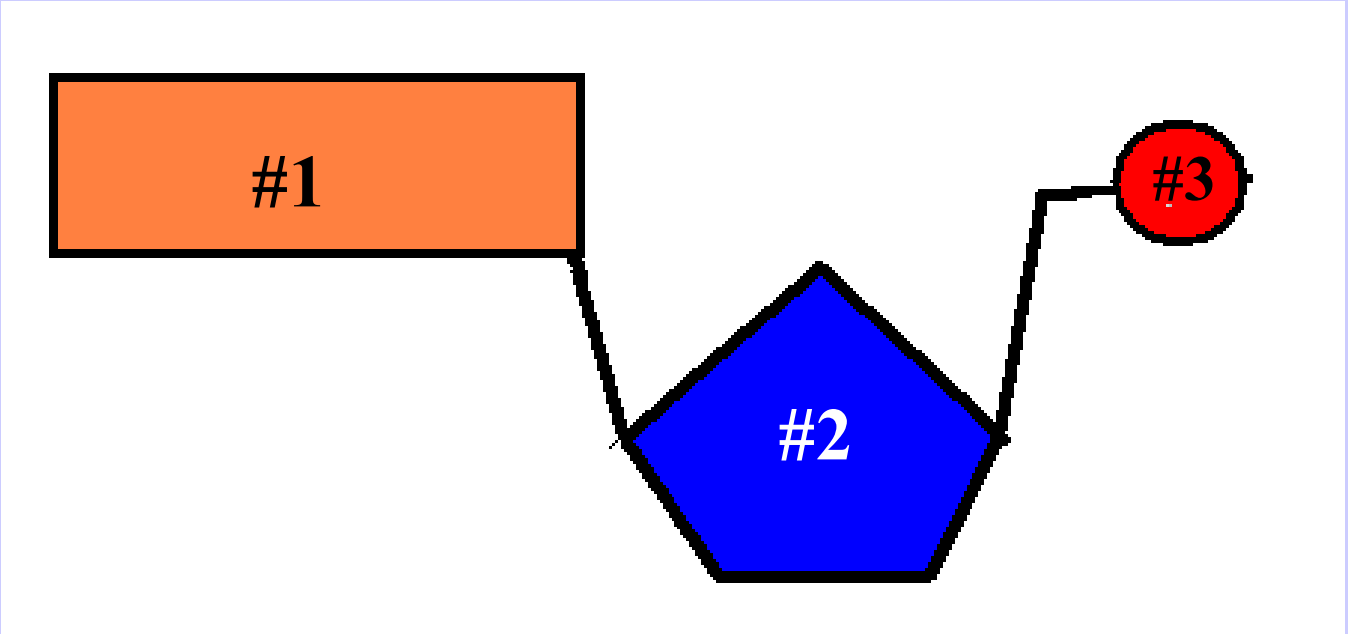




Cis & trans isomers across a double bond

Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

Name the 3 parts of a nucleotide



#1 = nitrogen base (A, T, C, G, or U)

#2 = sugar (deoxyribose or ribose)

#3 = phosphate

Essential knowledge 4.A.1

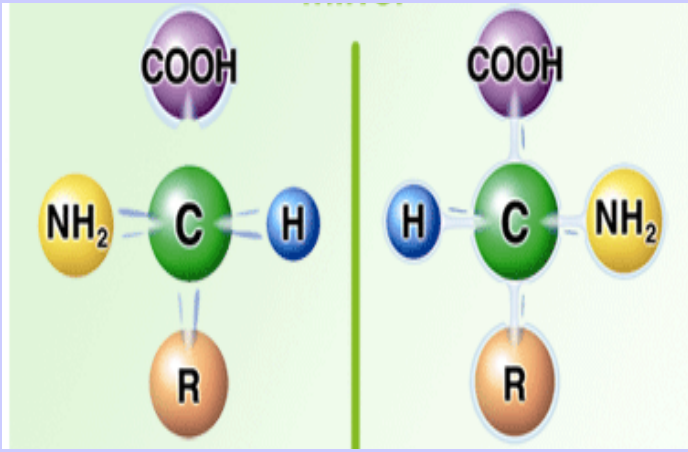
a. Structure and function of polymers are derived from the way their monomers are assembled.

1. In nucleic acids, biological information is encoded in sequences of nucleotide monomers. Each nucleotide has structural components: a five-carbon sugar (deoxyribose or ribose), a phosphate and a nitrogen base (adenine, thymine, guanine, cytosine or uracil). DNA and RNA differ in function and differ slightly in structure, and these structural differences account for the differing functions. [See also **1.D.1, 2.A.3, 3.A.1**]

✘✘ *The molecular structure of specific nucleotides is beyond the scope of the course and the AP Exam*

Image from; http://www.noticiasbioiberica.com/images/noticias_fisio/img_20_1_ing.gif

Remember molecules with asymmetric carbons (like amino acids and sugars) can form enantiomers (stereo/mirror image isomers) with D or L forms.



Interestingly, most amino acids used by living things to make proteins are the L form and most sugars used by living things are the D form. EXPLAIN how this provides evidence for Darwin's theory of evolution and common descent.

Conserved chemical processes are evidence for shared common ancestry. At some point (for unknown reasons at this time) one isomer form must have provided an advantage and the use of that form and chemistry that supported it were passed on to subsequent generations. (HOMOCHIRALITY THEORY)

1.B.1. Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today
SP 6. The student can work with scientific explanations and theories.

Image from: http://i.stack.imgur.com/sucSu.jpg

The amount of energy that must be absorbed for 1 g of liquid to be converted to gas =

heat of vaporization

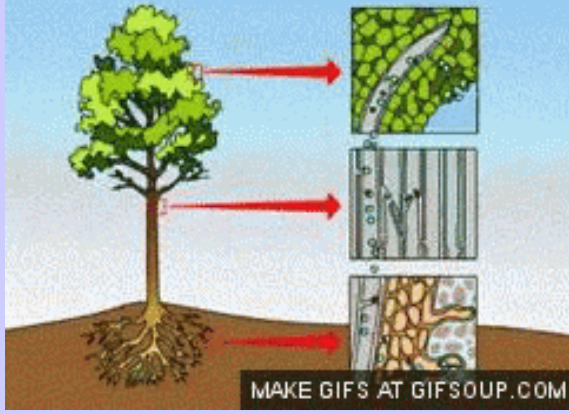
The amount of energy that must be absorbed for 1 g of solid to be converted to liquid =

heat of fusion

SP 7 The student is able to connect and relate knowledge across various scales, concepts, And representations in and across domains
2.A.3..a..3 Living systems depend on properties of water that result from its polarity and hydrogen bonding
Cohesion
- **High specific heat capacity**
- **Heat of vaporization**
- **Heat of fusion**

Animation from: http://stream1.gifsoup.com/view4/4699896/transpiration-pull-o.gif

EXPLAIN how the properties of water work to move water from roots to shoots in a tree.



Polarity of H_2O molecules results in ability of water molecules to **form hydrogen bonds** between water molecules (**cohesion**) and between water molecules and other surfaces (**adhesion**).

As water evaporates from leaf surface via openings (stomata), water molecules below are pulled up like "beads on string" due to cohesion. Adhesion of water molecules to the cell walls of transport tubes (xylem) resists pull of gravity back downward as water moves up from roots to leaves.

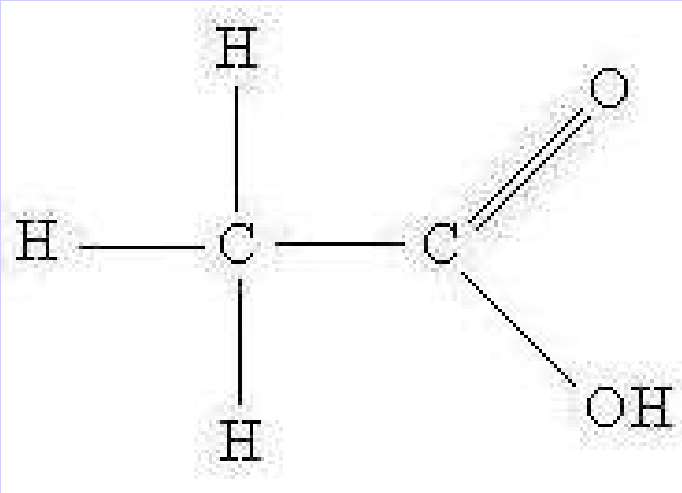
Cohesion, adhesion, and surface tension create a capillary action that keeps water molecules interacting and moving through the plant.

VIDEO

SP 7 The student is able to connect and relate knowledge across various scales, concepts, And representations in and across domains
2.A.3..a..3 Living systems depend on properties of water that result from its polarity and hydrogen bonding.
Cohesion
- **Adhesion**

Image and question from: Holtzclaw & Holtzclaw study guide

Do you think this molecule is hydrophilic or hydrophobic? EXPLAIN YOUR ANSWER

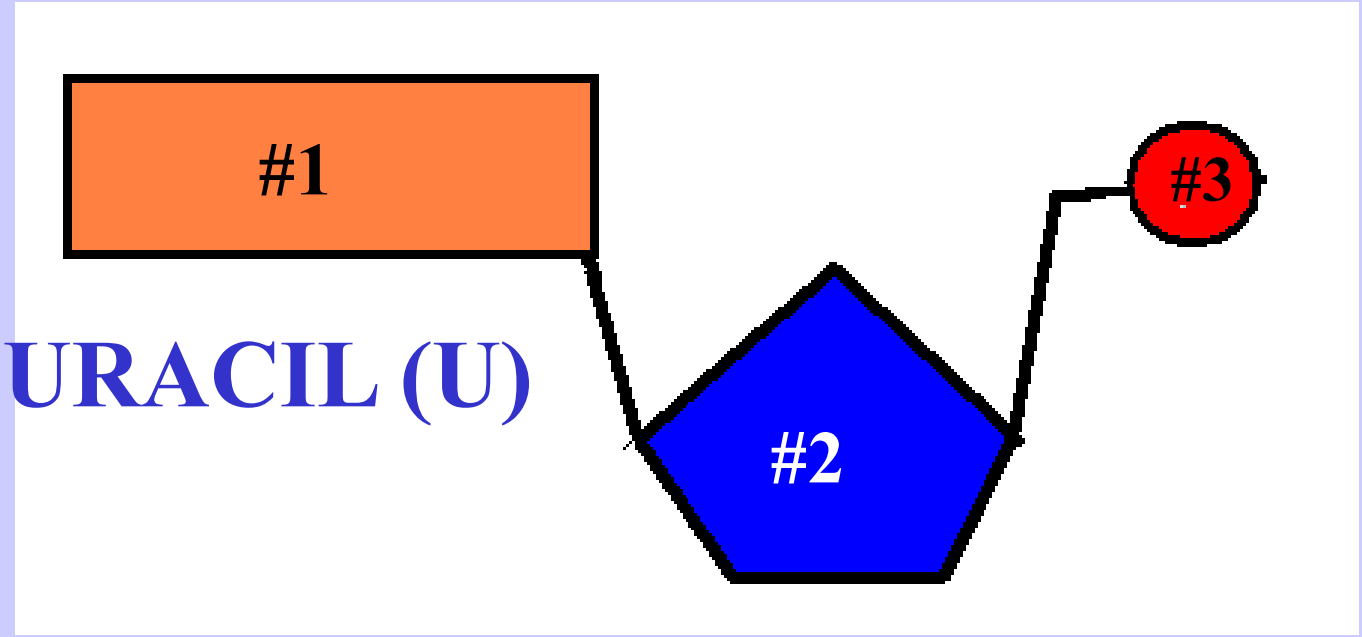


The addition of a carboxyl group makes this molecule more hydrophilic because the carboxyl group can lose a H^+ ion to become slightly charged. This would make it associate with a polar molecule like water.

SP 6..1 The student can Justify claims with evidence. d representations in and across domains

Essential knowledge 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule

If you want to make DNA which nitrogen bases CAN'T be used in the #1 spot?



NO URACIL (U)

Essential knowledge 4.A.1

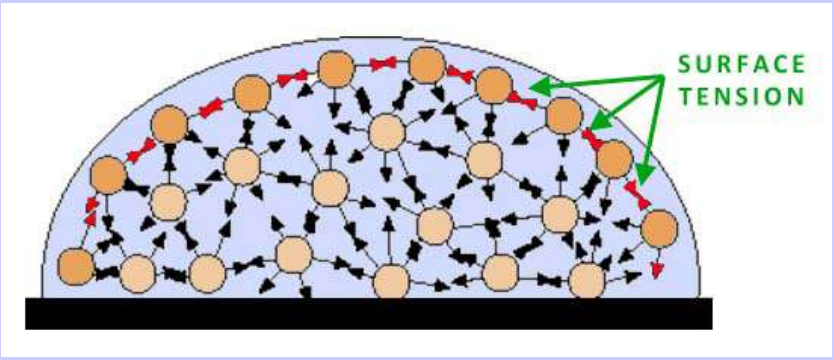
a. Structure and function of polymers are derived from the way their monomers are assembled.

1. In nucleic acids, biological information is encoded in sequences of nucleotide monomers. Each nucleotide has structural components: a five-carbon sugar (deoxyribose or ribose), a phosphate and a nitrogen base (adenine, thymine, guanine, cytosine or uracil). DNA and RNA differ in function and differ slightly in structure, and these structural differences account for the differing functions. [See also **1.D.1, 2.A.3, 3.A.1**]

✘✘ *The molecular structure of specific nucleotides is beyond the scope of the course and the AP Exam*

Image from: http://fusedglass.org/imgs/02_surface_tension.jpg

The measure of how difficult it is to stretch or break the surface of a liquid = SURFACE TENSION



Surface tension is due to HYDROGEN bonding.

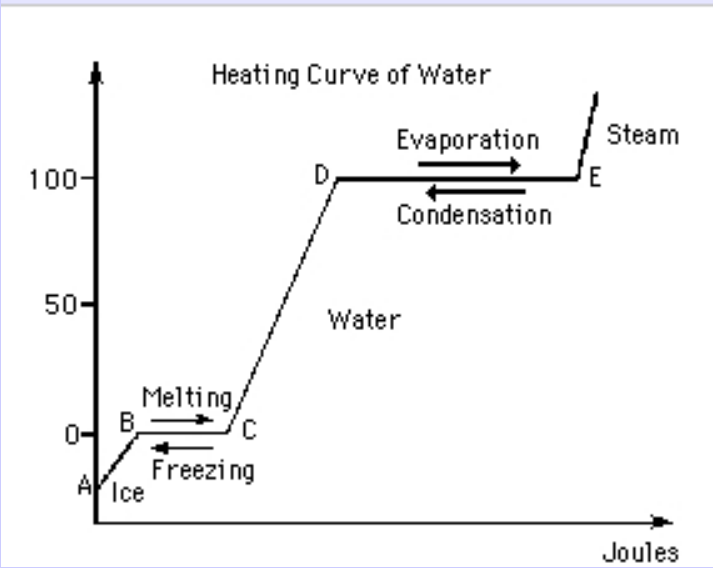
Compared to other liquids water has a very HIGH surface tension.

LOW HIGH

SP 7 The student is able to connect and relate knowledge across various scales, concepts, And representations in and across domains
2.A.3..a..3 Living systems depend on properties of water that result from its polarity and hydrogen bonding
Cohesion

Image from: http://i.stack.imgur.com/sucSu.jpg

One type of question you may encounter on the AP Exam asks you to interpret a graph. What is happening to water molecules between points A-B and C-D on this graph.



Adding energy increases the kinetic energy of the molecules and the temperature of the H_2O molecules increases.

What is happening between points B-C and D-E?

At these points on the graph, water is changing phase (solid → liquid/liquid →gas) and adding energy increases the kinetic energy of the molecules but the temperature of the H_2O molecules stays the same until enough molecules have the energy to change phase.

SP 7 The student is able to connect and relate knowledge across various scales, concepts, And representations in and across domains
2.A.3..a..3 Living systems depend on properties of water that result from its polarity and hydrogen bonding
Cohesion
- **High specific heat capacity**
- **Heat of vaporization**
- **Heat of fusion**

Image from: http://fusedglass.org/imgs/02_surface_tension.jpg

The amount of heat that must be absorbed or lost for 1 g of a substance to change its temperature by 1° C = Specific heat

Compared to other substances water has a very HIGH specific heat due to HYDROGEN bonding.

LOW HIGH

Give an example of how this impacts life on Earth.

Moderates climate: Large bodies of water absorb and store heat from sun in day/summer and return it to environment at night/winter. Keeps temps on land/water within range that supports life.

Bodies of living things mainly water; resist changes in body temp

SP 7 The student is able to connect and relate knowledge across various scales, concepts, And representations in and across domains
2.A.3..a..3 Living systems depend on properties of water that result from its polarity and hydrogen bonding
High specific heat capacity
•Water's thermal conductivity

Image from: http://image.shutterstock.com/z/stock-vector-sweating-cartoon-man-dying-of-heat-and-using-a-mini-fan-120823501.jpg
http://citadel.sjfc.edu/students/kmd06085/e-port/msti260/transpiration.gif

Water molecules must absorb energy from the environment in order to change phase from liquid to gas during evaporative cooling

absorb energy from release energy to

Body heat provides this energy.
(It's the reason why sweating when its hot cools you off)

The evaporation of water (transpiration) from the surface of leaves helps keep the tissues cooler

warmer cooler

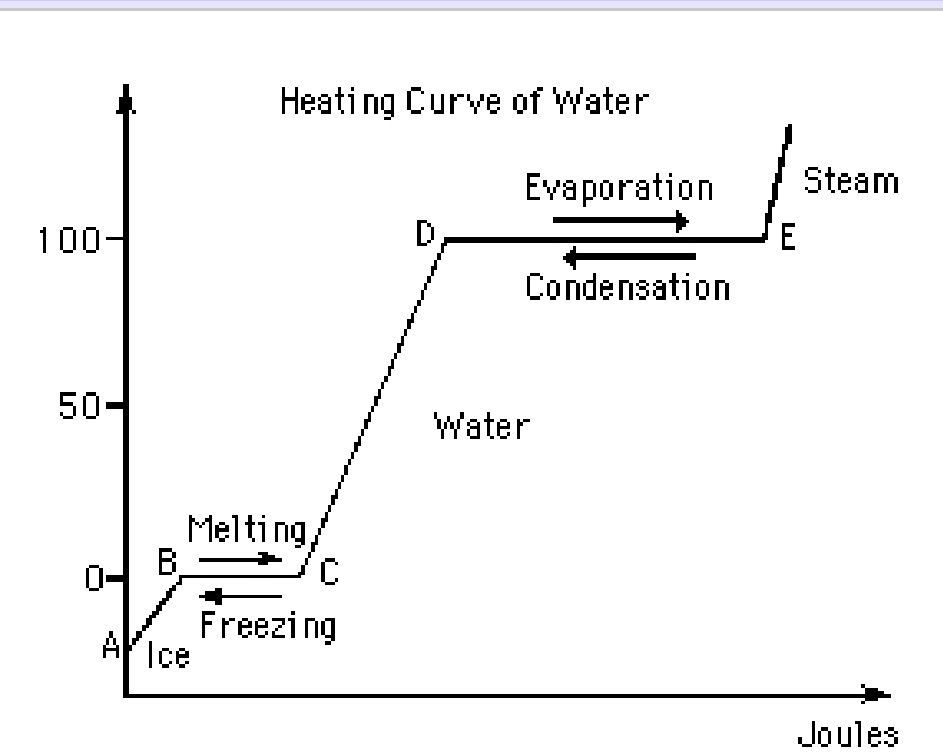
SP 7 The student is able to connect and relate knowledge across various scales, concepts, And representations in and across domains
2.A.3..a..3 Living systems depend on properties of water that result from its polarity and hydrogen bonding
High specific heat capacity
•Heat of vaporization

Image from: http://i.stack.imgur.com/sucSu.jpg

In the graph shown, the line between points D-E doesn't increase even though energy is added because water has a _____ heat of vaporization

HIGH

low high



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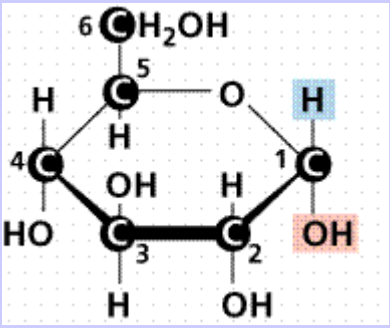
2.A.3..a..3 Living systems depend on properties of water that result from its polarity and hydrogen bonding
Cohesion
- **High specific heat capacity**
- **Heat of vaporization**
- **Heat of fusion**

http://www.thisisitstores.co.uk/media/catalog/product/4/4/442916_1.jpg
http://www.clipartkid.com/images/648/water-drop-images-cliparts-co-aCb6i1-clipart.png

Monosaccharides (simple sugars) all have the same 1C:2H:1O ratio.
EX: Glucose = $C_6H_{12}O_6$ and Ribose = $C_5H_{10}O_5$



DISSACHARIDES like lactose and sucrose vary a little from this ratio. EX: Sucrose = $C_{12}H_{22}O_{11}$

Use what you learned about chemical reactions that join molecules and the numbers of sugar molecules found in different kinds of carbohydrates to explain why disaccharides seem to have a "few atoms missing".

SP 5.1 The student can analyze data to identify patterns or relationships

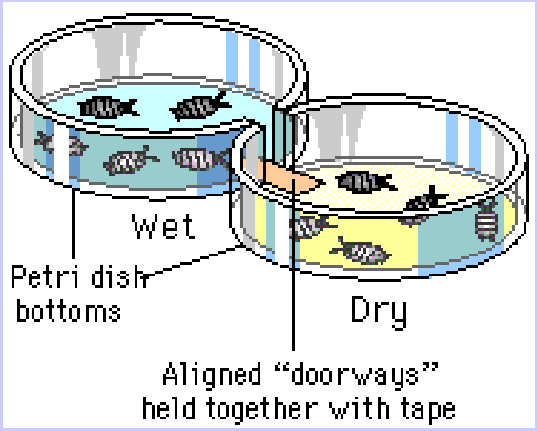
http://www.thisisitstores.co.uk/media/catalog/product/4/4/442916_1.jpg
http://www.clipartkid.com/images/648/water-drop-images-cliparts-co-aCb6i1-clipart.png

Dehydration synthesis joins monosaccharides to make disaccharides by removing a water molecule (H_2O)

For 1C:2H:1O expect $C_{12}H_{24}O_{12}$
but Sucrose = $C_{12}H_{22}O_{11}$

Missing atoms (2 H's and 1 O) are lost as water during dehydration synthesis

SP 5.1 The student can analyze data to identify patterns or relationships



http://www.phschool.com/science/biology_place/labbench/lab11/images/setup.gif

An AP Biology student set up the pillbug choice chambers in an experiment similar to the one you designed in class.

Data was collected and analyzed using Chi-square analysis.

Chi-Square Table

p value	Degrees of Freedom							
	1	2	3	4	5	6	7	8
0.05	3.84	5.99	7.82	9.49	11.07	12.59	14.07	15.51
0.01	6.64	9.21	11.34	13.28	15.09	16.81	18.48	20.09

How many degrees of freedom are there in this experiment? 1 (2 choices – 1)

What conclusion can you draw from a calculated $X^2 = 6.85$? EXPLAIN your answer.

6.85 > 3.84 (use 0.05 row and 1 df)

REJECT the null hypothesis that there is
"no difference between observed and expected outcomes".

There is a difference. Pillbugs appear to prefer one side over the other

SP 2:The student can use mathematics appropriately
SP 5:The student can perform data analysis and evaluation of evidence

https://c2.staticflickr.com/8/7120/6904687426_4f5d9edaab_z.jpg
http://www.biologyjunction.com/images/earthw1.jpg

The study of biology encompasses a vast amount of info. On the AP Exam you should be prepared to encounter questions over info we have not covered in class. One type of question will give you a short paragraph like this to read and then ask you to interpret an observation, apply what you know to a new situation, or make a prediction.

You may encounter vocab words you are not familiar with. Because many science words/names have their origins in Latin, you can often decode the meaning of an unfamiliar word by becoming familiar with Latin prefixes/suffixes.

Many different kinds of carbs are built by joining monosaccharide subunits and are group/named accordingly. Two sugar carbs are disaccharides; oligosaccharides contain a few/some sugars; polysaccharides have many sugars.

Segmented worms are classified based on the number of bristles on their bodies.
(Remember Kingdom, Phylum, Class . . . From Honors Bio?)
Worms with "many bristles" are in the CLASS: Polychaeta.

Make a prediction about what the class name is for worms (like earthworms) with just "a few/some bristles"

OLIGOchaeta

SP 5.1 The student can analyze data to identify patterns or relationships
SP.7 The student is able to connect and relate knowledge across various scales, concepts, and representations in and across domains.

Animation from:
http://static1.squarespace.com/static/538a9498e4b021e5d49572ab/t/55adc34be4b039eb798658ce/1437451121085/Hand-Writing-The-End-84758.gif?format=1000w