Chem 106: Class/ Lab
Week 14

Sign Roster

Pick up papers & Amino Acids Handout

Global Warming

Organic Functions → Proteins & DNA

Cooking an Egg

Chem 106: Class/ Lab
Week 14

http://chemconnections.org/general/chem106/Tech%20Prep/Protein%20Activity%20I-2016.html

TODAY's Experiment

Amino Acids & Proteins (egg albumin) Course/ Lab Manual pp. 97-98; (pg. 97 Stamped Today)

Completed pp. 97-98 Due Next Week

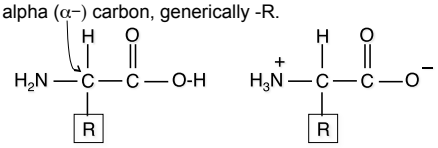
Chem 106: Class/ Lab
Week 14

Organic Molecules
Amino Acids (small molecules) –
Proteins (large: "macro" molecules)

A base + an acid in the same molecule?

Amino Acids

- More than 700 amino acids occur naturally, but **20** of them are **particularly important.**
- These 20 amino acids are the **building blocks of proteins** in humans and other organisms
- They differ in respect to the group attached to the alpha (α−) carbon, generically -R.

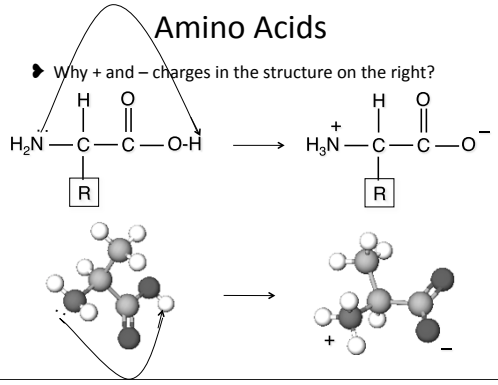


- Why + and – charges in the structure on the right?

A base + an acid in the same molecule?

Amino Acids

- Why + and – charges in the structure on the right?

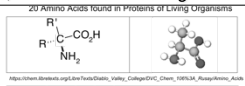


Amino Acids

https://chem.libretexts.org/LibreTexts/Diablo_Valley_College/DVC_Chem_106%3A_Rusay/Amino_Acids

- Our bodies can synthesize about 10 amino acids.
- "Essential" amino acids are the other 10 amino acids, which have to be ingested in our diet.

20 Amino Acids found in Proteins of Living Organisms



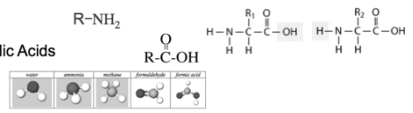
https://chem.libretexts.org/LibreTexts/Diablo_Valley_College/DVC_Chem_106%3A_Rusay/Amino_Acids

Name	1	II	R-	R' -	Reagent Color	Function & Class
Alanine	Ala	A	H-	CH_3-	dark gray	Aliphatic Hydrophobic
Arginine	Arg	R	H-	$-CH_2CH_2CH_2NHC(NH_2)NH_2$	blue	Basic Hydrophilic
Asparagine	Asn	N	H-	$-CH_2CNH_2$ (O)	cyan	Amide Highly Hydrophilic
Aspartate	Asp	D	H-	$-CH_2COH$ (O)	bright red	Acidic Hydrophilic
Cysteine	Cys	C	H-	$-CH_2SH$	yellow	Sulphur Containing Hydrophobic
Glutamine	Gln	Q	H-	$-CH_2CH_2CNH_2$ (O)	cyan	Amide Highly Hydrophilic
Glutamate	Glu	E	H-	$-CH_2CH_2COH$ (O)	bright red	Acidic Hydrophilic

Amino acids: two functions, an acid & a base, in the same mol

Amines $R{-}NH_2$

Carboxylic Acids $R\text{-}\overset{O}{\overset{\|}{C}}\text{-}OH$

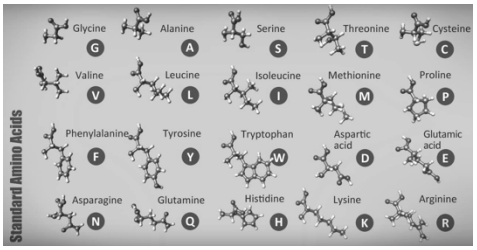


	Alcohol	R−OH
	Ether	R−O−R′
X	Amine	$R{-}NH_2$
	Aldehyde	$R\text{-}\overset{O}{\overset{\|}{C}}\text{-}H$
	Ketone	$R\text{-}\overset{O}{\overset{\|}{C}}\text{-}R'$
X	Carboxylic Acid	$R\text{-}\overset{O}{\overset{\|}{C}}\text{-}OH$
	Ester	$R\text{-}\overset{O}{\overset{\|}{C}}\text{-}OR'$
	Amide	$R\text{-}\overset{O}{\overset{\|}{C}}\text{-}\overset{R''}{\underset{R'}{N}}$

Amino Acids

"Legos" of Chemical Biology

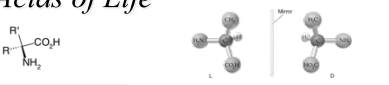
All amino acids contain C, H, O, and N; two, C & M also have sulfur.



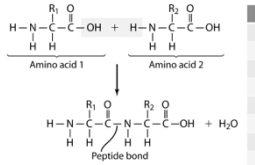
http://chem.libretexts.org/LibreTexts/Diablo_Valley_College/DVC_Chem_106%3A_Rusay/Amino_Acids

20 Amino Acids of Life

chiral: mirror images

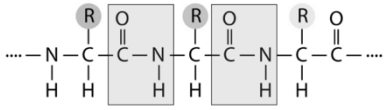


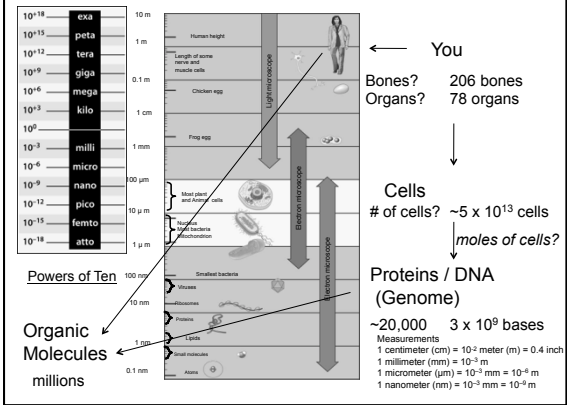
Name	I	H	R-	R'	Rasmol Color	Function & Class
Alanine	Ala	A	H-	$-CH_3$	dark gray	Aliphatic Hydrophobic
Arginine	Arg	R	H-	$-(CH_2)_3NHC(NH_2)NH$	blue	Basic Hydrophilic
Asparagine	Asn	N	H-	$-CH_2CONH_2$	cyan	Amide Highly Hydrophilic
Aspartate	Asp	D	H-	$-CH_2COH$	bright red	Acidic Hydrophilic
Cysteine	Cys	C	H-	$-CH_2SH$	yellow	Sulphur Containing Hydrophobic
Glutamine	Gln	Q	H-	$-CH_2CH_2CONH_2$	cyan	Amide Highly Hydrophilic
Glutamate	Glu	E	H-	$-CH_2CH_2COH$	bright red	Acidic Hydrophilic
Glycine	Gly	G	H-	H-	light gray	Aliphatic Hydrophobic
Histidine	His	H	H-	$-CH_2$	pale blue	Basic Hydrophilic
Isoleucine	Ile	I	H-	$-CH(CH_3)CH_2CH_3$	green	Aliphatic Hydrophobic
Leucine	Leu	L	H-	$-CH_2CH(CH_3)_2$	green	Aliphatic Hydrophobic
Lysine	Lys	K	H-	$-(CH_2)_4NH_2$	blue	Basic Hydrophilic
Methionine	Met	M	H-	$-CH_2CH_2SCH_3$	yellow	Sulphur Containing Hydrophobic
Phenyl-alanine	Phe	F	H-	$-CH_2$	mid blue	Aromatic Hydrophobic
Proline	Pro	P	-		flesh	Aliphatic Hydrophobic
Serine	Ser	S	H-	$-CH_2OH$	orange	Hydroxylic Hydrophobic
Threonine	Thr	T	H-	$-CHOHCH_3$	orange	Hydroxylic Hydrophobic
Tryptophan	Trp	W	H-	$-CH_2$	pink	Aromatic Hydrophobic
Tyrosine	Tyr	Y	H-	$-CH_2$	mid blue	Aromatic Hydrophobic
Valine	Val	V	H-	$-CH(CH_3)_2$	green	Aliphatic Hydrophobic



(Amide bond)

	Alcohol	R−OH
	Ether	R−O−R′
X	Amine	$R{-}NH_2$
	Aldehyde	$R\text{-}\overset{O}{\overset{\|}{C}}\text{-}H$
	Ketone	$R\text{-}\overset{O}{\overset{\|}{C}}\text{-}R'$
X	Carboxylic Acid	$R\text{-}\overset{O}{\overset{\|}{C}}\text{-}OH$
	Ester	$R\text{-}\overset{O}{\overset{\|}{C}}\text{-}OR'$
X	Amide	$R\text{-}\overset{O}{\overset{\|}{C}}\text{-}\overset{R''}{\underset{R'}{N}}$





You

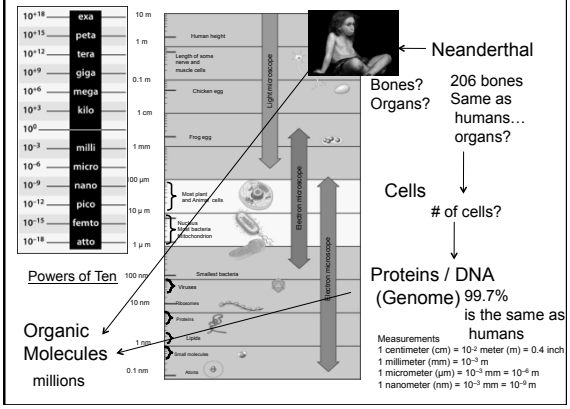
Bones? 206 bones
Organs? 78 organs

Cells
# of cells? ~5 x 10^{13} cells

moles of cells?

Proteins / DNA (Genome)
~20,000 3 x 10^9 bases

Measurements
1 centimeter (cm) = 10^{-2} meter (m) = 0.4 inch
1 millimeter (mm) = 10^{-3} m
1 micrometer (μm) = 10^{-3} mm = 10^{-6} m
1 nanometer (nm) = 10^{-3} mm = 10^{-9} m



Neanderthal

Bones? 206 bones
Organs? Same as humans… organs?

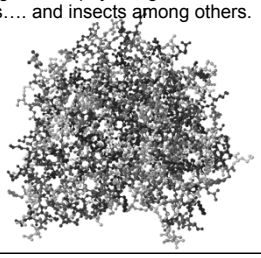
Cells
# of cells?

Proteins / DNA (Genome) 99.7% is the same as humans

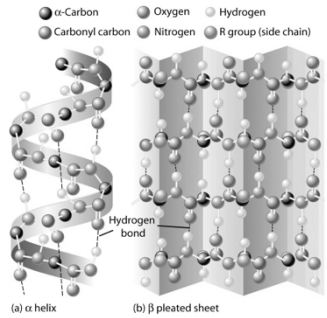
Measurements
1 centimeter (cm) = 10^{-2} meter (m) = 0.4 inch
1 millimeter (mm) = 10^{-3} m
1 micrometer (μm) = 10^{-3} mm = 10^{-6} m
1 nanometer (nm) = 10^{-3} mm = 10^{-9} m

Proteins: Macromolecular Biopolymers
Acetylcholinesterase (ACE)

ACE, an enzyme, which catalyzes a key reaction in a repetitive biochemical cycle that is crucial to neurological and physiological functions in humans…. and insects among others.

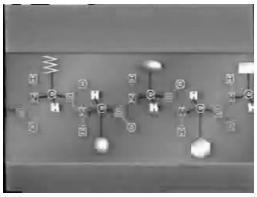


4,496 atoms;
4,404 bonds
574 amino acid residues



http://chemconnections.org/general/movies/HydrogenBonding.MOV

Hair: α-Helix
Annenberg World of Chemistry
#23 Proteins : *http://www.learner.org/resources/series61.html*

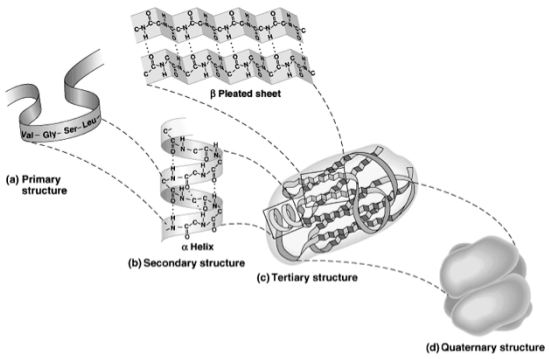


http://chemconnections.org/general/movies/protein-hair-2.mov

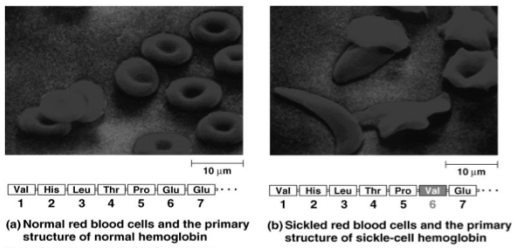
Silk: β-Sheets

http://chemconnections.org/general/movies/proteins-silk-2.mov

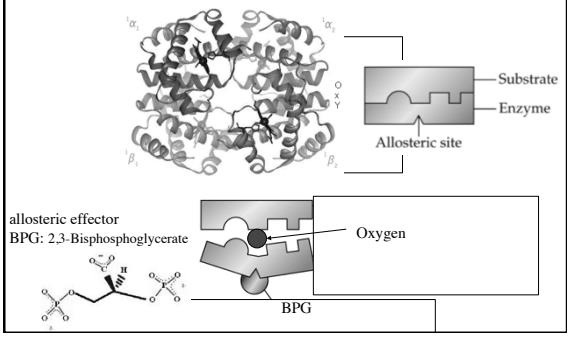
Summary



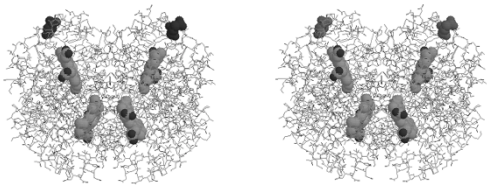
https://www.youtube.com/watch?v=GVU_zANtroE&feature=em-subs_digest



Hemoglobin and Oxygen Transport
An allosteric effect & sickle cell anemia



Normal hemoglobin vs sickle cell hemoglobin



Valine replaces Glutamate

http://chemconnections.org/Presentations/Columbia/slide8-3.html

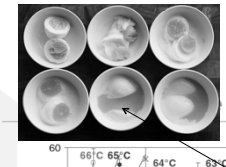
Firefox to listen

Albumin: Egg White Protein

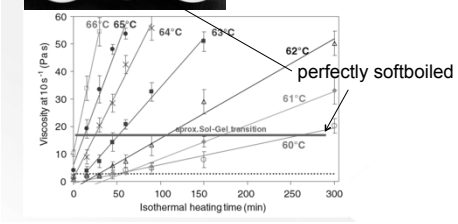
Molar Mass: 65,000-70,000 grams / mole

Cooking egg white with and without heat; changing the protein's shape.

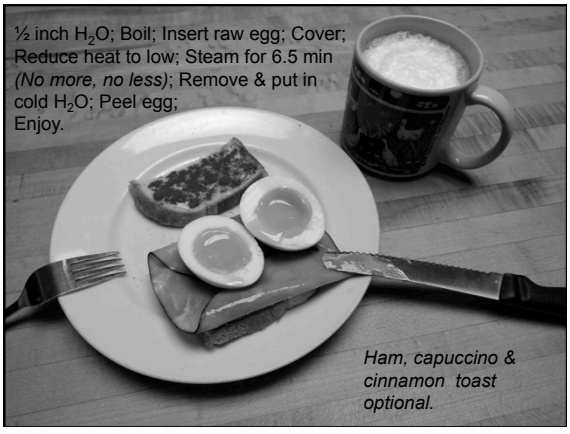
http://chemconnections.org/general/chem106/Tech%20Prep/Protein%20Activity%20I-2016.html



Cooking the perfect egg: denaturing albumin



http://chemconnections.org/general/chem106/Tech%20Prep/Protein%20Activity%20I-2016.html



Chem 106: Class/ Lab

Week 14

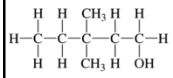
Organic Molecules

Functional Groups

Amino Acids - Proteins

Organic Formulas: Kekulé / Condensed / Bond-Line Structures / Drawings

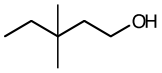
Molecular formula: $C_7H_{16}O$



Empirical Formula: $C_7H_{16}O$

$CH_3CH_2C(CH_3)_2CH_2CH_2OH$ or $CH_3CH_2\underset{CH_3}{\underset{|}{C}}HCH_2CH_2OH$

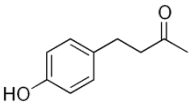
Bond-Line Structure:

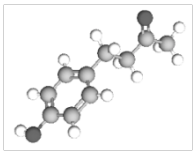


QUESTION

A compound that smells like fresh raspberries, the following structure, $C_?H_?O_?$, matches its calculated molar mass which is 164 g/mol.

A) TRUE
B) FALSE

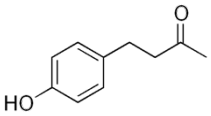


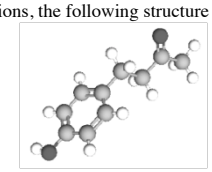


ANSWER

Based on your answers for the compound, which smells like fresh raspberries, in the previous two questions, the following structure matches its molecular formula.

A) TRUE
B) FALSE

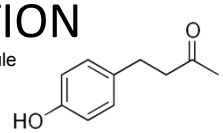




$164\ g/mol = C_{10}H_{12}O_2$

QUESTION

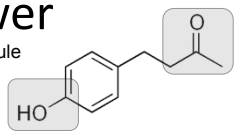
Select the function(s) in the molecule



	Alcohol	R−OH
	Ether	R−O−R′
	Amine	$R-NH_2$
	Aldehyde	R-C(=O)-H
	Ketone	R-C(=O)-R′
	Carboxylic Acid	R-C(=O)-OH
	Ester	R-C(=O)-OR′
	Amide	R-C(=O)-N(R″)R′

Answer

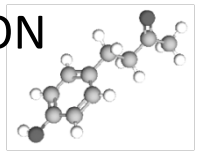
Select the function(s) in the molecule

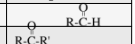
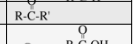
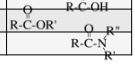


X	Alcohol	R−OH
	Ether	R−O−R′
	Amine	$R-NH_2$
	Aldehyde	R-C(=O)-H
X	Ketone	R-C(=O)-R′
	Carboxylic Acid	R-C(=O)-OH
	Ester	R-C(=O)-OR′
	Amide	R-C(=O)-N(R″)R′

QUESTION

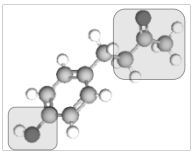
Select the function(s) in the molecule

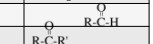
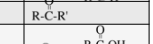
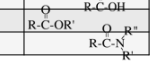


	Alcohol	R−OH
	Ether	R−O−R′
	Amine	$R-NH_2$
	Aldehyde	
	Ketone	
	Carboxylic Acid	
	Ester	
	Amide	

Answer

Select the function(s) in the molecule



X	Alcohol	R−OH
	Ether	R−O−R′
	Amine	$R-NH_2$
	Aldehyde	
X	Ketone	
	Carboxylic Acid	
	Ester	
	Amide	

Chem 106: Class/ Lab

Week 14

Do Today:

Amino Acids & Proteins (egg albumin)
Course/ Lab Manual pp. 97-98; (pg. 97 Stamped Today)

Completed pp. 97-98 Due Next Week

http://chemconnections.org/general/chem106/Tech%20Prep/Protein%20Activity%20I-2016.html

DNA / RNA: Proteins

Macromolecular Biopolymers

https://unlockinglifescode.org/