There is very little original material in this lecture. Nearly all text is taken directly with references from internet sources and or from the medical literature.

The layout is our own.

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**This lecture is on chocolate**

- Introduction
- History
- Types of chocolate
- Chocolate and your health.

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**Bottom Line**

If you remember only one thing about chocolate from this course, it is this:

"All of the evil that people have thrust upon chocolate is really more deserved by milk chocolate, which is essentially contaminated. The closer you get to a pure chocolate liquor (the chocolate essence ground from roasted cacao beans) the purer it is, the more satisfying it is, the safer it is, and the healthier it is."

Arnold Ismach: ‘The Darker Side of Chocolate’

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**Put another way....**

“I have this theory that chocolate slows down the aging process.... It may not be true, but do I dare take the chance?”

Unknown

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**What Is Chocolate?**

- The seeds of the Cacao plant.
Cacao grows in very moist tropical environments, usually under the high canopy of rainforest.

The cacao plant contains many beans inside. Juice can be extracted to drink or the seeds can be dried and made into chocolate.

The cacao bean ...

• Contains both liquor and butter.
• “Cocoa” by definition is the cacao bean liquor. Cocoa is what contains (1) most of the flavor and (2) all of the beneficial chemicals. In the bean, Cocoa is only about 7% water. When it is dried, it becomes a solid (“Cacao solids”), albeit one that easily melts.

Timeline

1500 BC-400 BC - The Olmec Indians are believed to be the first to grow cocoa beans as a domestic crop.

“...from these settled villages, rose great civilizations in about 1500 BC. These civilizations emerged in the South American Continent, where environmental conditions were best suited. The earliest of these civilizations was that of the Olmec. The Olmec also a religion that spread to most of the civilized parts of South America. This religion consisted of symbols, rituals and spirits. The main god of the Olmec religion was the Rain God, a figure with both human and jaguar-like features.”

Concrete record of chocolate: 400-600 AD. Mayan Indians

Bowl with images of the Chocolate God
Mexico or Guatemala, 400-600, stone
Dumbarton Oaks Research Library and Collections
Washington, D.C.

Chocolate: the beginning

According to the Popol Vuh, the Maya creation myth that was written down in the sixteenth century, maize and cacao were both discovered when the god K’awiil hurled a lightning bolt at a mountain, breaking it in two and revealing the two plants growing inside. Cacao and maize are therefore closely linked in Maya mythology. The Chocolate God may even have been a special aspect of the Maize God, or perhaps his brother.

As early as 600 AD, dried, roasted cacao was ground into chocolate powder and blended with chili, maize gruel, honey, and water to make the most valued beverage of ancient Mexico. Cacao beans became a kind of currency; the white shell replicas from a Maya tomb provided cash for the afterlife.

“In 1492 Columbus sailed the ocean blue. He sailed and sailed and sailed and sailed… until he found chocolate for me and you.”

Columbus ‘discovered’ cocoa beans on August 15, 1502, when he robbed the cargo of a native Mayan trader near modern Honduras. Columbus assumed that the beans were a kind of almond, and all he really knew about them was that someone else thought they were valuable; so, for the glory of Church, State, and Christopher Columbus, he took them.

“They seemed to hold these almonds at a great price; for when they were brought on board ship with their goods, I observed that when any of these almonds fell, they all stooped to pick it up, as if an eye had fallen”

However, Columbus was still searching for the route to India, so he failed to realize the potential cocoa market that had fallen into his lap.

Circa 1520: Don Cortez coming back from war with the Aztecs, reintroduced Chocolate to Spain, and it became a popular beverage, mixed with sugar and spices.

1585 - First official shipments of cocoa beans began arriving in Seville, Spain from Vera Cruz, Mexico.

1674 - Eating solid chocolate was introduced in the form of chocolate rolls and cakes, served in chocolate emporiums.

Timeline By Mary Bellis and John Bozaan
Picture Source: http://www.pignatelli.org/grafica/Cortez.gif
1765 - Chocolate was introduced to the United States when Irish chocolate-maker John Hanan imported cocoa beans from the West Indies into Dorchester, Massachusetts, to refine them with the help of American Dr. James Baker. The pair soon after built America's first chocolate mill and by 1780, the mill was making the famous BAKER’S® chocolate.

Timeline By Mary Bellis and John Bozaan

1795 - Dr. Joseph Fry of Bristol, England, employed a steam engine for grinding cocoa beans, an invention that led to the manufacture of chocolate on a large factory scale.

1828 - The invention of the cocoa press, by Conrad Van Houten, helped cut prices and improve the quality of chocolate by squeezing out some of the cocoa butter and giving the beverage a smoother consistency. Conrad Van Houten patented his invention in Amsterdam and his alkalizing process became known as "Dutching".

Timeline By Mary Bellis and John Bozaan

1847 - Joseph Fry & Son discovered a way to mix some of the cocoa butter back into the "Dutched" chocolate, and added sugar, creating a paste that could be molded. The result was the first modern chocolate bar.

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Timeline By Mary Bellis and John Bozaan

John Cadbury opened his shop in 1824 in Birmingham England. He sold the first heart-shaped candy box.

Daniel Peter created milk chocolate in 1875

Daniel Peter and Henri Nestlé joined together to form the Nestlé Company in 1879

1879 - Rudolphe Lindt of Bern, Switzerland, produced a more smooth and creamy chocolate that melted on the tongue. He invented the "conching" machine. To conch meant to heat and roll chocolate in order to refine it. After chocolate had been conched for seventy-two hours and had more cocoa butter added to it, it was possible to create chocolate "fondant" and other creamy forms of chocolate.

In 1892, Milton S. Hershey decides at the World's Columbus Exposion, USA, to get into chocolate making.

In 1926, Joseph Draps names his chocolate company Godiva. His inspiration came from the well-known Saxon legend of Lady Godiva who rode unclothed through the streets of Coventry to entreat her husband, Leofric the Dane, to lower taxes.

More players
• Mars and Murrie: M&M
• Reason – played no role in inventing or defining chocolate.
• Frank Mars did invent the Milky Way, but he always bought the chocolate used in Milky Way manufacturing from Hershey.
• William Murrie was the president of the Hershey Company appointed by Milton Hershey and Hershey’s right hand man.

And Mars begat Forest...
• Frank Mars had a son named Forest.
• William Murrie had a son named Bruce who happened to know exactly how Hershey chocolate was made.
• Forest and Bruce went into business themselves, deciding they could make the Hershey recipe chocolate on their own, and didn’t owe Hershey anything.
• In all fairness to thieves, it was Forest Mars who came up with the idea for M&Ms.

What Is Chocolate?
• Historically, “Chocolate” had to contain both chocolate liquor and cocoa butter. If the cocoa butter has been removed and replaced with vegetable oil the result is, by definition, not chocolate. The higher the cocoa butter content in chocolate the better it is considered to be.

My own correction to the above website: the definition of specific foods...
• Is under the jurisdiction of the FDA and regulatory bodies in other countries.
• Real Chocolate must contain some Cocoa. The whole world is in agreement on this.
• There continue to be legal arguments, both in the US and in Europe as to whether it must also contain cocoa-butter as opposed to cheaper vegetable-olives.

If Hershey wants market chocolate that does not contain cocoa-butter,
• It’s difficult even for the FDA to argue the definition of chocolate with the people who invented the first chocolate candy-bar in this country.

Types of Chocolate
• Unsweetened or Baking Chocolate: Chocolate Liquor that has been cooled and hardened. (Chocolate liquor is not alcoholic, but is only the liquid that is pressed from the cocoa bean. It is chocolate in its most basic form).
• Dark or Bittersweet Chocolate: Bittersweet chocolate must contain a minimum of 34 percent cacao solids. (the higher the percentage, the better tasting).
Types of Chocolate

• Semi-sweet Chocolate: Chocolate with extra cocoa butter and sugar added.

• German Chocolate: German Sweet Chocolate was formulated in the mid 1800's by S. German. This form of chocolate is sweeter and richer than semi-sweet chocolate, and is a special blend of chocolate, sugar and cocoa butter.
http://www.gifttree.com/gifts/food/chocolate.php

• Milk Chocolate: A creamy sweet chocolate that has extra cocoa butter, sugar, milk, and vanilla.

• Cocoa: Chocolate liquor with the cocoa butter having been removed, creating a fine bitter tasting powder.
http://www.gifttree.com/gifts/food/chocolate.php

• Dutch Process Cocoa: A special process used to neutralize the natural acids in cocoa powder. It has a much different taste then regular cocoa powder.

• White Chocolate: Chocolate is technically made up of cocoa and cocoa butter. However, white chocolate consists of the cocoa butter without the cocoa and is therefore not considered chocolate. It also usually contains sugar, milk, and other flavorings. Cheap imitations that substitute vegetable oil for cocoa butter are often referred to as Vanilla chips.
http://www.gifttree.com/gifts/food/chocolate.php

Another great website for chocolate-related definitions:
http://www.worldagroforestry.org/treesandmarkets/inaforesta/faq.htm

Photo Source:
http://www.worldagroforestry.org/treesandmarkets/inaforesta/images/inagroforesta_wwwbanner_3.gif

Chocolate Facts

• The melting point of cocoa butter is just below the human body temperature which is why it literally melts in your mouth.

• The word ‘Chocolate’ comes from the Aztec word ‘cacahuatl’ or ‘xocolatl’. This means ‘bitter water.’

• The scientific name for Cocoa is Theobroma Cacao. Theobroma means “Food of the Gods.” Cacao means “Seeds.” The word Cacao comes from misquoting “Cocoa.”

• Napoleon carried along chocolate on his military campaigns, and always ate it to restore energy.

• The Mars company (namely the two thieving sons) invented M&Ms in 1940 for soldiers off to fight in World War II.

• Consumers worldwide spend more than $20 billion a year on chocolate. Over a lifetime the average person will eat approx 160kg of chocolate.

• Chocolate syrup was used for blood in the famous shower scene in Alfred Hitchcock’s film ‘Psycho’.

More chocolate facts
Still more chocolate facts

• The government of 17th century England that the government imposed a duty of 15 shillings per pound on chocolate, thus making it worth 3/4 of its weight in gold.

• The microwave oven was invented by accident, when Percy Spencer found that his chocolate bar had been melted by an experiment he was running on radar systems. He immediately started experimenting successfully on microwave popcorn.

• Dark chocolate is good for you!

Questions!

1. Which of the following worked as a chocolate God?
   A. The Egyptians.
   B. The Greeks
   C. The Mayans
   D. The Pima

2. Who was the first to sell chocolates in a heart-shaped box?
   A. Hershey
   B. Cadbury
   C. Mars
   D. Godiva

3. In the U.S., why is the definition of chocolate in dispute?
   A. Nestle has marketed Carob as Chocolate with “34% less calories.”
   B. The FDA has said that milk chocolate must contain 50% milk.
   C. The FDA has said that “special dark” chocolate must be at least 65% cacao solids.
   D. Hershey wants to market some chocolate with little or no cocoa-butter.

4. White chocolate is predominantly:
   A. Coconut butter (flavored with white chocolate-liquor)
   B. Cocoa-butter
   C. Evaporated sweetened milk (flavored with Carob)
   D. Carob and soy milk

5. The purest concoction of cacao bean widely available in the US today is:
   A. Hershey Dark Chocolate with 70% Cacao beans
   B. Cadbury Special Dark Chocolate
   C. Starbucks chocolate covered coffee beans
   D. Bakers Chocolate
6. Who invented M&Ms?
A. Forest Mars  
B. Milton Hershey  
C. Alexander Fleming  
D. William Murrie

The health claims: Fact or Fiction?
Which of the following claims are true?
- Chocolate is an aphrodisiac
- Chocolate is an antidepressant
- Chocolate can suppress a cough
- Chocolate is poisonous to cats and dogs
- Chocolate prevents the atherosclerotic that leads to heart attacks and stroke
- Chocolate reduces blood pressure in those with high blood pressure
- Chocolate suppresses cancer growth
- Chocolate improves cognition
- Cocoa-butter has a beneficial effect on lipids (LDL/HDL)

Chocolate an aphrodisiac?
An aphrodisiac is any substance that puts people in the mood for sex. The name comes from the Greek Goddess of Love, Aphrodite

Fact or Fiction?

Chocolate is an aphrodisiac: Fact or Fiction?

- **Basis:** The conquistadores saw the Emperor Montezuma of the Aztecs consuming cocoa in the form of a beverage called chocholatl before entering his harem. The invading Spaniards spread the Emperor's belief that cocoa was an aphrodisiac and brought it to Europe.

Casanova

- **Answer:** Fiction (probably)
- A medline search turned up only one study actually testing the association between chocolate consumption and sexual desire.
- The study in 163 Italian women found no association between consumption of chocolate and sexual pleasure, after adjusting for age differences.
However ....

• Although chocolate is not an aphrodisiac, as the ancients believed, it does contain in small amounts, phenylethylamine (PEA), a substance that is reputed to stimulate the same reaction in the body as falling in love.

Chocolate is an antidepressant: Fact or Fiction?

Basis: Eating chocolate is highly pleasurable

“Chocolate is cheaper than therapy and you don’t need an appointment.” — Unknown.

• Answer: Fiction (probably)
• A Medline search turned up no clinical trials addressing this question
• A careful, thorough 2006 literature and pharmacologic review by Australian researchers concluded that there was no plausible mechanism by which chocolate would have anti-depressant effects.

Parker et al conclude:

“When experiencing an aversive mood state, any carbohydrate will suffice in an attempt to achieve relief, with chocolate no better than ice cream, cake or potato chips. When taken in response to a dysphoric state as an ‘emotional eating’ strategy, chocolate may provide some transient ‘comforting’ role but it is more likely to prolong rather than abort the dysphoric mood. It is not, as some would claim, an antidepressant.”

[Note to class: “dysphoria” means low-grade depression – like when you are sad and lacking in energy, but are not suicidal]

Chocolate can suppress a cough: Fact or Fiction?

• Basis: An inappropriate cough reflex happens when nerve fibers in the airway (in the upper throat) become overly sensitized leading to the release of neurotransmitters from the nerve endings.
• Theobromine prevents the activation of these nerve fibers in vitro.
• Chocolate contains theobromine. Recall the scientific name for Cocoa is Theobroma Cacao.

Chocolate can suppress a cough: Fact or Fiction?

• Answer: FACT
• Chocolate has been shown to suppress an induced cough in both guinea-pigs and humans.
  Usmani et al. Theobromine inhibits sensory nerve activation and cough. The FASEB Journal, January 2005
Chocolate is harmful to cats and dogs: Fact or Fiction?

- Basis: Neither cats nor dogs can metabolize theobromine, a substance found in chocolate.

- Answer: FACT

- Chocolate appears on the Veterinary Poison Information Service top twenty list of pet poisoning cases. A small bar of plain chocolate (100-150g) will be enough to kill your average sized Yorkie. A medium sized bar (200g) an average sized Spaniel and a large bar (400g) an average sized Labrador. In some susceptible individuals it may be significantly less! Chocolate is also poisonous to horses.

Chocolate prevents the atherosclerosis that leads to heart attacks and stroke: Fact or Fiction?

- Related claim: chocolate reduces blood pressure in those with high blood pressure: Fact or Fiction?

To understand these claims, we need some remedial biology.

What is atherosclerosis?

The cardiovascular system includes a heart, a muscular pump that contracts to force blood out to the body through arteries, and a series of blood vessels. The upper chamber of the heart, the atrium, is where the blood enters the heart. Passing through a valve, blood enters the lower chamber, the ventricle. Contraction of the ventricle forces blood from the heart through an artery. Arteries are blood vessels that carry blood away from heart. Arterial walls are able to expand and contract.
In atherosclerosis, plaque forms on the inside of the arteries, making it harder for arteries to expand or contract and for blood to flow through.

LDL oxidation

- This is how the plaque is made:
  LDL – cholesterol, (which comes from dietary intake in part) merges with oxygen ions to form oxidized-LDL. The oxidized LDL then combines with macrophages to form plaque that sticks to artery walls and hardens. If you can prevent the LDL from becoming oxidized, you can prevent production of this plaque. Nitric oxide is a chemical that prevents LDL from being oxidized.

Hypertension

- Hypertension (high blood pressure) is often a consequence of atherosclerosis. If the blood is having trouble moving through the arteries, the blood pressure goes up to help push the blood through.

And now a story.

- Chocolate prevents the atherosclerosis that leads to heart attacks and stroke: Fact or Fiction?
  - Basis: A story.

The story of the Kuna

- A fellow by the name of Hollenberg noted that there was a striking family history of hypertension. If one member of a family had hypertension, so did their brothers and sisters. He also knew that while there were genes that promoted hypertension, they only accounted for hypertension in a small number of individuals. He thought there might be genes that protected against hypertension.

Enter the Kuna (drumroll)

- The Kuna Indians live on off-shore islands on the coast of Panama. They do not develop hypertension. Their blood pressure does not increase as they grow older. Among humans, this is very unusual. Hollenberg thought they must have a protective gene, and set out to study it.
Protective genes?
Migration study

- If the Kuna were genetically protected, then they could move off their island into cities and still keep their low blood pressure. Hollenberg identified several hundred Kuna who had moved to Panama City. He found that in these Kuna, unlike those living on the island, hypertension was common.

Side note, this type of research is called a “migration study”.

This means ...

- Whatever was protecting the Kuna from hypertension was not genetic, but environmental.
- Now, instead of giving up, Hollenberg did what every great scientist did, he became more curious.

And he...

- Checked whether the Kuna had low sodium intake (answer: No)
- Whether the omega fatty acids in in the increased fish consumption could have done this (answer: No)
- Whether the slightly elevated potassium from increased fruit consumption could have done this (answer: No)

And finally he asked...

- Whether the high chocolate consumption (5-6 cups/day) could have done this.
- And to find this out, he called Mars Incorporated, and asked them for a food composition analysis. This led to a crucial finding.

Flavinols in chocolate

- Hollenberg writes:
- “The cocoa ingested by the Kuna is naturally very rich in a specific subclass of flavonoids known as flavanols. We also learned from this collaboration that commercially available cocoa based products, what we can buy in stores, is routinely very low and/or inconsistent in flavanol content compared with what was observed with the Kuna cocoa as a result of routine postharvest handling and food processing …”

Hollenberg continued...

- In addition, we were made aware of, and subsequently a part of, a research collaboration between Mars and the University of California, Davis. That team, led by Carl L. Keen, had used various cell and tissue culture systems to study purified and well-characterized flavanol fractions from cocoa isolated by the Mars chemists. Key observations made in this research included a striking ability of certain cocoa flavanol fractions to induce synthesis of prostacyclin and, perhaps even more exciting, relaxation of isolated aortic rings in a manner consistent with increased nitric oxide synthesis.”
Chocolate is rich in Flavonoids. Flavonoids increase nitric oxide synthesis thereby suppressing LDL-oxidation.

Chocolate prevents the atherosclerosis that leads to heart attacks and stroke: Fact or Fiction?

Answer: FACT

Related claim: chocolate reduces blood pressure in those with high blood pressure: Fact or Fiction?

Answer: FACT

- A clinical trial found that dark flavanol rich chocolate significantly reduced blood pressure in persons with high blood pressure when compared to white chocolate, which is devoid of flavonols.

Side note: The white chocolate acted as a "placebo".

ASIDE: Migration Study

- In Epidemiology a migration study is a study that compares people of a given ethnicity in two or more locations, usually including the "native" location. Its purpose is to determine whether a characteristic of a people is genetic or environmental.

Questions!

7. The ingredient in chocolate that is poisonous to cats and dogs is
   A. Flavonol
   B. Theobromine
   C. Nitric Oxide
   D. Psudonephrine

8. Atherosclerosis is:
   A. Clogging of the arteries with plaque
   B. Stiffening of joints caused by depletion of nitric oxide
   C. Back pain related to bone-loss
   D. Shortness of breath due to the heart muscle becoming de-conditioned
9. Dysphoria is
A. Low grade depression
B. A sugar headache
C. Increased sex appeal following ingestion of an aphrodisiac.
D. None of the above

10. In Epidemiology, a migration study is:
A. A study of the path that birds take in the winter
B. A study with the purpose of determining whether characteristic of a people is genetic or environmental
C. A study comparing people of a given ethnicity in two or more locations, usually including the "native" location.
D. B and C

Questions for paper
- If you select chocolate as the topic for your paper, you must answer these three questions. Determine by searching the original medical literature if it is probably true or not. You may supplement the medical literature with other on-line or written sources. Be sure to list all references. Do not exceed five pages not including references, double spaced, Times New Roman, font size 11, default margins.
  - Chocolate suppresses cancer growth: Fact or Fiction?
  - Chocolate improves cognition: Fact or Fiction?
  - Cocoa-butter has a beneficial effect on lipids (LDL/HDL): Fact or Fiction?

Presentation: For students presenting on Chocolate
- Although this is a team presentation, each person on the team must be featured for between 2 and 4 minutes in this team presentation. On average each person should speak (or act) for 3 minutes.
  - See syllabus for grading rubric. The class (non-presenters) will also be judging your presentation.

Presentation details
- You are a marketing consultant for Nestle who wants to increase their chocolate sales in the USA. You are presenting to the corporate head honchos. Your presentation may include and would not be limited to:
  - Suggestions for new products
  - Sample commercials
  - Conducting clinical trials and seeking FDA approval for health claims