Chem 106: Class
Week 15

- Sign in Roster @ front of lab
- Pick up papers, Handouts & Sugar Wordsearch

- Global Warming Assignment

Chem 106 Capstone
Research & Writing Assignment

http://chemconnections.org/Global%20Warming/Global%20warming%20&%20Carbon%20Footprint.pdf

Global Warming, Your Carbon Footprint & Your Future

INTERGOVERNMENTAL PANEL ON climate change

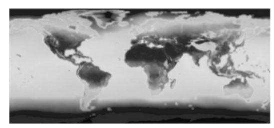
http://chemconnections.org/Global%20Warming/

ARC Groups with the designation (M1…. etc.) noted on today's roster next to your name are active

ARC Group designations

Chem 106: Chemistry for Non-Science Majors		
Sec. 2273		
	6-Nov	
Akli, Anissa E.		2
Cornelius, Evan K.		3
Dawson, Randell W.		5
Edwards, Aaron C.		2
Felt, Emma E.		5
Gudzikowski, Nikolas K.		1
House, Lilly M.		1
Hsu, Wensha		3
Jang, Junyeong		3
Jeha, Colton D.		4
Kim, Gyuntae		3
Lazaro Dolores, Alonso		4
Medina, Hector E.		4
Persson, Grant D.		3
Price, Josh		3
Strachan, Chelsea M.		3
Strohl, Trevor J.		2
Tawfik, Adel W.		4
Truong, Anh H.		1
Van Warmerdam, Katrina J.		1
Villena, Justin P.		4
Yllescas, Oscar E.		2
Zhang, Teng-Dyrus		2
Zhang, Zhijian-Kevin		

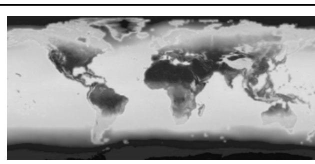
Chem 106: Class/ Lab
Week 15



Global Warming & Your Carbon Footprint

http://chemconnections.org/Global Warming/Global warming & Carbon Footprint.pdf

http://chemconnections.org/Global Warming/



https://chem.libretexts.org/LibreTexts/Diablo_Valley_College/DVC_Chem_106%3A_Rusay/Vocabulary_III#global%25252Bwarming

ChemWiki / Libretext login & password required to complete & submit writing

Global Warming, Your Carbon Footprint & Your Future

Capstone Writing Project

http://chemconnections.org/Global%20Warming/

Chem 106
Week 15

Functional Groups Continued:

Amino acids-Enzymes

Carbohydrates

(sugars)

Synthesis of Aspirin

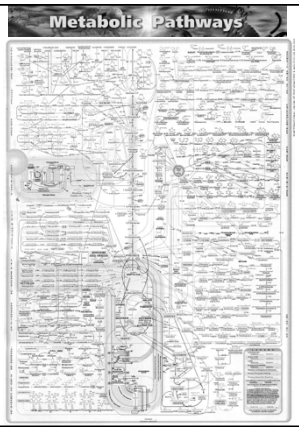
Chemical Biology

Globular Proteins / Enzymes

Metabolism

Human Metabolism

Defined by enzymes: globular proteins that catalyze all reactions & processes in human chemical biology



Digestion

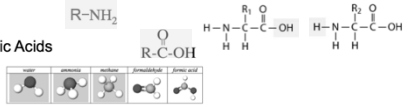
Globular Proteins / Enzymes

Trypsin / α-Galactosidase / Invertase / Sucrase

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

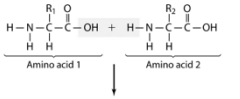
Amines $R{-}NH_2$

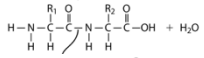
Carboxylic Acids $R{-}\overset{O}{\overset{\|}{C}}{-}OH$



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

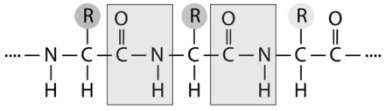
(Amide bond = Peptide bond)





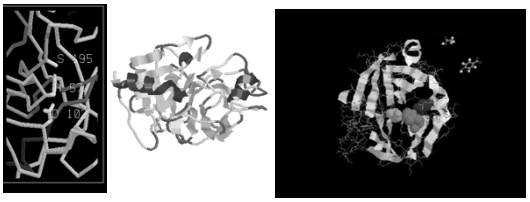
Amides $R{-}\overset{O}{\overset{\|}{C}}{-}N\begin{matrix}R''\\R'\end{matrix}$

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



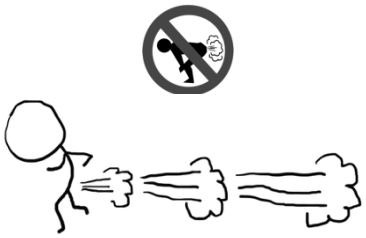
Digestion

Trypsin: Hydrolysis



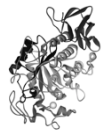
Trypsin, which catalyzes the digestion of proteins through hydrolysis, works in a similar way to acetylcholinesterase, but in breaking down other proteins instead of small molecules, acetylcholine - choline.

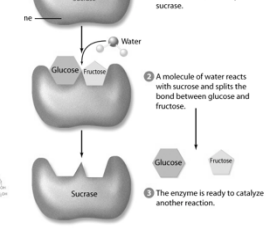
Biproduct of Digestion

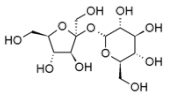


Digestion / Hydrolysis

α-*Galactosidase/ Invertase/ Sucrase*







β-Fructose
α-Glucose

Organic Molecules
Functional Groups

alcohols, ethers, aldehydes, ketones

Carbohydrates / Saccharides / Sugars

Name: _____

Sugar Wordsearch

Terry L. Helser
Department of Chemistry, SUNY College at Oneonta, Oneonta, NY 13820-4015; helsertl@oneonta.edu

This puzzle contains 29 names, terms, prefixes, and acronyms that describe sugars and their polymers. Find and highlight these terms in the matrix below. "CARBOHYDRATE" is already done for you. Then, correctly transfer them to the blanks in the description below the matrix. Use the letters remaining in the matrix to complete the sentence describing these molecules. Your success will be rewarded. The answers to the Sugar Wordsearch are found below. Good hunting!

N I E T O R P O C Y L G S U
N I T I H C G L U C O S E G
K E T O S E S S E S O D L A
E A G C H E X O S E I P E R
S S L S E S O B I R A Y S S
O U Y T M P A N A M K R O N
T G C A R B O H Y D R A T E
C A O R E N C L L I F N C G
A R L C O C O E Y S W U O
L N I H A S E L P M I S R C
A A P S E R E M O N A S F Y
G N I C U D E R E T S E E L
E D D C E L L U L O S E T G

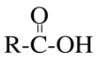
CARBOHYDRATEs can be S_____, S_____, S_____s that are either A_____ or K_____ and are therefore R_____ sugars. Table sugar, S_____, is a D_____ of the H_____s F_____ and G_____ in cyclic furanose and P_____ forms, respectively. L_____ is glucose linked to G_____. Plants store energy in the ____saccharide S_____, which contains A_____ and A_____. The animal equivalent is G_____. The only ____mer to them is the alpha A_____ of glucose. Beta-linked glucose or *N*-acetylglucosamine makes C_____ or C_____, respectively. Both are structural polymers. Complex molecules like G_____s and _____P_____s have sugars attached. Finally, phosphoS_____ bonds link R_____ units in the backbone of ____. Converting the pentose into the deoxy form produces a ___ strand.

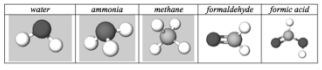
Use the remaining letters to fill in the following sentence: _____ _____ _____ _____.

Wordsearch Due Next Week

Sugars (Carbohydrates)

Common Functional Groups

Name	General Formula
Alcohols	R–OH
Ethers	R–O–R′
Amines	R–NH_2
Carboxylic Acids	



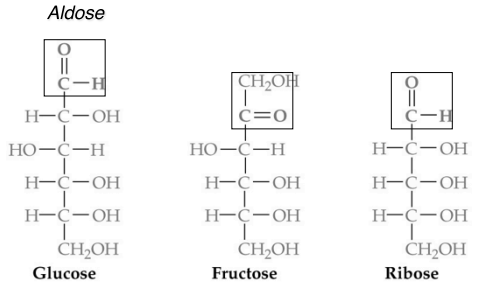
Sugars (Carbohydrates)

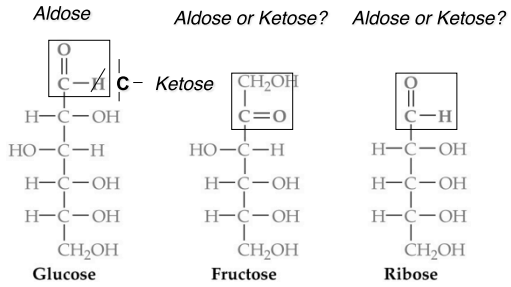
Common Functional Groups

Name	General Formula
Aldehydes	
Ketones	
Carboxylic Acids	
Esters	
Amides	

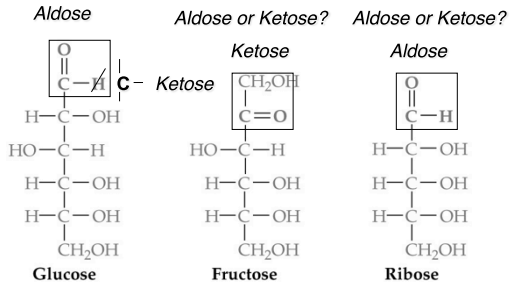
Carbohydrate (-ose) Formation

- The chemical reaction of light, chlorophyll and two greenhouse gases, which also provide oxygen:
  - $n\ CO_2 + n\ H_2O \longrightarrow C_n(H_2O)_n + n\ O_2$
- Empirical formula = CH_2O
- Monosaccharides (simple sugars)
- C_5 : pent-oses – *rib-ose*
- C_6 : hex-oses – *fruct-ose, gluc-ose*
  - Can be either an ald-ose (aldehyde + alcohols) or ket-ose (ketone + alcohols)



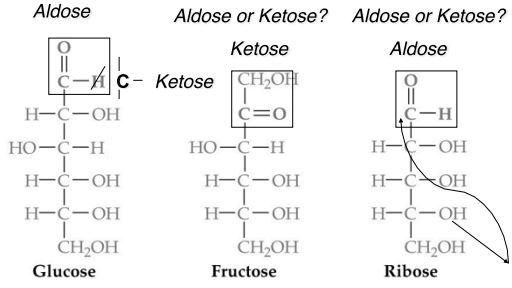


Chirality & Carbon Atoms



There are 2^n possible stereoisomers, where n = the number of chiral atoms. Glucose? Fructose? Ribose?

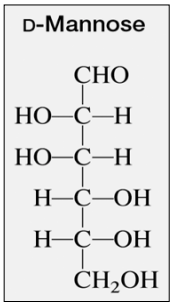
Chirality & Carbon Atoms



There are 2^n possible stereoisomers, where n = the number of chiral atoms. Glucose? 16 Fructose? 8 Ribose? 8

And +1: Cyclization

QUESTION



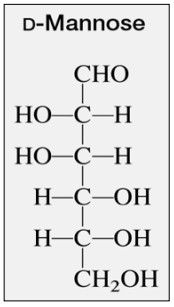
The monosaccharide mannose has how many chiral carbon centers?

A. None
B. Two
C. Four
D. Six

ANSWER

C. there are four chiral carbons in one molecule of mannose. Carbon one and carbon six do not satisfy the basic requirement of having four different attachments to the carbon. Carbon atoms two through four have four different attachments in a tetrahedral shape.

QUESTION

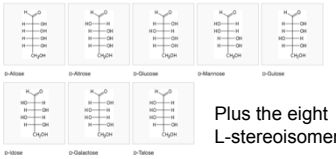


The monosaccharide mannose has how many stereoisomers?

A. four
B. six
C. eight
D. sixteen
E. thirty two

ANSWER

D. There are 2^n possible stereoisomers where n = the number of chiral atoms.
Mannose is one of 16 possible stereoisomers (2^4)
Each is a unique sugar (monosaccharide)….. With its own name.



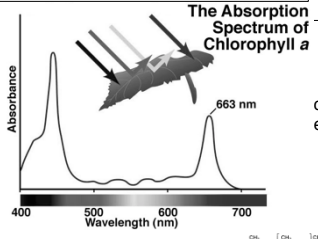
Plus the eight L-stereoisomers

https://ssec.si.edu/stemvisions-blog/what-photosynthesis

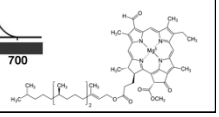
Photosynthesis

Energy Capture → Carbohydrates (Sugars)

$n\ CO_2(g) + n\ H_2O(g) + \text{energy} \xrightarrow{\text{Chlorophyll a}} \textbf{CARBOHYDRATES}$

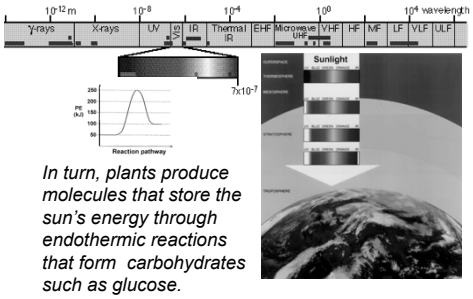


a complex collection of enzymes with:



Artificially possible?

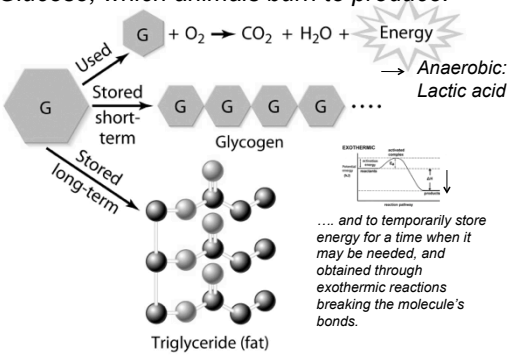
Plants absorb energy; i.e., visible light.



In turn, plants produce molecules that store the sun's energy through endothermic reactions that form carbohydrates such as glucose.

http://chemistry.beloit.edu/Stars/EMSpectrum/index.html

Glucose, which animals burn to produce:



…. and to temporarily store energy for a time when it may be needed, and obtained through exothermic reactions breaking the molecule's bonds.

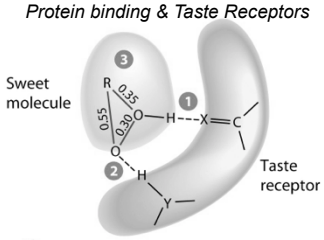
Different Raw & Refined Sugars (Carbohydrates)

Rum

Historical Significance & the 1791 British Sugar Boycott

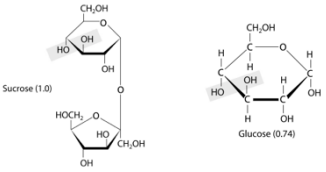
British Abolition of the Slave Trade Act in 1807

Protein binding & Taste Receptors

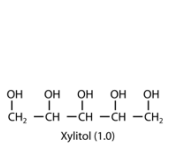


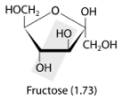
- *Sweet*
- *Sour*
- *Bitter*
- *Salty*
- *Umami*

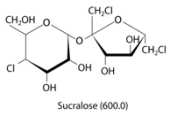
1. —H in OH group on sweet molecule forms hydrogen bond with X— on receptor.
2. O— on sweet molecule forms hydrogen bond with H— in HY group on receptor.
3. Hydrophobic area behind O— atoms on sweet molecule.



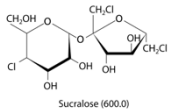
Sweetness factor = 1.0 Sweetness factor = 0.74



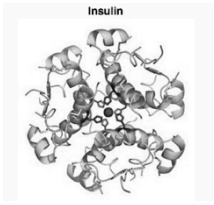




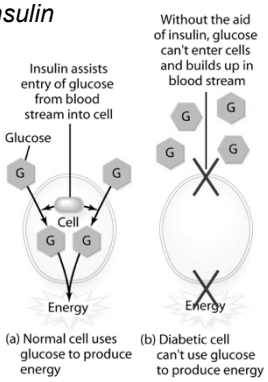
Relative Sweetness Scale - Sucrose = 1	
Compound	Rating
Saccharin	300 X
Cyclamate	30 X
Aspartame	180 X
Acesulfame	200 X
Sucralose	600 X



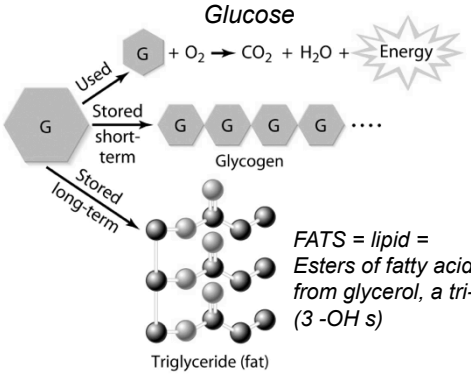
Sugars/Glucose & Insulin



Zinc is @ the center



Glucose

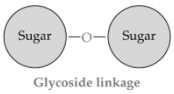


FATS = lipid = Esters of fatty acids from glycerol, a tri-ol (3 -OH s)

Carbohydrates

Prof. Carolyn Bertozzi: https://www.youtube.com/watch?v=VBwNMR3C0Ys&feature=PlayList&p=10F61E434B646DE1&index=1%20

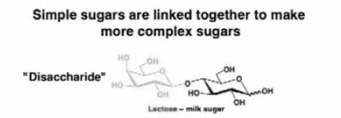
- Disaccharides
  - (2 cyclic monosaccharides joined by a "glycoside" linkage α-alpha or β-beta [ether]
- e.g. (glucose + fructose) ⟶sucrose



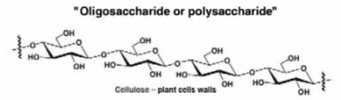
Glycoside linkage

- Polysaccharides
  - (many linked monosaccharide units)
- e.g. starch (α-alpha), cellulose (β-beta)

Disaccharide & Polysaccharide

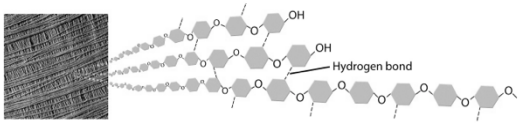


Why are there relatively few dairy farms in Asia?



Do you eat starch? ..easily digested α-linkages
…tree bark (fiber)? .. Non digestible β-linkages
Do they smell and taste appetizing?

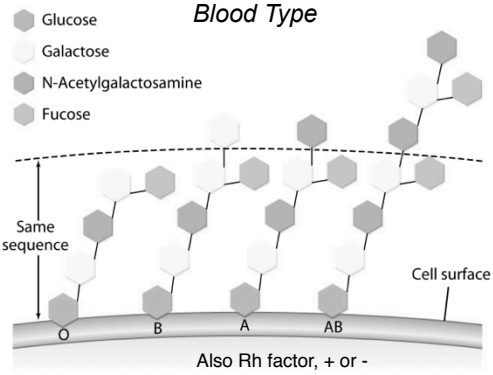
- *Humans cannot digest cellulose, only alpha (α)-sugars, not (β)- beta.*
- *Goats and termites can digest (β)- beta sugars using enzymes humans do not have*



(a) Cellulose fibrils in a plant cell wall

(b) Structure of cellulose in a fibril

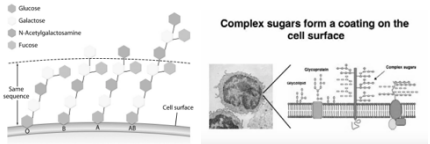
Blood Type



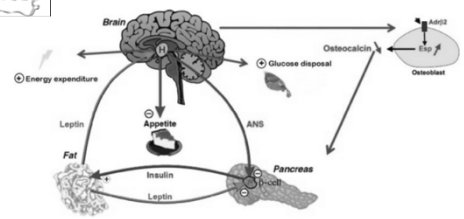
Also Rh factor, + or -

Blood Histocompatibility

http://anthro.palomar.edu/blood/Rh_system.htm



Leptin & Ghrelin: Glucose, Fat, Appetite & Weight



http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3602983/figure/F2/

https://www.ncbi.nlm.nih.gov/pubmed/17212793

http://www.nytimes.com/2016/05/02/health/biggest-loser-weight-loss.html?rref=collection%2Fsectioncollection%2Fscience&action=click&contentCollection=science&region=rank&module=package&version=highlights&contentPlacement=1&pgtype=sectionfront&_r=0

Procedure

This procedure must be carried out in the fume hood. Acetic anhydride is an irritant and sulfuric acid is very corrosive.

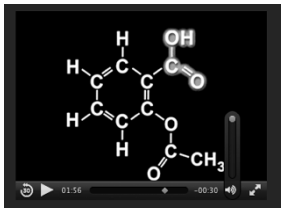
Record the mass of approximately 6.0 g of salicylic acid in a clean, dry 125 mL erlenmeyer flask. **In the fume hood** add 8 mL of acetic anhydride to the flask and then slowly add 10 drops of concentrated sulfuric acid. Clamp the flask in a beaker of warm water and a boiling chip or two to a ring stand. Heat the Erlenmeyer flask in the warm water bath with occasional stirring for 15 minutes. If solid remains, heat it for an additional 15 minutes. Remove the flask and slowly add 20 drops of deionized water to consume the excess acetic anhydride. Add about 20 mL of ice-cold deionized water and cool the flask in an ice bath for 15 minutes to be complete. (Hint: slow rubbing of the bottom of the flask with a stirring rod sometimes speeds up crystallization.) Assemble a Büchner funnel and filter the crystals by vacuum filtration. (Your instructor will demonstrate how to do vacuum filtration.) If you wish to rinse the residue from the flask into the funnel, you may either use the filtrate (the solution in the filter flask) or a small amount of ice-cold deionized water. The filtrate may be disposed of in the hood sink.

The aspirin may be further purified by recrystallization. Dissolve the aspirin in about 20 mL of ethyl alcohol, and warm the mixture slightly by placing it in a beaker of water which has been heated. **DO NOT GET ETHYL ALCOHOL ANYWHERE NEAR A FLAME–HIGHLY FLAMMABLE!!** Stir to dissolve it completely, and then add 50 mL of warm (70°C) deionized water. Cool the mixture in an ice bath until recrystallization is complete. Vacuum filter the product and allow it to dry on the filter paper until the next lab period. The filtrate may be disposed of in the sink. When your aspirin is dry, put it in a weighed plastic vial and weigh it again. Record the mass. Calculate the percent yield.

Solid aspirin should be disposed in the organic solid waste.

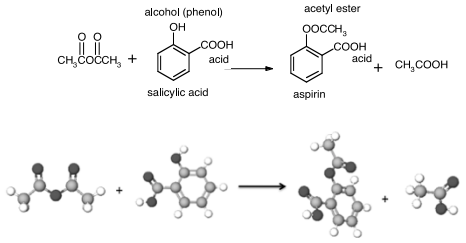
Chem 106
Synthesis of Aspirin
(Handouts)

Representing Organic Molecules
Aspirin



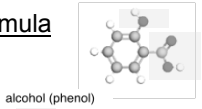
http://chemconnections.org/general/movies/Representations.MOV

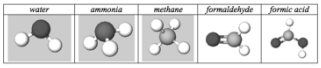
Chem 106
Synthesis of Aspirin
(Handouts)



Salicylic Acid
Common Functional Groups

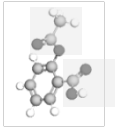
Name	General Formula
Alcohols	R–OH
Ethers	R–O–R′
Amines	$R–NH_2$
Carboxylic Acids	R-C(=O)-OH

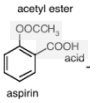




Aspirin
Common Functional Groups

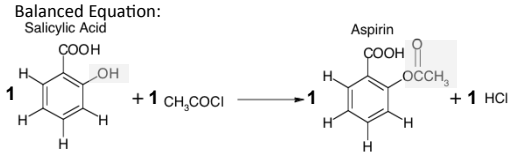
Name	General Formula
Aldehydes	R-C(=O)-H
Ketones	R-C(=O)-R′
Carboxylic Acids	R-C(=O)-OH
Esters	R-C(=O)-OR′
Amides	R-C(=O)-N(R″)R′





Mass Calculations: Reactants ⟷ Products

- How many grams of aspirin are theoretically produced from 6.0 g of salicylic acid with an excess of acetyl chloride, C_2H_3OCl?
- Balanced Equation:



$C_7H_6O_3$	C_2H_3OCl	$C_9H_8O_4$	HCl
MW = 138.12	MW = 78.49	MW = 180.15	MW= 36.45

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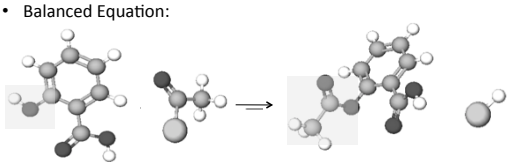

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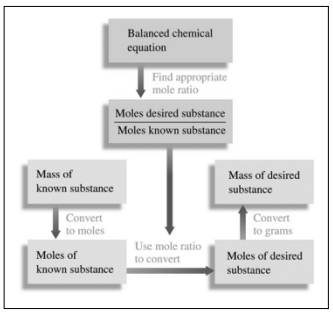
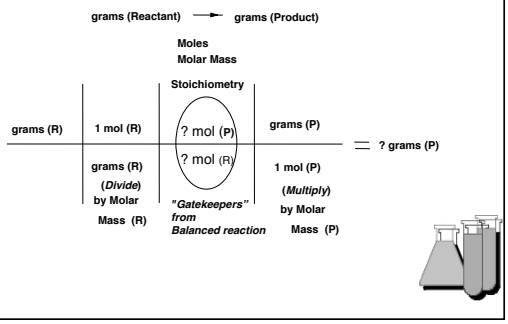
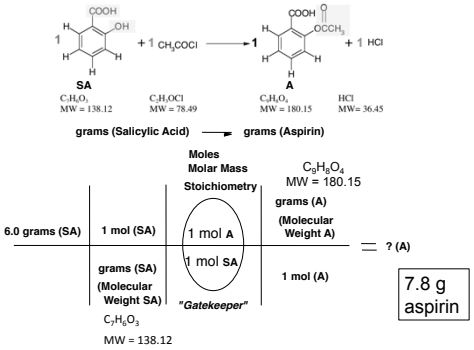
Mass Calculations: Reactants ⟷ Products



*Theoretical (Yield) Mass Calculations Reactant → **Product***



Mass Calculations:

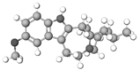


7.8 g aspirin

Percent Yield

- In synthesis as in any experiment, it is very difficult and at most times impossible to be perfect. Therefore the actual yield (g) is measured and compared to the theoretical calculated yield (g). This is the percent yield:
- % Yield = actual (g) / theoretical (g) x 100

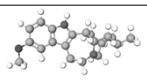
QUESTION



- A synthetic reaction produced 2.45g of Ibogaine, $C_{20}H_{26}N_2O$, a natural product with strong promise in treating heroin addiction (at least in Europe), the calculated theoretical yield was 3.05g, what is the % yield?

A) 19.7% B) 39.4% C) 80.3% D) 160.6%

Answer



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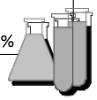
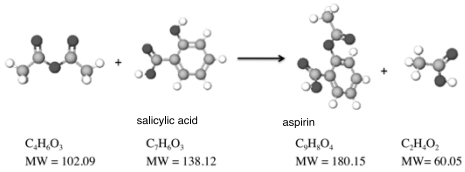


% yield = 2.45g / 3.05g x 100
= 80.3%

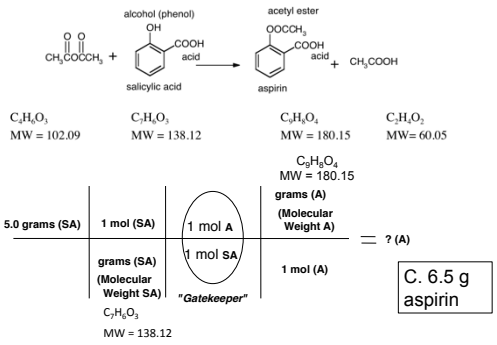
QUESTION

- How many grams of aspirin are theoretically produced from 5.0 g of salicylic acid reacting with an excess of acetic anhydride, $C_4H_6O_3$?
- Balanced Equation:



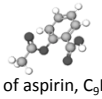
A) 3.8 g B) 5.0 g C) 6.5 g D) 7.8 g

Answer



C. 6.5 g aspirin

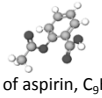
QUESTION



✿ Noelle's synthesis of aspirin, $C_9H_8O_2$, produced 5.90g. The calculated theoretical yield was 6.50g; what is her % yield?

A) 47.5% B) 80.3% C) 90.6% D) 110%

Answer



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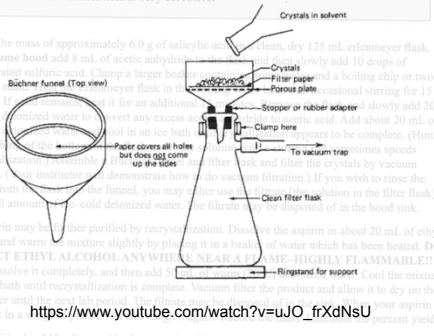
A) 47.5% B) 80.3% C) 90.6% D) 110%

% yield = 5.90 g / 6.50 g x 100
= 90.6 %

Vacuum Filtration



https://www.youtube.com/watch?v=uJO_frXdNsU

Aspirin Synthesis

1. Select partner(s); working in a group of 2-4.
2. Get materials from stockroom.
3. Follow instructions carefully and be mindful of your safety. WEAR eye protection.
4. DO NOT begin re-crystallization portion in the experiment's instructions

Equipment

From the stockroom:
- Beaker clamp
- filter flask
- Büchner funnel
- ice bath – in lab

From the common drawer:
- ring stand and ring
- wire gauze
- Bunsen burner

From your drawer:
- 125 mL Erlenmeyer flask
- large beaker

Chem 106: Class/ Lab

Week 15

Amino Acids & Proteins (egg albumin)

Course/ Lab Manual: completed pp. 97-98
Due Today

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