3 MOLECULES THAT CHANGED THE COURSE OF HISTORY

FSU-PC Student Research Symposium 2021

GCSC Honors Program

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Vitamin C

Cellulose

Pepper

Youth In a Bottle: Vitamin C

Vitamin C

Cellulose

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A Vital Molecule for Survival

Vitamin C is crucial for the production of collagen. Collagen is a protein found in the connective tissues that bind and support other tissues. A lack of collagen can lead to swelling of limbs, softening of gums, loosening of teeth, and other appalling effects. Vitamin C plays a crucial role in one's diet as it is linked to a plethora of diseases.

The Misnomer of the Molecule

- Vitamin → vital + amine
- An amine is a nitrogen containing organic compound.
- Contrary to previous beliefs, vitamin C does not contain nitrogen.

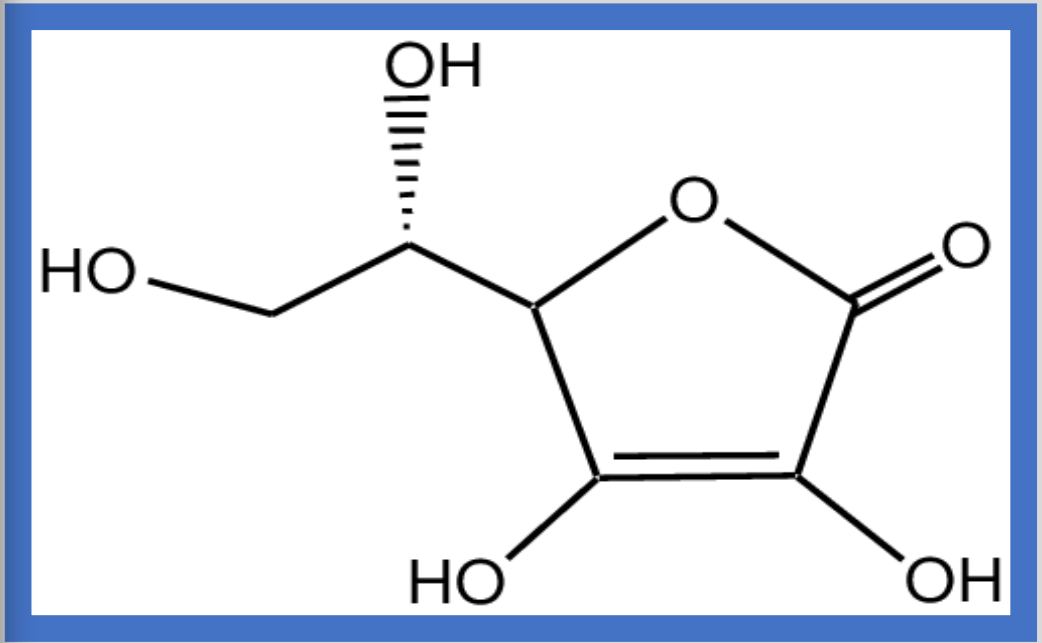
Diseases Linked to Vitamin C Deficiency

- **Scurvy**
- **Bursitis**
- **Gout**
- **Crohn's disease**
- **multiple sclerosis**
- **gastric ulcers**
- **Obesity**
- **Osteoarthritis**
- **Parkinson's**
- **Anemia**
- **coronary heart disease**
- **autoimmune diseases**
- **schizophrenia**
- **Depression**
- **Alzheimer's**
- **cancer**

(Couteur & Burreson, 2004)

Molecular Structure

Structure of Vitamin C



Al-Mokaram, A. (2010). *Scheme-1: Molecular structure of vitamin (C)* . ResearchGate. Al-Mustansyriah University. https://www.researchgate.net/figure/Scheme-1-Molecular-structure-of-vitamin-C_fig2_269694697.

Lost Through Evolution

- Vitamin C is synthesized in the liver of most mammals.
- Humans were once able to synthesize vitamin C from glucose.
- Gluconolactone oxidase is the enzyme necessary for vitamin C's synthetization.
- Through evolution, humans have lost the genes that encode for gluconolactone oxidase (Couteur & Burreson, 2004).

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Neglected Importance

Knowledge on vitamin C, was neglected by sailors in the fourteenth and fifteenth centuries—a time in which longer voyages were taken at sea.

A disease known as scurvy claimed the lives of many sailors on a diet of butter, cheese, vinegar, bread, dried peas, beer, and rum—lacking in vitamin C. The symptoms of scurvy include exhaustion and weakness, swelling of the arms and legs, softening of the gums, excessive bruising, hemorrhaging from the nose and mouth, foul breath, diarrhea, muscle pain, loss of teeth, lung and kidney problems, and depression.

As a result, over 90 percent of Ferdinand Magellan's crew did not survive his circumnavigation of the world in 1519-1522.

(Couteur & Burreson, 2004)

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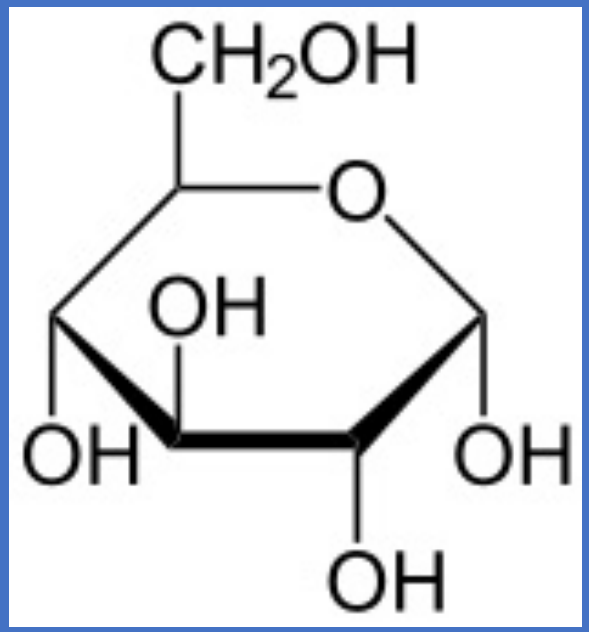
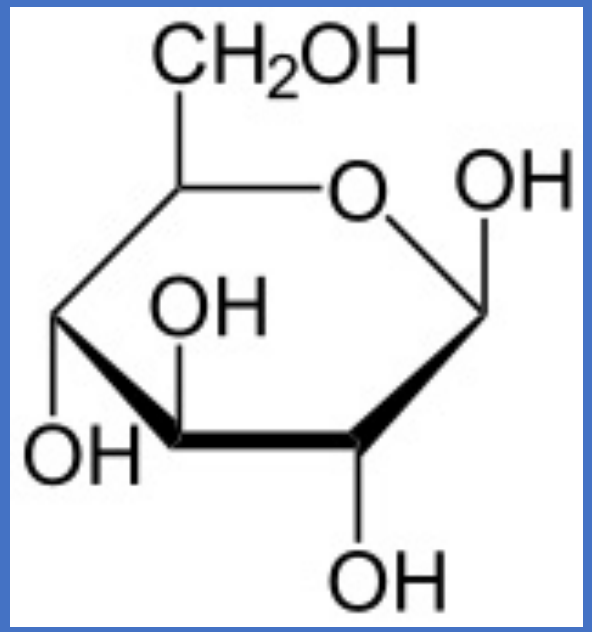
α-Glucose



ß-Glucose (Cellulose)



EDinformatics.com. (n.d.). *Glucose 3D Molecular Structures using Jsmol*. World of Molecules. https://www.worldofmolecules.com/3D/what-is-the-difference-between-alpha-and-beta-glucose.html.

ß-Glucose is cellulose. Unlike with a chain of α-Glucose, humans do not have the enzyme necessary to break down a chain of ß-Glucose molecules for metabolization due to its structural differences with α-Glucose.

(Couteur & Burreson, 2004)

Vitamin C

Component of Cotton

- Cellulose constitutes over 90 percent of cotton.
- Cotton has played a huge role on the history of the United States
  - As a result, cotton has greatly contributed to the United States' prosperity as well as the social dilemmas of today.

DENIMHUNTERS. (n.d.). *Cotton Plants*. Denimhunters. https://denimhunters.com/denim-wiki/denim-explained/cotton/.

(Couteur & Burreson, 2004)

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Unexpected Explosive

- Friedrich Schonbein, a German-Swiss Chemist, was experimenting on mixtures of nitric and sulfuric acids in the kitchen of his home, much against his wife's wishes (Britannica, 2020).
- Schonbein had spilled some of the acid and thus rushed to mop up the mess with his wife's cotton apron that he had nearby.
- After doing so, Schonbein hung the apron over his stove to dry, but soon after doing this the apron suddenly exploded which a loud bang and a big flash.

- When the cellulose in the apron touched the nitric acid, it dissolved and exploded.
- Schonbein called this material guncotton, which consisted of nitrocellulose—cellulose in which the hydroxide groups are replaced with nitro groups.
- The more nitrated the cellulose, the more explosive it was.

Nitrocellulose proved to be extremely dangerous when not dealt with carefully, thus, Schonbein's hope to gain profit from his discovery was not realized after violent explosions destroyed many of nitrocellulose's manufacturing factories.

(Couteur & Burreson, 2004)

A Versatile Molecule

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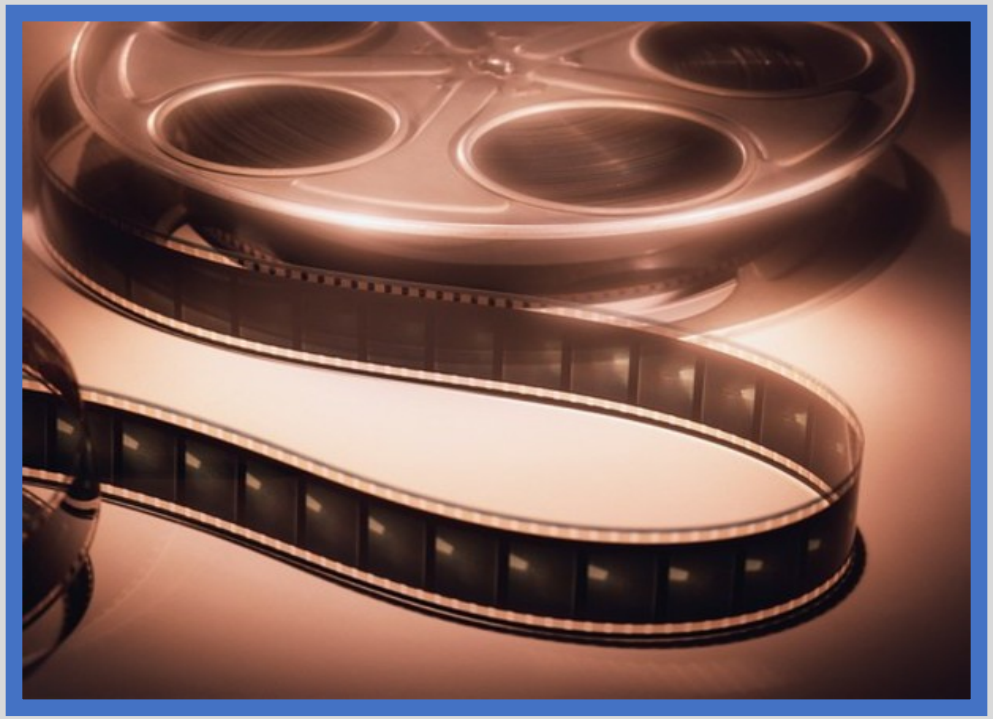
- Cellulose also brought about explosions within the entertainment industry.
- When techniques of controlling the nitration of cellulose improved, collodion and celluloid were formed, both of which were used in photography and film.

Celluloid Film



pkdash. (n.d.). *Invention of celluloid film*. Timetoast Timelines. Timetoast timelines. https://www.timetoast.com/timelines/film-history-e40c17db-2045-449a-b380-d71c0ec5fd00.

Cellulose has had a lasting impact on the world as it allowed for advancements in an interesting variety of areas from film to firepower (Couteur & Burreson, 2004).

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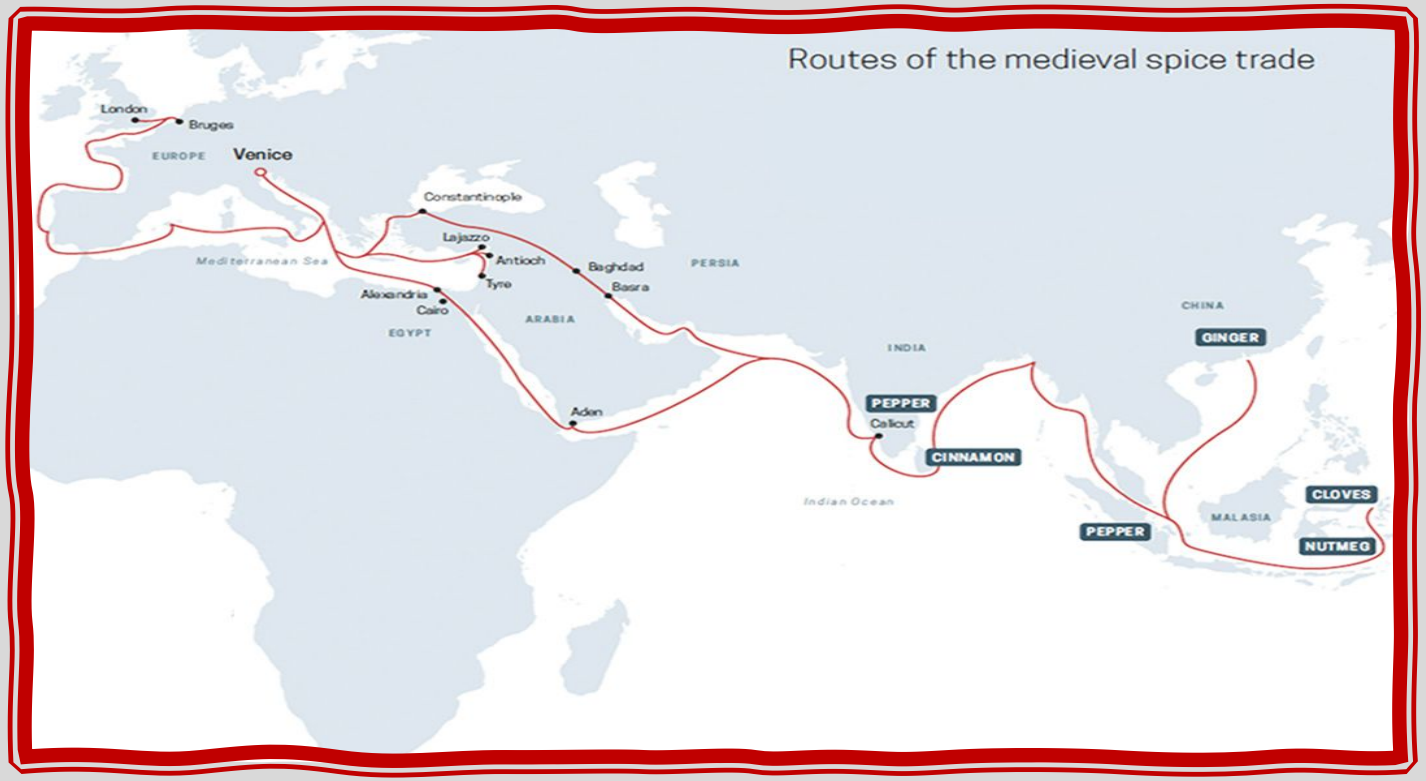
A Fiery Favorite: Pepper

Black pepper—or Piper nigrum—originated in India and was initially introduced to Europe by Arab traders through Damascus and across the Red Sea. Pepper was used as an antidote to poison by the Greek and as a spice by the Romans. Pepper helped make foods that were not very enjoyable into something that had much flavor and a slower rate of decay (Couteur & Burreson, 2004).



Turner, J. (2015). *Routes of the medieval spice trade*. Smithsonian Magazine. Smithsonian. https://www.smithsonianmag.com/travel/spice-trade-pepper-venice-180956856/.

Pepper

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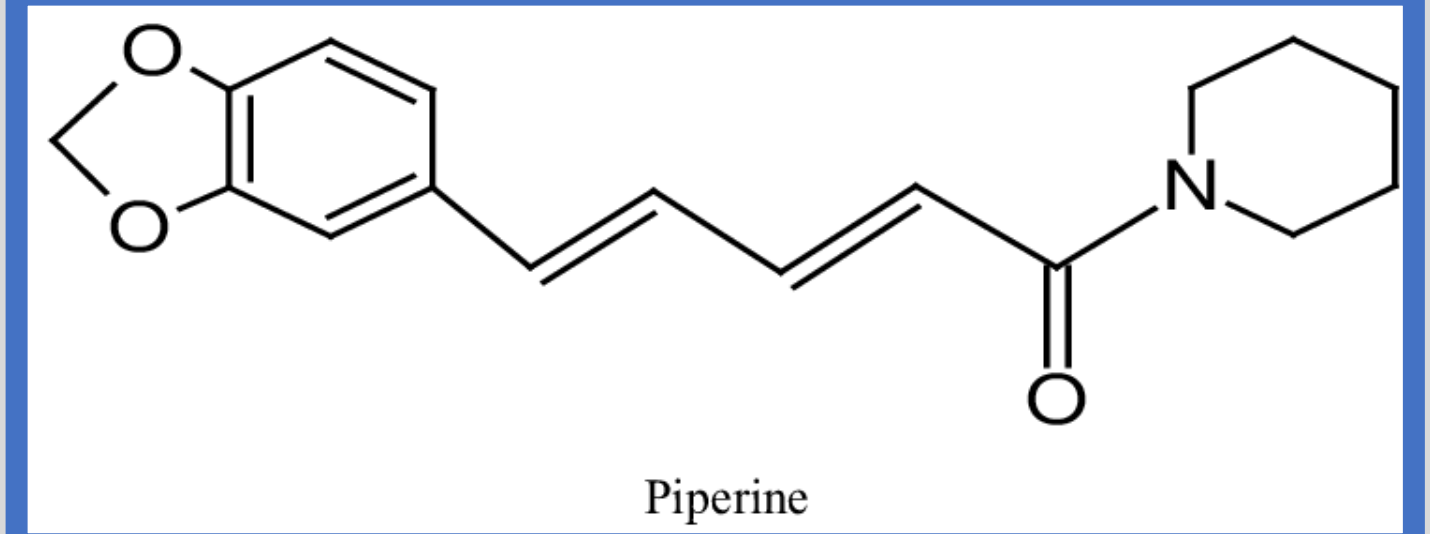
Molecular Structure

- Peppercorn has the active ingredient piperine.
- It is thought that the spicy sensation one feels when ingesting piperine is due to the molecule's shape.
- Piperine fits into proteins on the pain nerve endings in the mouth and causes the proteins to change shape sending pain signals to the brain (Couteur & Burreson, 2004).



Piperine

Pepper

Quraishi, Mumtaz & Kumar, Dileep & Ahamad, Ishtiaque. (2009). *Green Approach to Corrosion Inhibition by Black Pepper Extract in Hydrochloric Acid Solution.* The Open Corrosion Journal. 2. 10.2174/1876503300902010056.

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A Lasting Impact

- People continue to benefit from the preservative and flavorful qualities that pepper brings to food.
- The search for pepper throughout history has brought massive changes that have undoubtedly affected today's society.
- The small seemingly insignificant molecule of piperine brought about the discovery and settling of new lands, good food, and blood shed.

FCER.org. (2021). *15 Health Benefits of Black Pepper*. For Care Education and Research. https://fcer.org/black-pepper-benefits/.

(Couteur & Burreson, 2004)

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Conclusion

The once seemingly insignificant molecules of vitamin C, cellulose, and pepper have had unrivaled effects on today's world.

- Knowledge of vitamin C has saved the lives of many as now people value its importance in their diets.
- Cellulose has contributed to the society of today in more ways than one: in clothes, firepower, and entertainment.
- While continuing to add flavor to foods around the world today, pepper has undeniably helped set the borders of nations as they are found today

These three molecules are not the only molecules to have had vast impacts on the world. It is beyond question that chemistry is the ultimate factor that has changed the course of history and shaped the world of today.

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Thank You!

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References

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