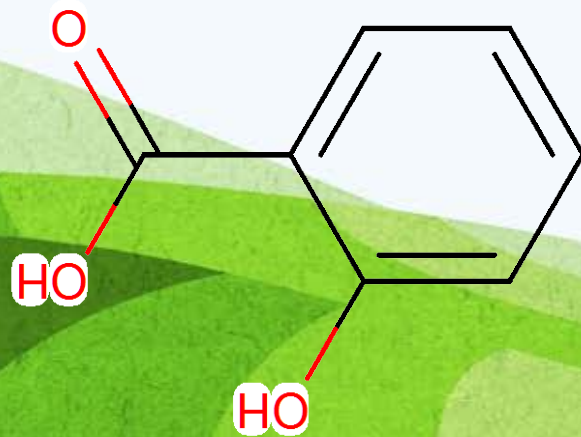


# The Synthesis, Properties, & Application of Salicylic Acid in the Treatment of Acne



Jenny Pham  
CHEM 4201 – Spring 2014

# Introduction

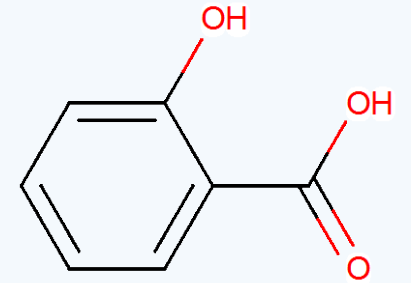
✦ Salicylic Acid – name derived from *Salix* (Latin name for the willow tree)

✦ Organic Compound – Chemically Synthesized & Biosynthesized

✦ Functions as a Hormone in Plants – Defense Against Pathogens

✦ Vast Array of Benefits & Uses

- Applications in Food Chemistry, Textiles, Medicine, Cosmetics, **Dermatology**
  - ✦ Food Chemistry – preservative
  - ✦ Textiles – synthesis of dyes; used for its antibacterial properties
  - ✦ Medicine – relieve fever and pain
  - ✦ Cosmetics – preservative; has exfoliating and cleansing properties
  - ✦ Dermatology – seborrheic dermatitis, viral warts, psoriasis, **acne vulgaris**, and more



# Background

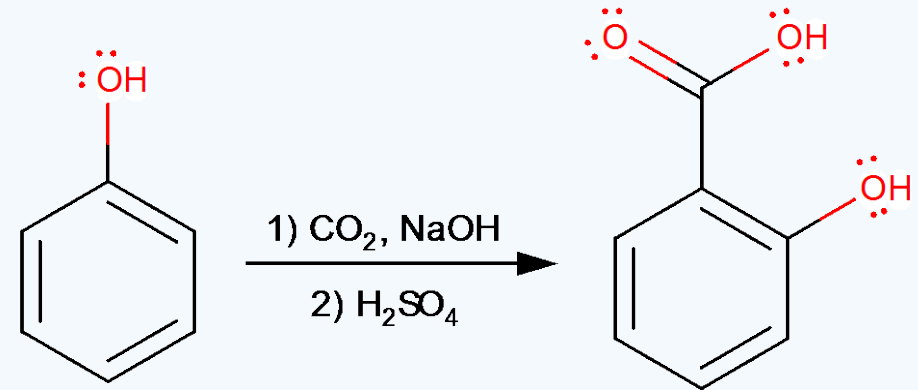
- ✦ 4000 BC – Assyrians used the extracts of willow leaves to treat painful musculoskeletal joint pain conditions, as well as an antipyretic drug to reduce fever.
- ✦ 400 BC – Hippocrates (Greek physician; known as the “father of Western medicine”) used willow bark extract to treat fever and relieve pain associated with childbirth.
- ✦ 1828 – Johann Buchner was the 1<sup>st</sup> to extract and purify salicin (later determined to be the pharmacological active compound in 1935 by Raffaele Piria) from willow bark.
- ✦ 1859 – Kolbe & Schmitt discovered the Kolbe-Schmitt reaction to chemically synthesize salicylic acid from phenol, allowing for it to be produced on a large commercial scale.
- ✦ 1893 – Felix Hoffman was the 1<sup>st</sup> to synthesize pure and stable acetylsalicylic acid (known as aspirin).

# Synthesis of Salicylic Acid

## 🌿 Synthesis From Natural Sources



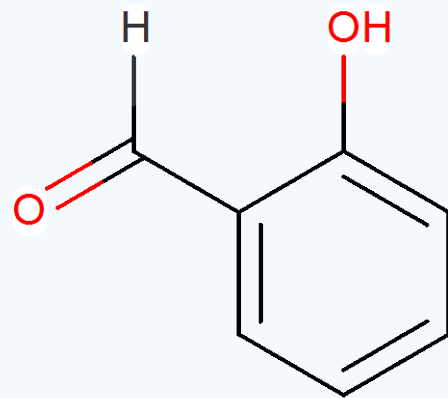
## 🏭 Industrial Synthesis



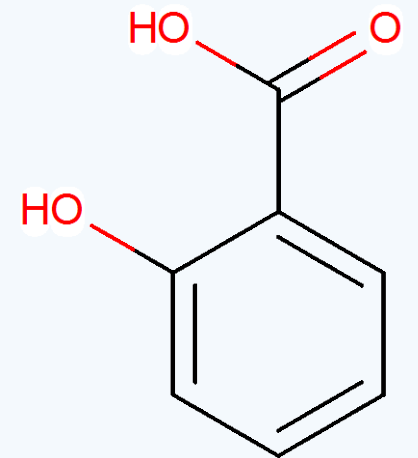
# Synthesis from Natural Sources

🌿 Salicylaldehyde from Meadowsweet Flowers (*Filipendula ulmaria*)

- Extracted by Pagenstecher (Swiss pharmacist) as early as 1835.
- Oxidized by Lowig (German chemist).



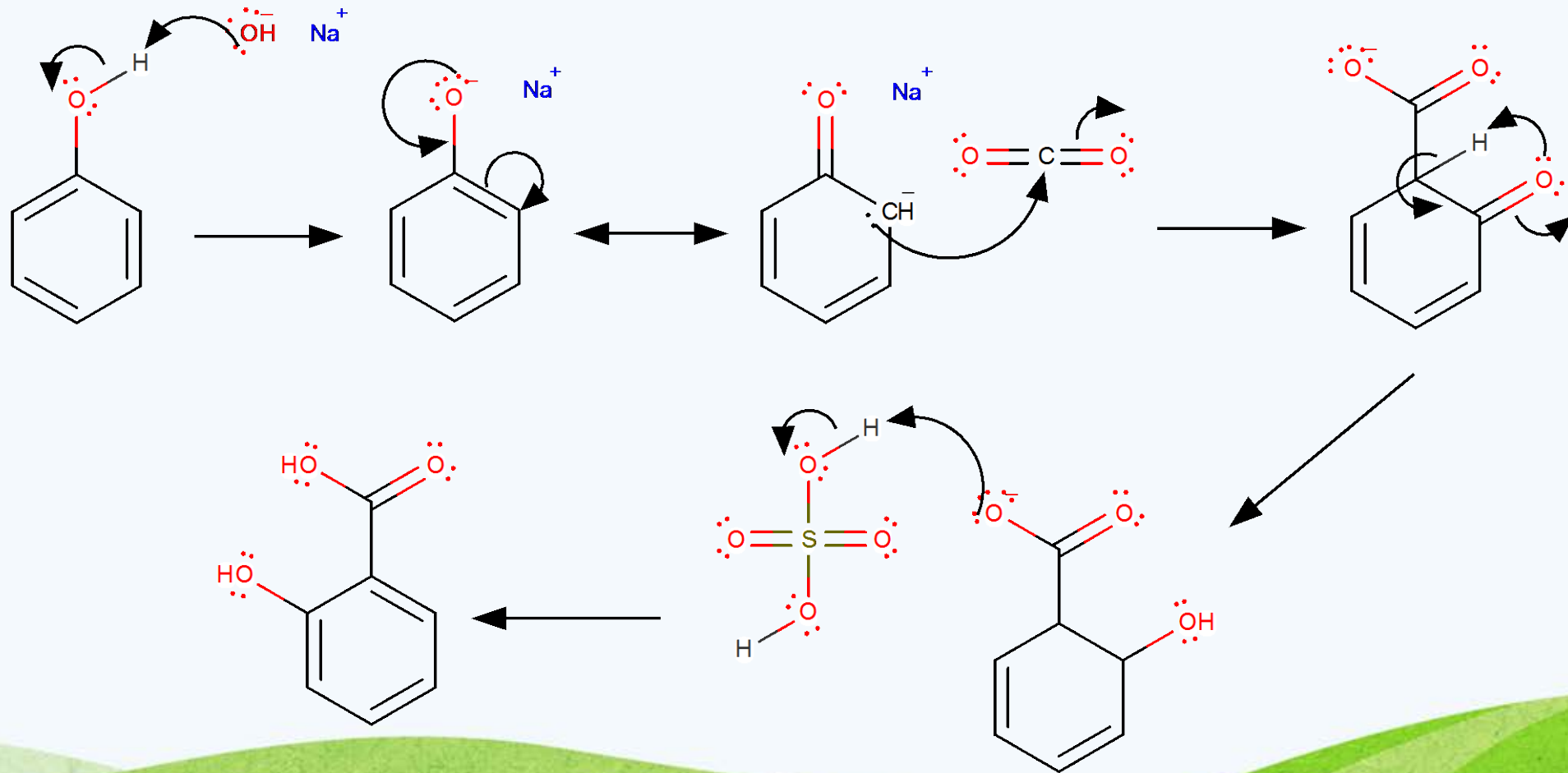
salicylaldehyde



salicylic acid

# Industrial Synthesis from Phenol

🦋 Kolbe-Schmitt Reaction by Hermann Kolbe & Rudolf Schmitt in 1859



# Chemical Properties

🍷 Common Name: Salicylic Acid

🍷 Molecular Formula:  $C_7H_6O_3$

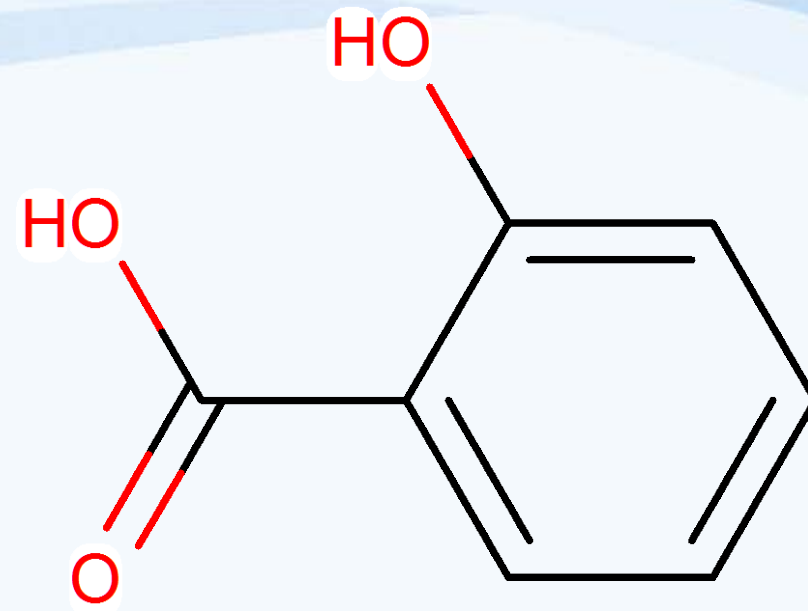
🍷 Molecular Weight: 138.12074 g/mol

🍷 IUPAC Name: 2-hydroxybenzoic acid →  $\alpha$ -hydroxy acid

🍷 Appearance: Colorless Crystalline Powder to White Needle-Shaped Crystals

🍷 Odor: Odorless

🍷 Taste: Acrid



# Beneficial Properties

✦ Antibacterial

✦ Antifungal

✦ Antiseptic

✦ Antipyretic

✦ Anti-Inflammatory

✦ Keratolytic

✦ Comedolytic

✦ Bacteriostatic



# What is Acne Vulgaris?

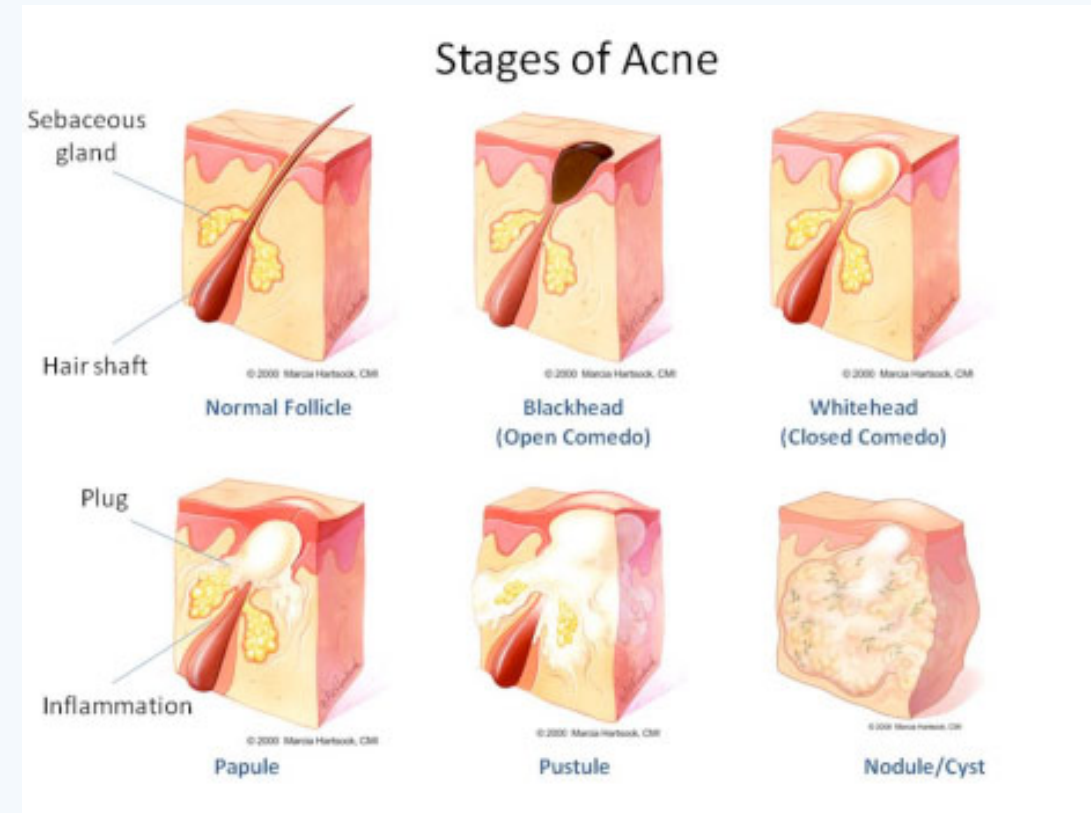
✦ It's a common chronic disease of the pilosebaceous unit of the skin, affecting more than 80% of adolescents and often persists into adulthood

✦ Cause – obstruction of the pilosebaceous canal

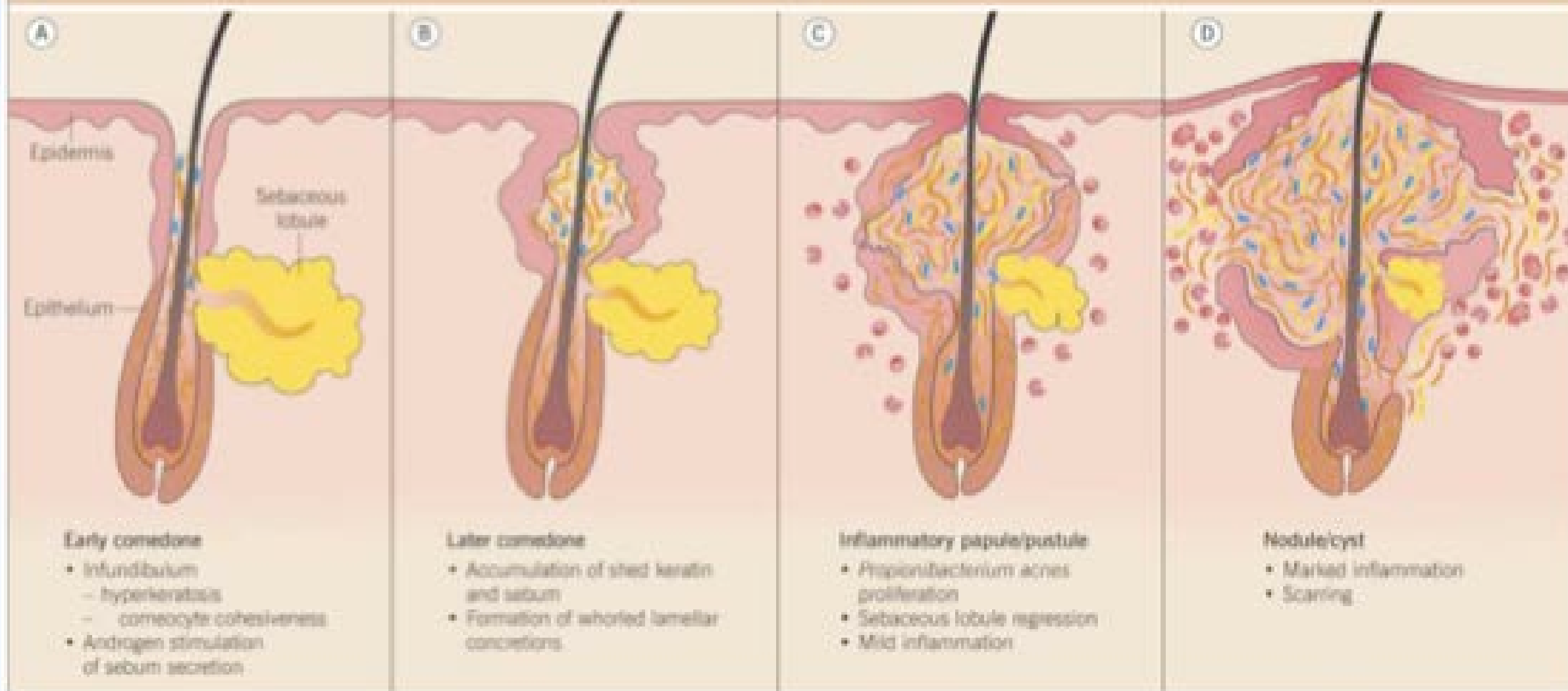
✦ Characteristics

- oily skin (excess sebum production)
- non-inflammatory lesions (open/closed comedones)
- inflammatory lesions (papules, pustules, and nodules)

✦ Normally affects the face, upper chest, and back – areas that have the densest amount of sebaceous follicles.



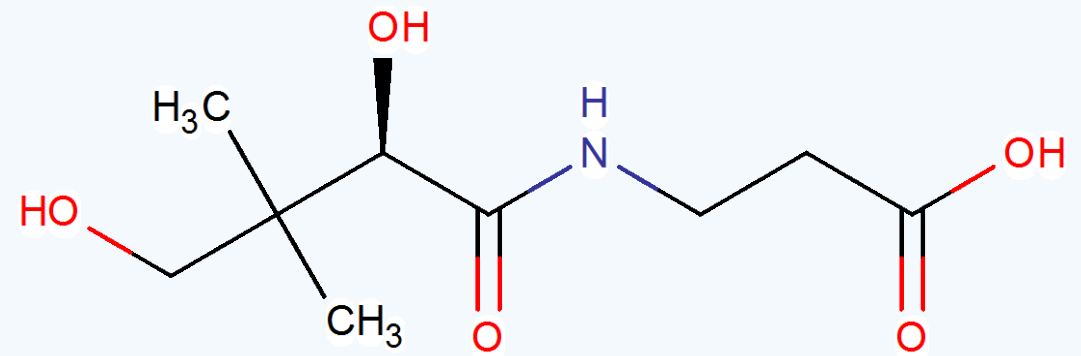
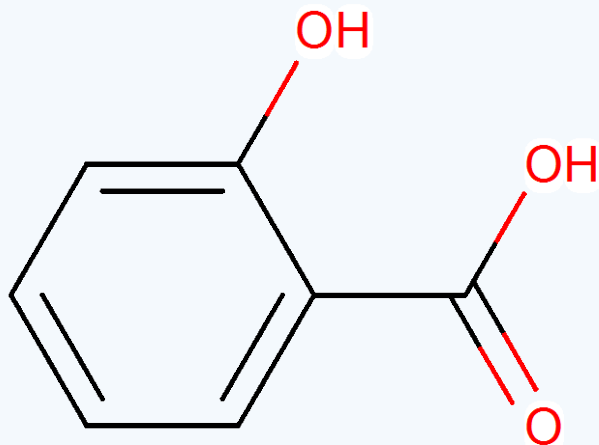
## PATHOGENESIS OF ACNE



# Salicylic Acid – Acne Treatment

🦠 Salicylic acid is applied topically to the skin affected by acne vulgaris.

- strong keratolytic and comedolytic agent
- increases penetration of other products
- has a slight anti-inflammatory effect
- bacteriostatic and fungistatic at low concentrations – competitive inhibition of pantothenic acid



# Written Component

✦ Designing an experiment that incorporates the synthesis of salicylic acid from a natural source, such as the flowers of the meadowsweet plant, wintergreen plant, or bark from the willow tree, and utilizing the salicylic acid to make a more natural product used to treat acne, rather than using industrially synthesized salicylic acid.



# References

1. Mahdi, J. (2010). Medicinal potential of willow: A chemical perspective of aspirin discovery. *Journal of Saudi Chemical Society*, 14(3), 317-322.
2. Vlot, A., Dempsey, D., & Klessig, D. (2009). Salicylic Acid, a Multifaceted Hormone to Combat Disease. *Annual Review of Phytopathology*, 47, 177-206.
3. Jack, D. B. (1997). One hundred years of aspirin. *The Lancet*, 350(9075), 437-439.
4. Kantouch, A., El-Sayed, A., Salama, M., El-Kheir, A., & Mowafi, S. (2013). Salicylic acid and some of its derivatives as antibacterial agents for viscose fabric. *International Journal of Biological Macromolecules*, 62, 603-607.
5. Young, J. (2008). Salicylic Acid. *Journal of Chemical Education*, 85(12), 1617.
6. Kornhauser, A., Coelho, S. G., & Hearing, V. J. (2010). Applications of hydroxy acids: classification, mechanisms, and photoactivity. *Clinical, Cosmetic and Investigational Dermatology : CCID*, 3, 135–142. doi:10.2147/CCID.S9042
7. Sladden, M. J., & Johnston, G. A. (2004). Common skin infections in children. *BMJ : British Medical Journal*, 329(7457), 95–99.
8. Salicylic Acid - PubChem. (2004, September 16). Retrieved November 15, 2014, from <http://pubchem.ncbi.nlm.nih.gov/compound/338>
9. Chemistry Experiments: Salicylic Acid and Salicylates. Retrieved November 18, 2014, from <http://www.crscientific.com/article-aspirin.html>
10. White Willow Bark \*Organic\*. Retrieved November 17, 2014, from <http://eternityinabox.com/shop/white-willow-bark-organic/>
11. Filipendula rubra. (2014, November 19). Retrieved November 22, 2014, from [http://en.wikipedia.org/wiki/Filipendula\\_rubra5](http://en.wikipedia.org/wiki/Filipendula_rubra5)
12. Native Plants for NYC Fall Color. Retrieved November 17, 2014, from <http://newecolandscapes.com/5-native-plants-for-fall-color/>
13. Kolbe-Schmitt Reaction. Retrieved November 16, 2014, from [http://www.chem.ucla.edu/harding/IGOC/K/kolbe\\_schmitt\\_reaction.html](http://www.chem.ucla.edu/harding/IGOC/K/kolbe_schmitt_reaction.html)
14. Strom, M., & Lio, P. (2014). Alternative Medicine in Pediatric Dermatology: What Is the Evidence? *Current Dermatology Reports*, 3(4), 165-170.
15. Krautheim, A., & Gollnick, H. (2012). Transdermal Penetration of Topical Drugs Used in the Treatment of Acne. *Clinical Pharmacokinetics*, 42(14), 1287-1304.
16. Comedogenesis: Inflammation, Androgens, Sebum Lipid and Cytokines. Retrieved November 22, 2014, from <http://health.tipsdiscover.com/acne-vulgaris-comedogenesis-the-role-of-inflammation-androgens-sebum-lipid-and-cytokines/>
17. Bowe, W., Glick, J., & Shalita, A. (2012). Solodyn and Updates on Topical and Oral Therapies for Acne. *Current Dermatology Reports*, 1(3), 97-107.
18. Natural Acne Solutions. Retrieved November 22, 2014, from <http://www.burtsbees.com/Natural-Acne-Solutions/naturalAcneSolutions,default,sc.html>