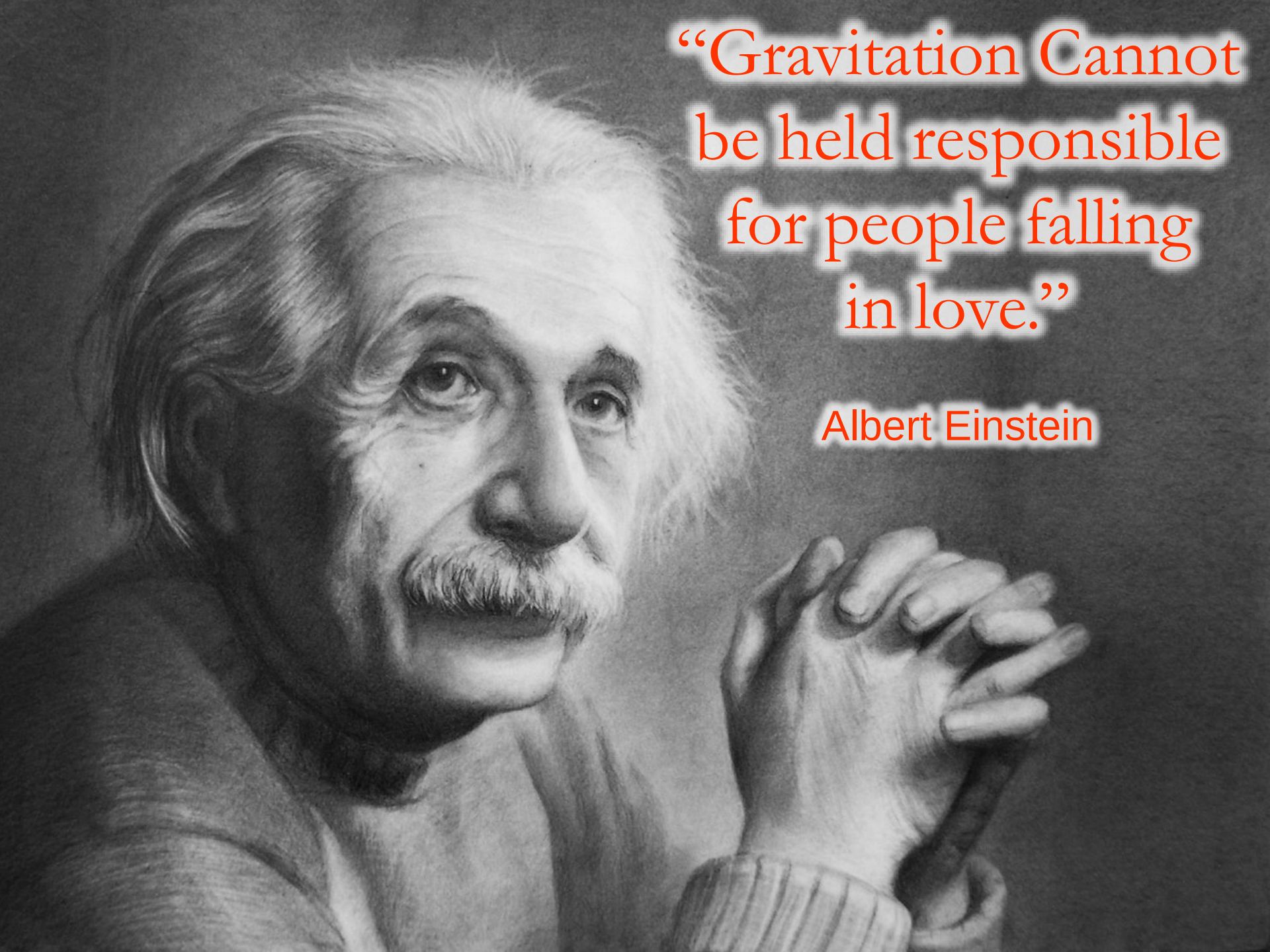
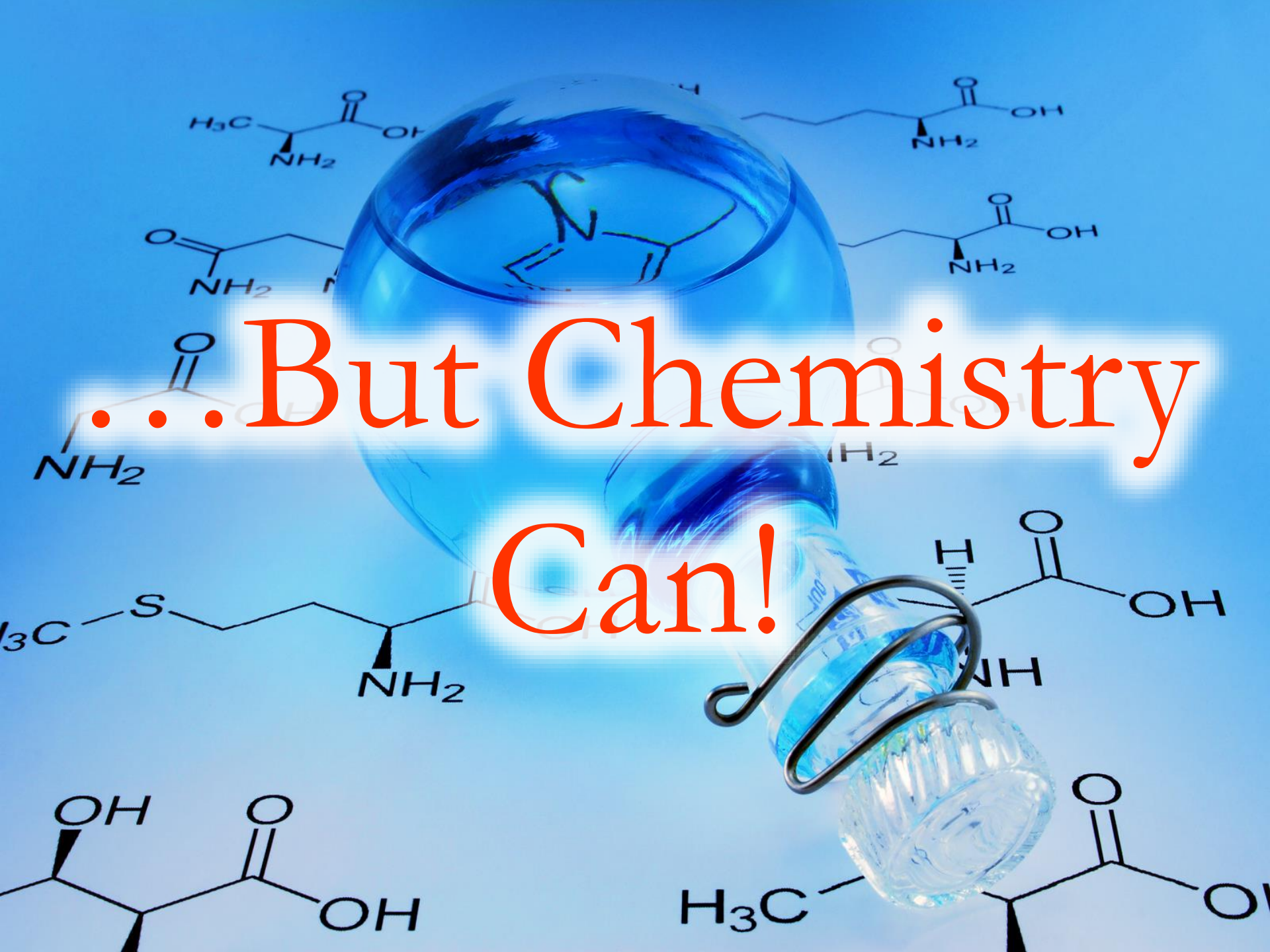

PARENTAL
ADVISORY
EXPLICIT CONTENT


“Gravitation Cannot be held responsible for people falling in love.”
Albert Einstein


Gravity Can't...


…But Chemistry
Can!

The Chemistry of Love

The Chemistry of Love

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Macroconcept:
Systems

Enduring Understanding:
Life is a combination of complex chemical reactions.

Essential Question:
What role does chemistry play in human relationships?

General Introduction

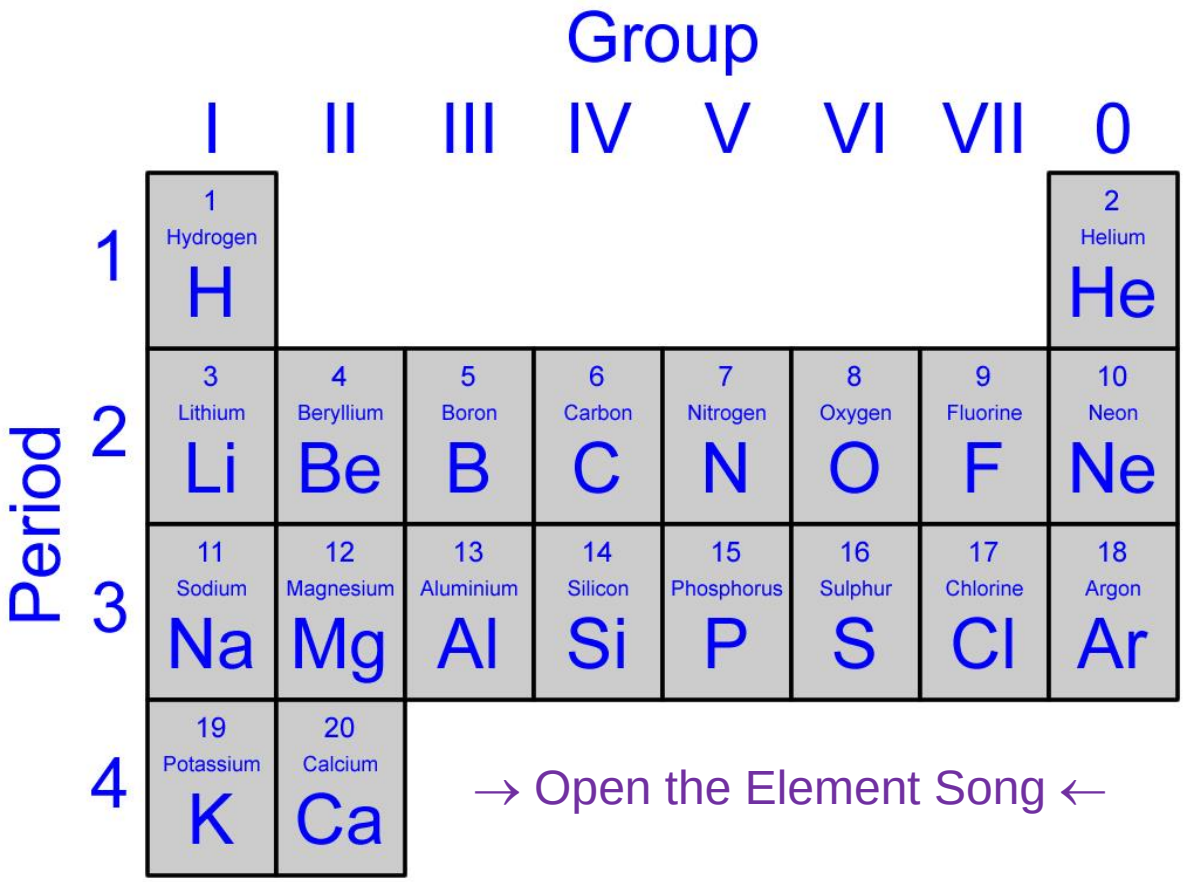
♥ Love is an interdisciplinary subject. To try and understand the concept of love, we will need to rely on our knowledge of:

Testosterone

What basic Chemistry do I need to know before we get started?

Introduction to Covalent Bonding

Abbreviated Version of the Periodic Table



Introduction to Covalent Bonding

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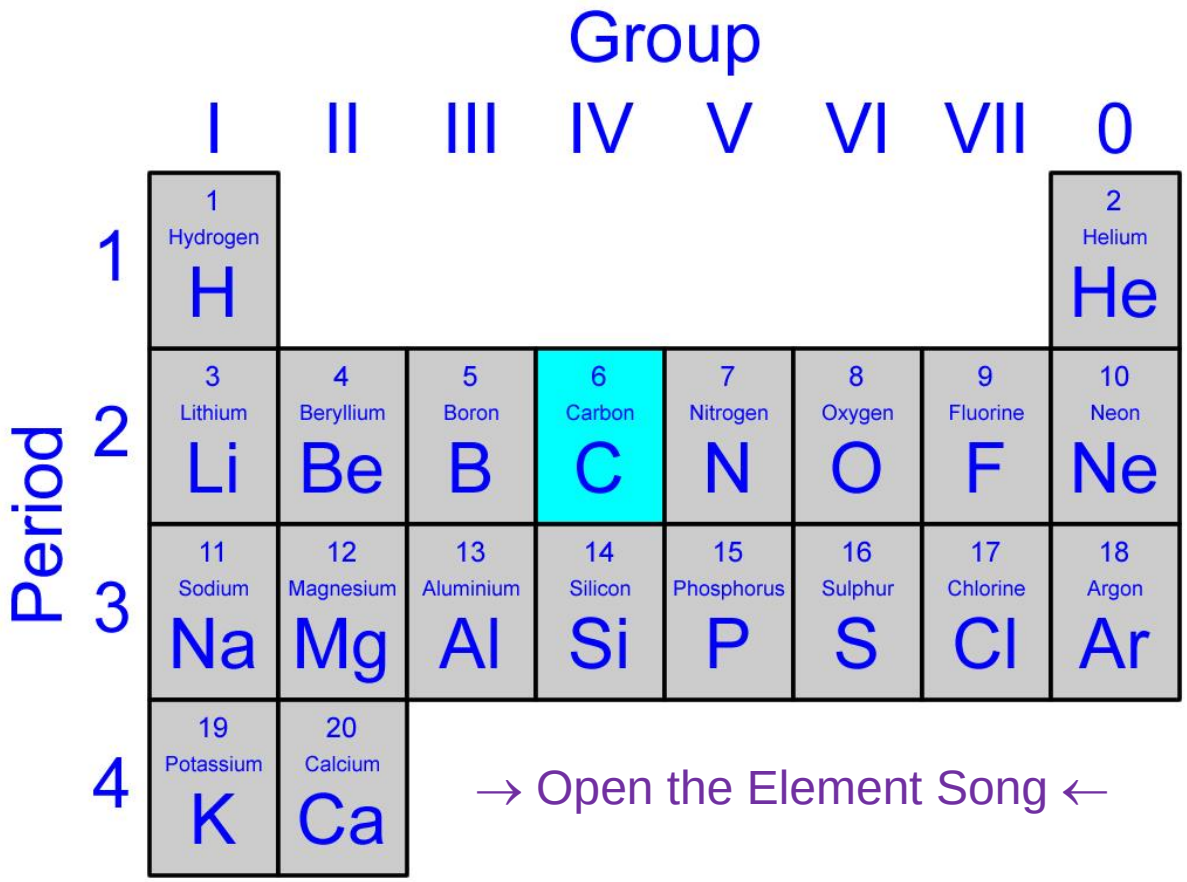
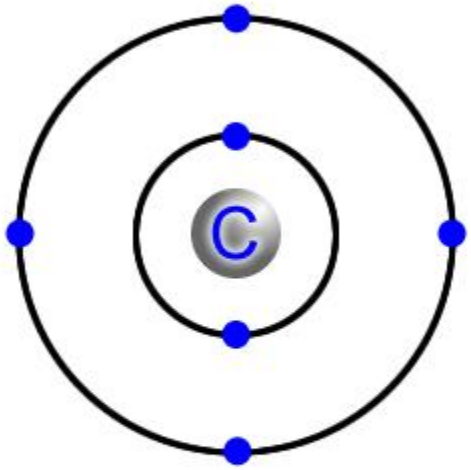


Introduction to Covalent Bonding

♥ Carbon has an atomic number of *six* because a single carbon atom has *six* protons and *six* electrons.

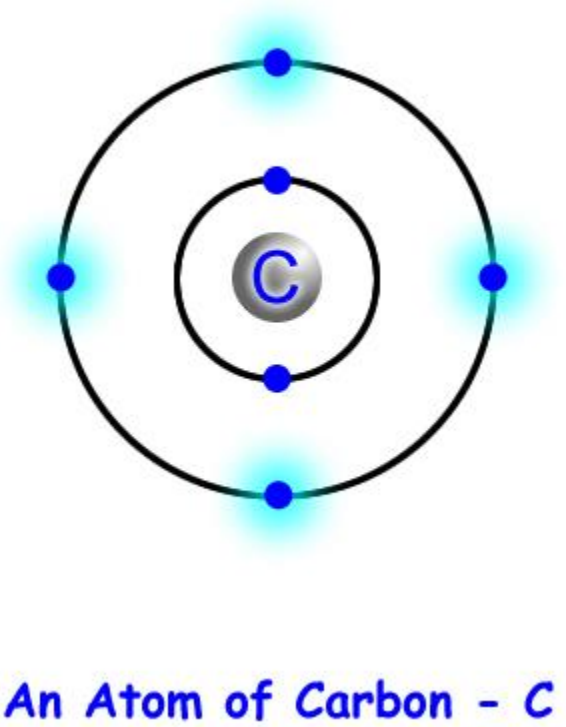


An Atom of Carbon - C

♥ Carbon is in the *second* Period of the Periodic Table because a single carbon atom has *two* electron shells.

Introduction to Covalent Bonding

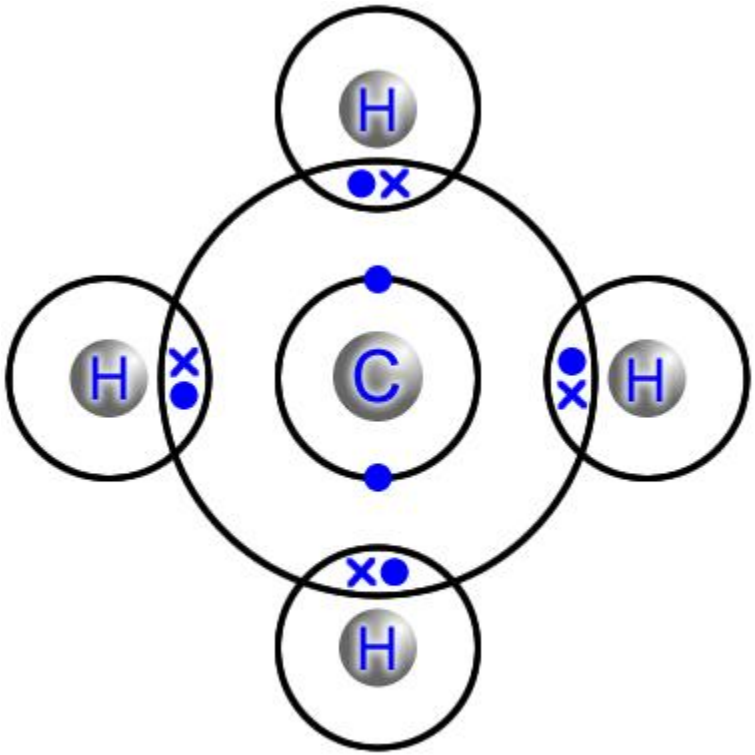
♥ Carbon is in the *Group IV* of the Periodic Table because a single carbon atom has *four* electrons in its outer electron shell.



♥ The outer electron shell of a single carbon atom can hold a maximum number of *eight* electrons.

Introduction to Covalent Bonding

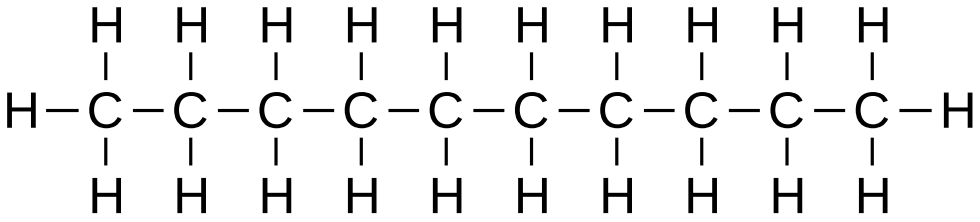
♥ A single carbon atom requires *four* more electrons to complete its outer electron shell.



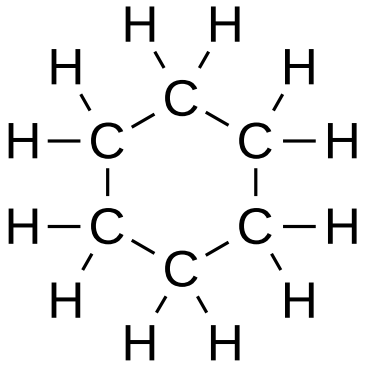
A Molecule of Methane - CH_4

♥ To achieve this, carbon atoms form *four* covalent bonds. Carbon is said to be *tetravalent*.

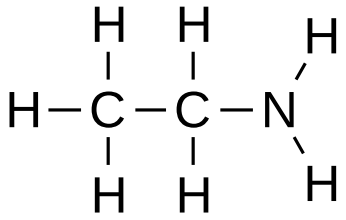
Introduction to Organic Chemistry



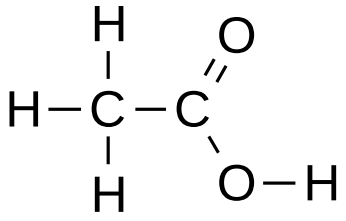
♥ Because the carbon-to-carbon covalent bond is very strong, carbon atoms can join together to form long chains and rings. Carbon is said to *catenate*.



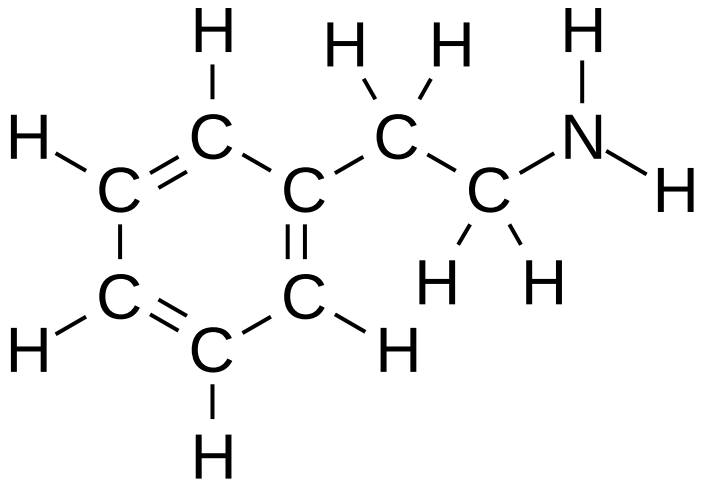
Introduction to Organic Chemistry

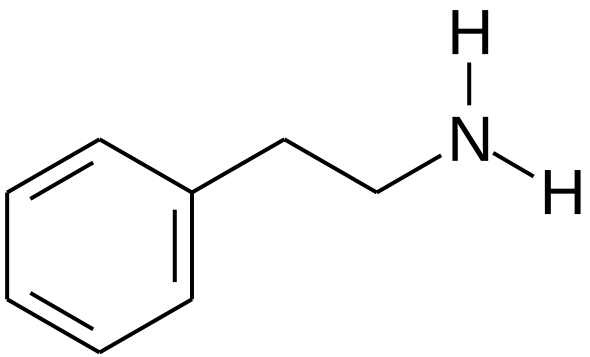


♥ Carbon atoms form strong, stable covalent bonds with other chemical elements such as *nitrogen* and *oxygen*.



Introduction to Organic Chemistry

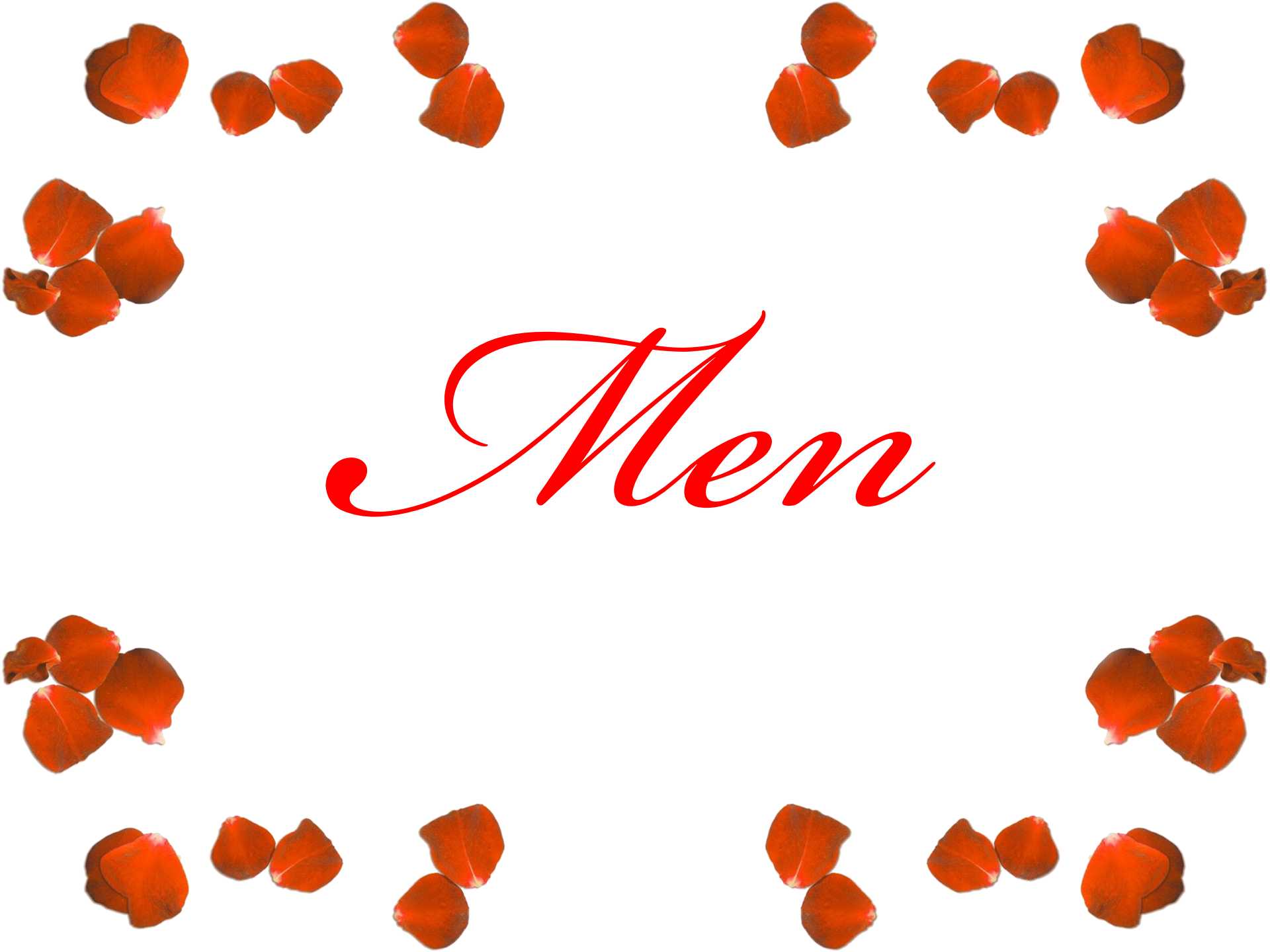


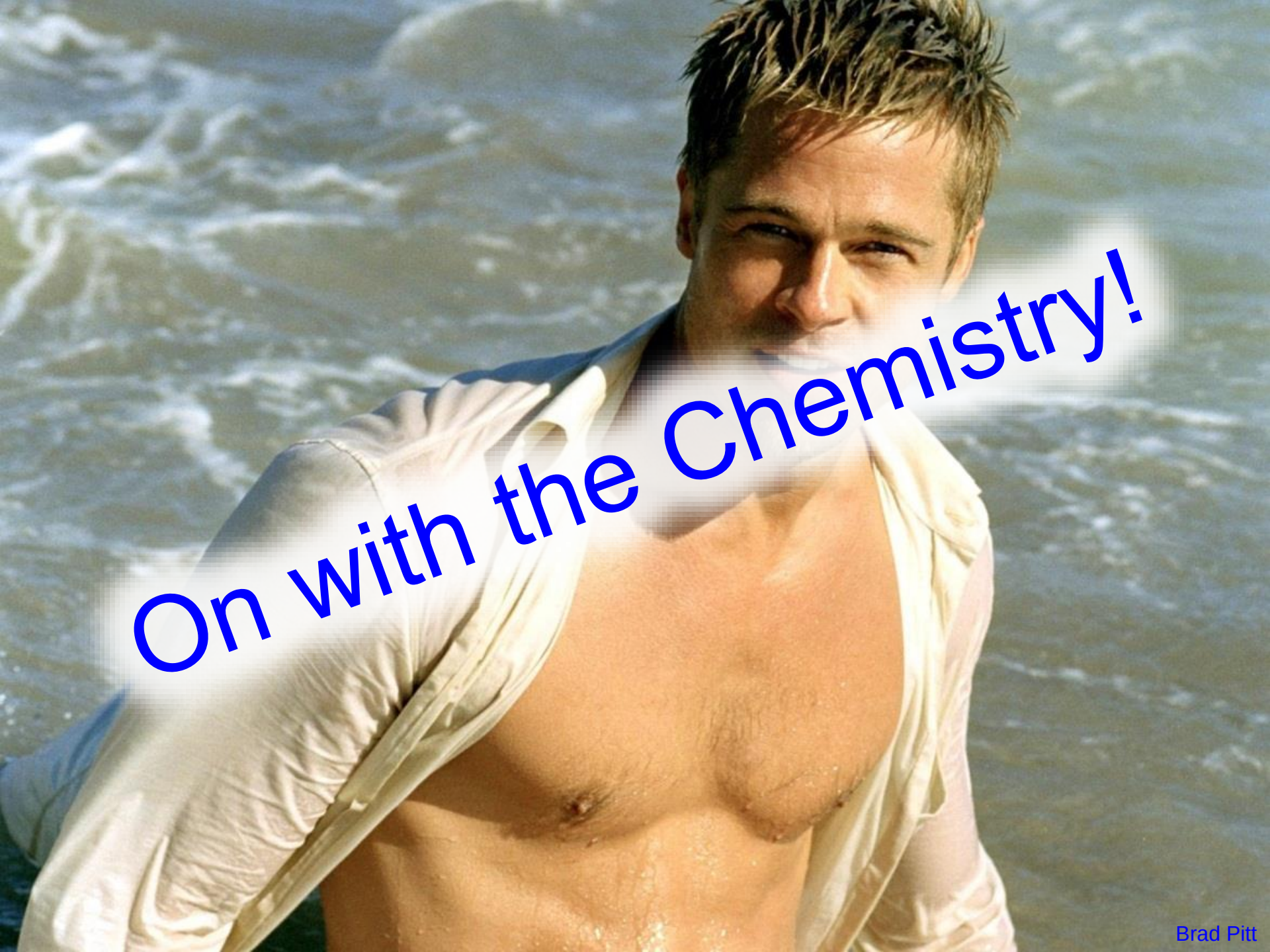


♥ It is often complex and time consuming to draw the full structural formulae of even relatively simple organic compounds.

♥ To avoid this problem, Chemists often use simplified structural formulae to represent organic compounds.

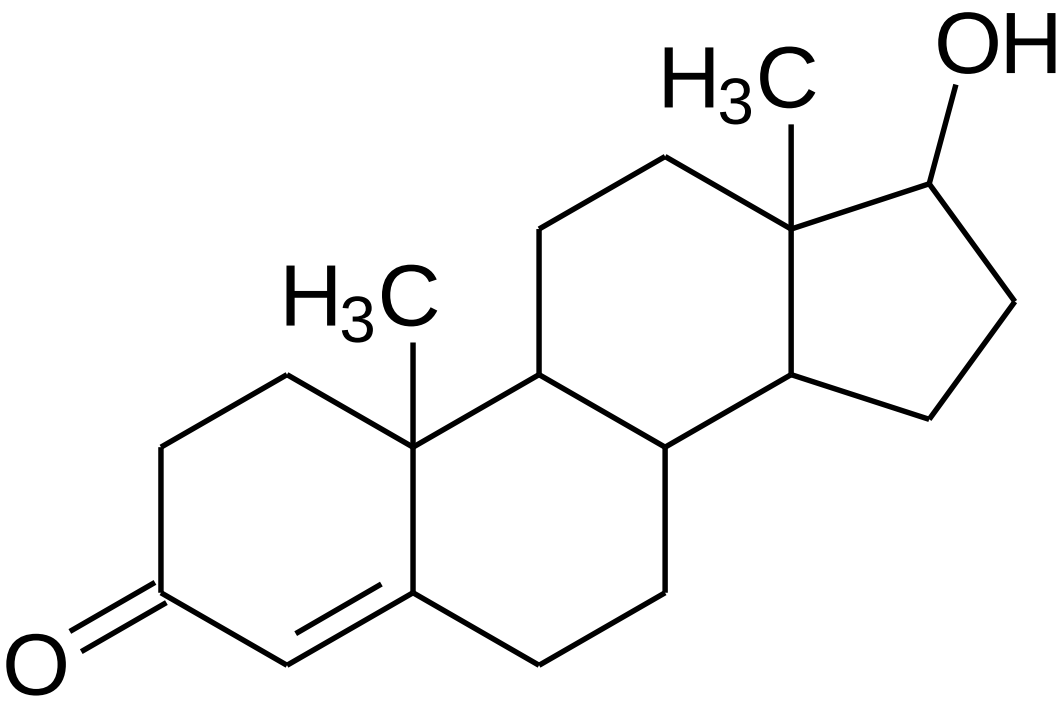

Part One
Infatuation


Men



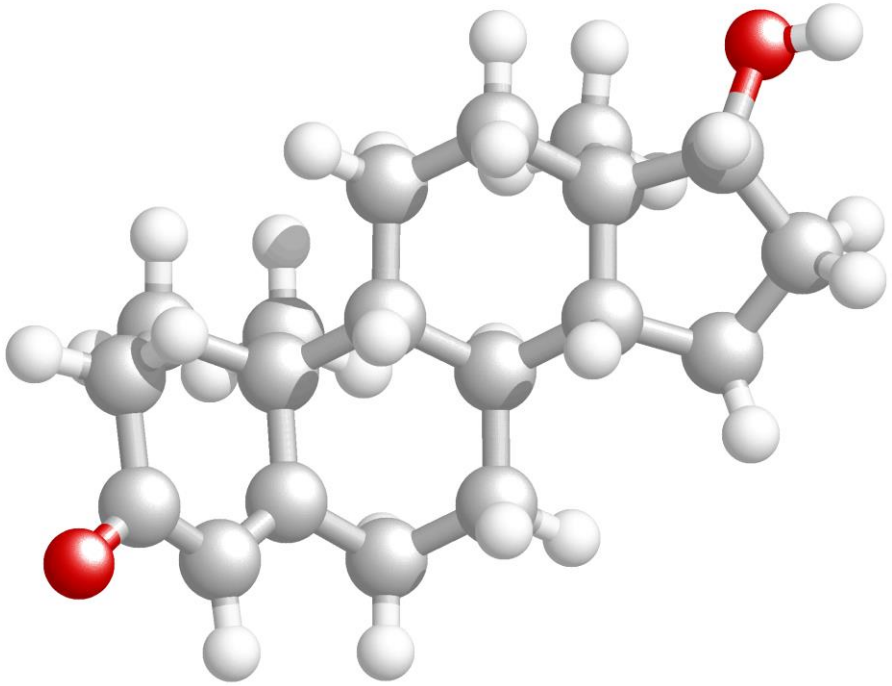
Brad Pitt

Testosterone



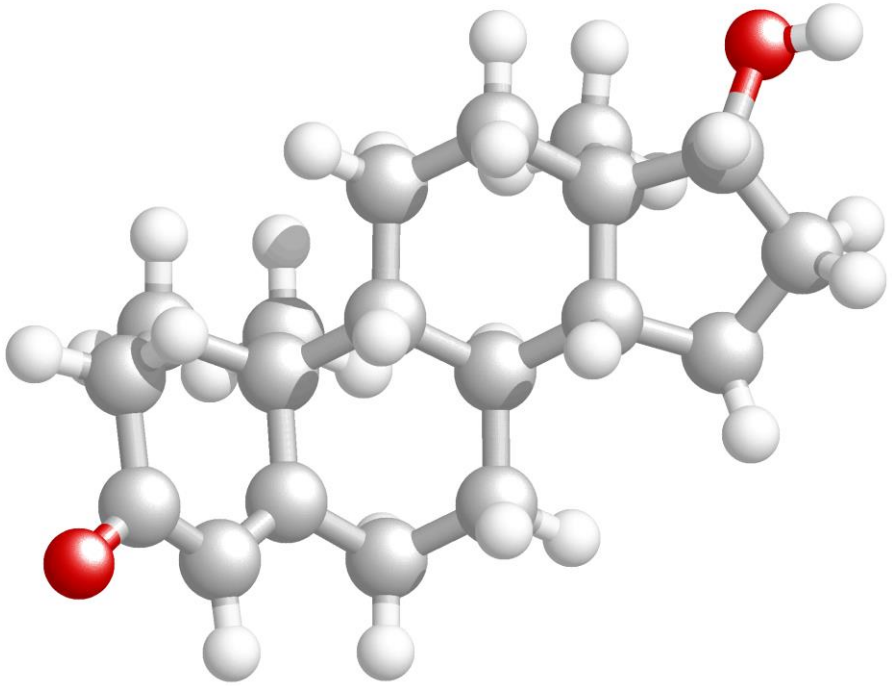
♥ *Testosterone* is the principle male sex hormone.

Testosterone



♥ *Hormones* are chemical messengers that travel throughout the body in the circulatory system.

Testosterone



♥ Compared to signals that are sent through the body via the central nervous system, signals sent using hormones have a *slower* response time but have a *longer lasting effect*.

Testosterone

Computer Manipulated Photographs of Julia Roberts and Tom Cruise.

♥ Research by scientists at the University of Liverpool has shown that women are more attracted to men with a feminine face. A masculine face is linked to high *testosterone* levels, which demonstrates good genetic qualities, while those men with a feminine face tend to be associated with stability and caring.

http://news.bbc.co.uk/2/hi/uk_news/4261489.stm

Testosterone

More Feminine Face

More Feminine Face

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http://news.bbc.co.uk/2/hi/uk_news/4261489.stm

Testosterone

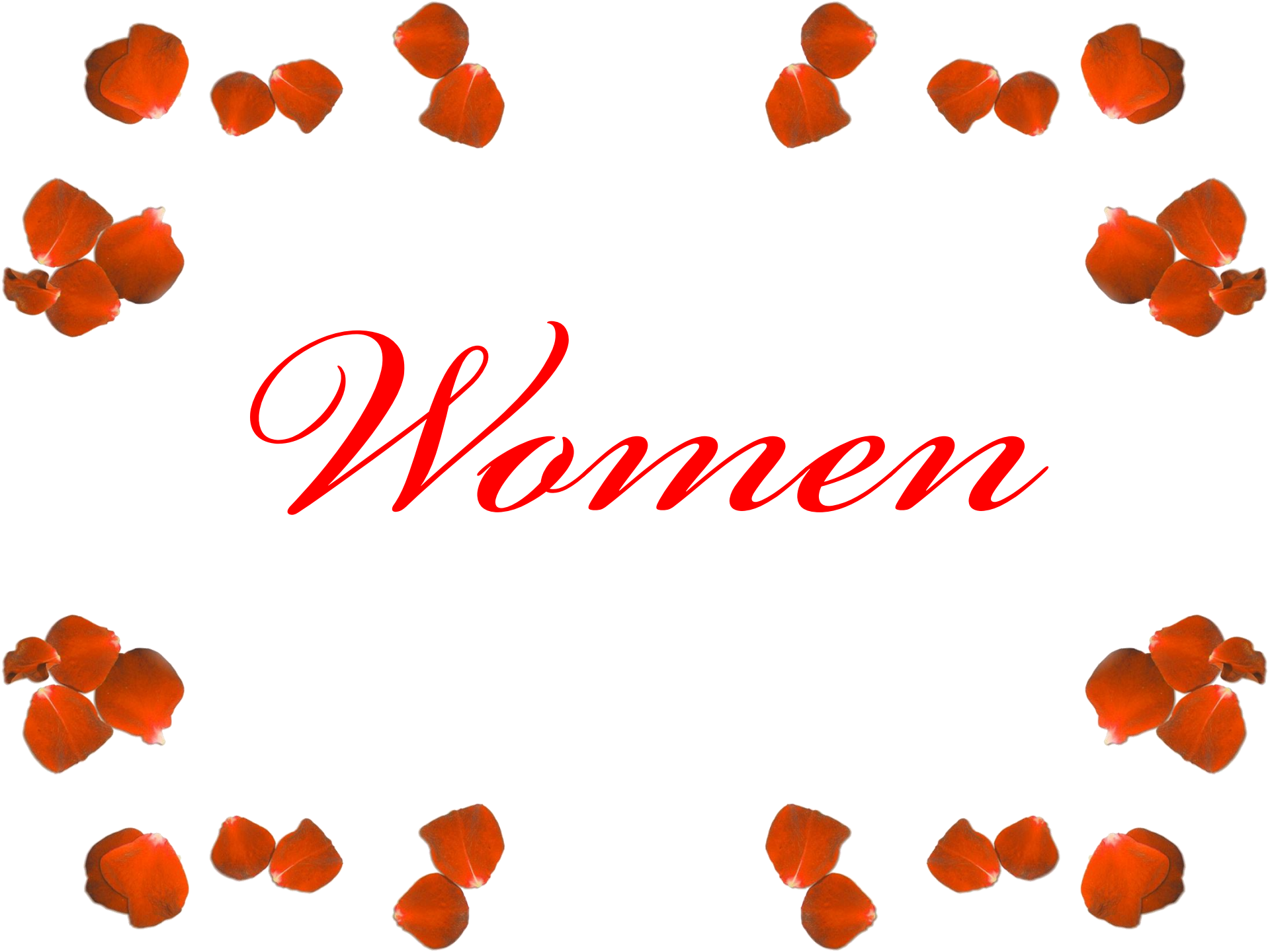
This supports my theory as to why K-Pop boy bands are so popular!

Testosterone

Testosterone… …In Women?

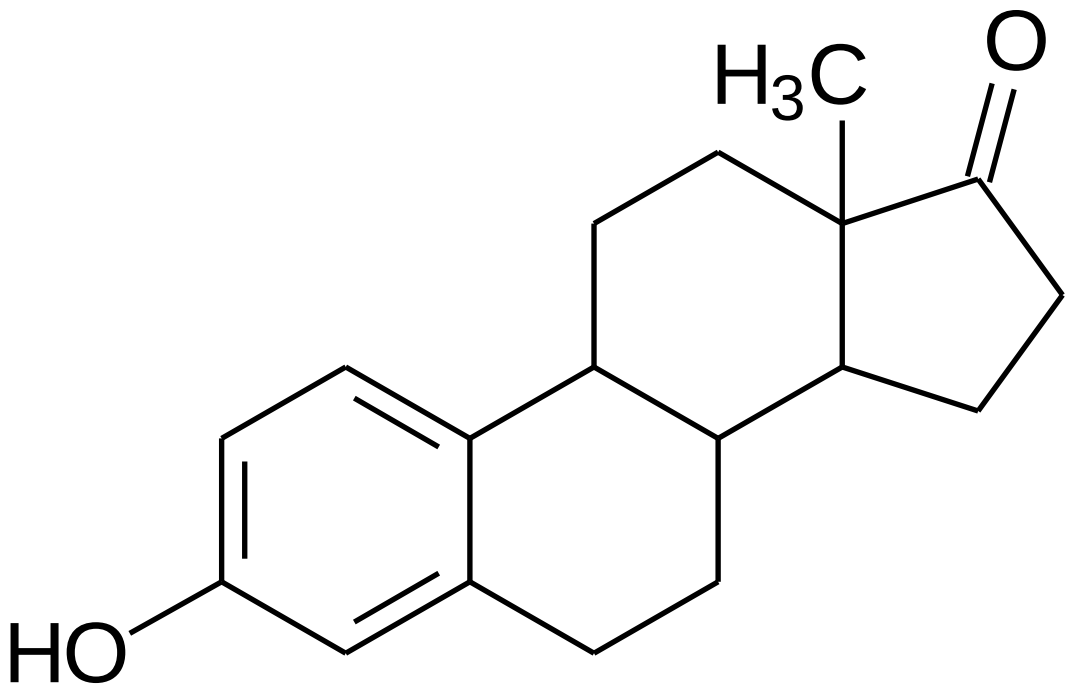
http://news.bbc.co.uk/2/hi/uk_news/4261489.stm

♥ A behavioural ecologist from the University of Cambridge has found *female* meerkats compete more intensely than *males* for breeding opportunities. This results in traits more usually found in males, such as increased size, *higher testosterone levels* and aggressiveness.


Women

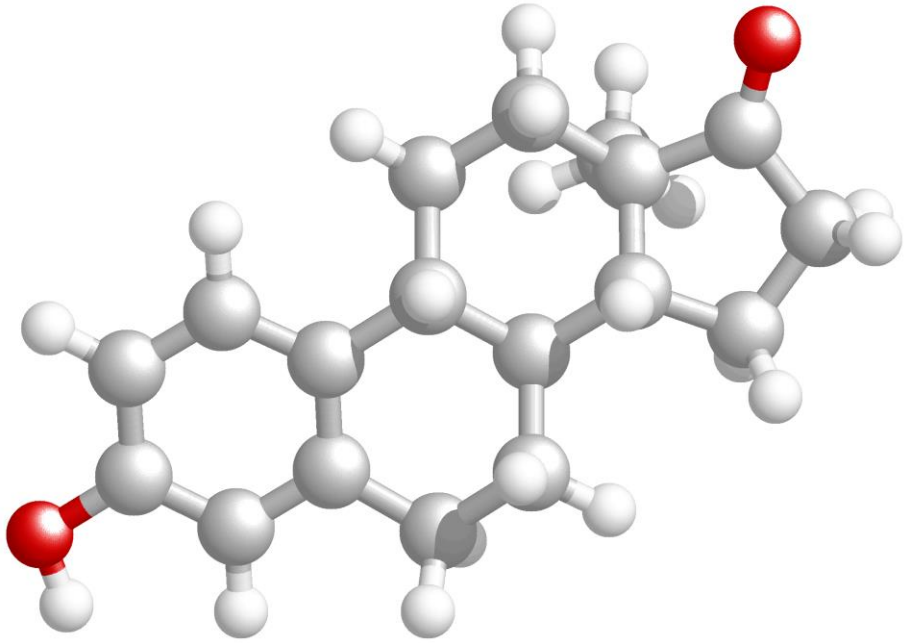

There’s more Chemistry!
Rebecca Lim

Oestrogens



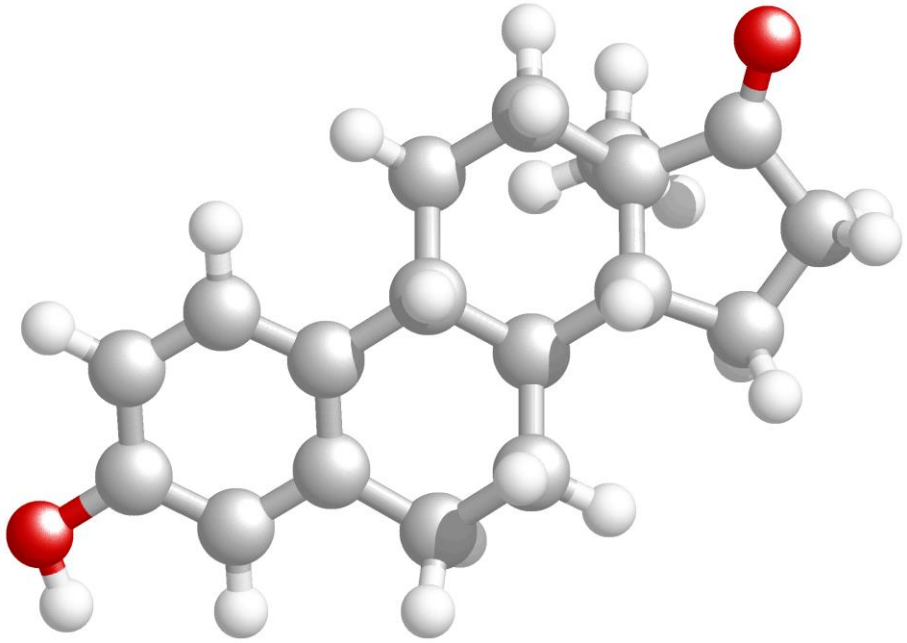
♥ *Oestrogens* are the principle female sex hormones.

Oestrogens



♥ Due to the unique and complex rings of carbon atoms that form their structures, testosterone and the oestrogens are described as a *steroidal hormones*.

Oestrogens



♥ A steroid is composed of four rings of carbon atoms – *three six-carbon rings* and *one five-carbon ring*.

Oestrogens

Photographs of identical twin sisters with different oestrogen levels.

♥ Research carried out at the University of St. Andrews suggests that women with high levels of the sex hormone *oestrogen* have prettier faces. The findings make evolutionary sense because it means that men are attracted to the most fertile women. Oestrogen levels during puberty can impact on appearance by affecting bone growth and skin texture.

http://news.bbc.co.uk/go/pr/fr/-/1/hi/health/4396230.stm

Oestrogens

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The Mathematics of Beauty

♥ What do these four women all have in common?

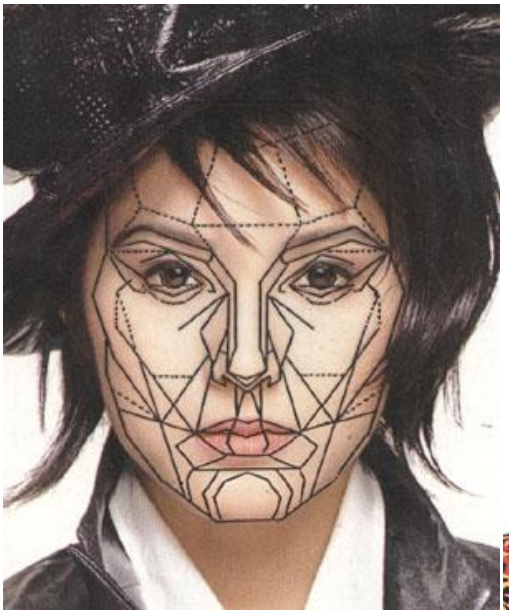


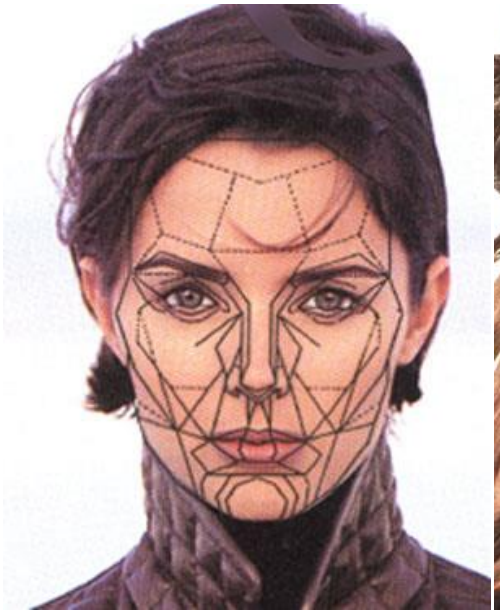
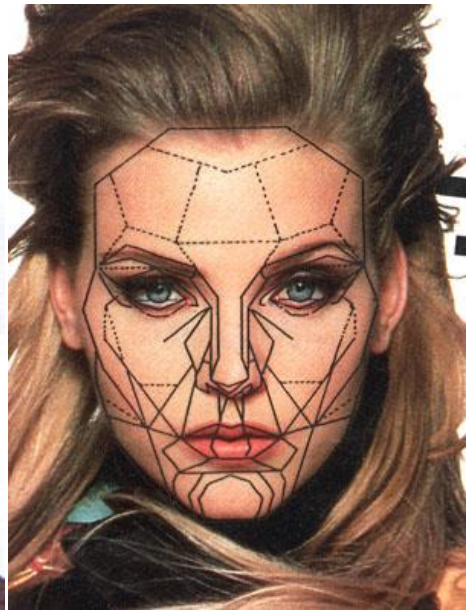

http://www.beautyanalysis.com

♥ They are all beautiful… …from a *mathematical* point-of-view.

The Mathematics of Beauty

- What do these four women all have in common?

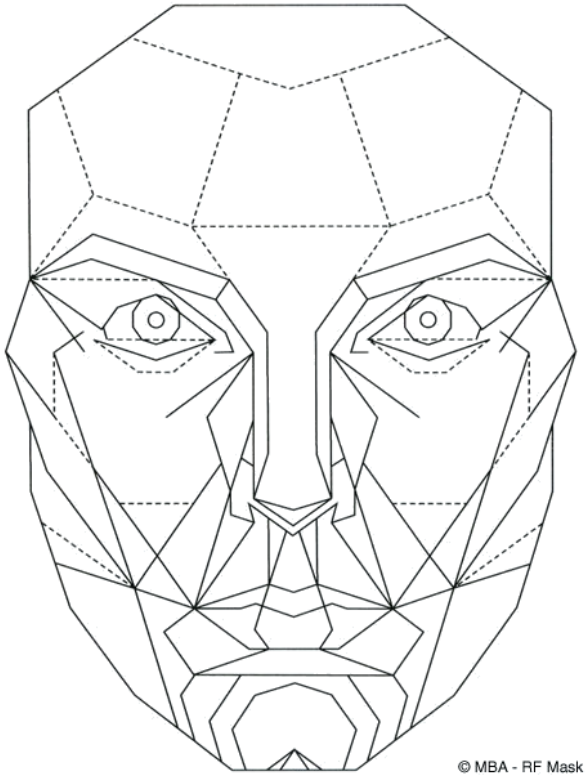


http://www.beautyanalysis.com

- Their facial features share the same mathematical arrangements, the same mathematical *ratios*.

The Mathematics of Beauty



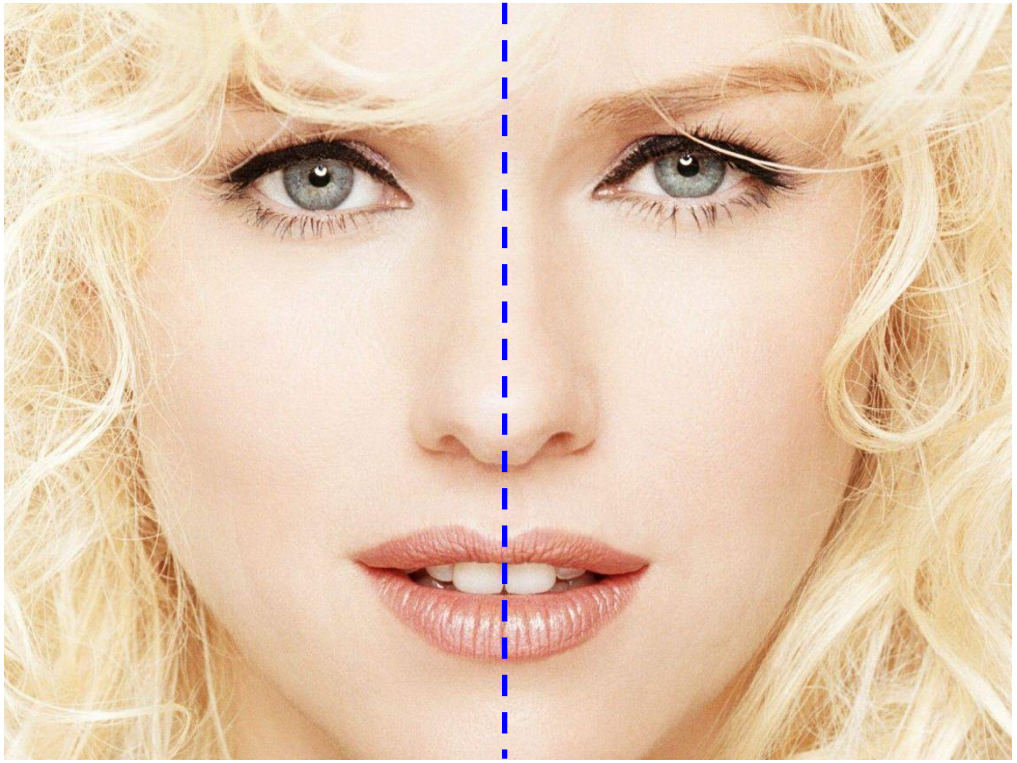
http://www.beautyanalysis.com

♥ Dr. Stephen Marquardt's *Golden Mask* based on the *Golden Ratio* of *1 : 1.61814*

The Mathematics of Beauty

Naomi Watts

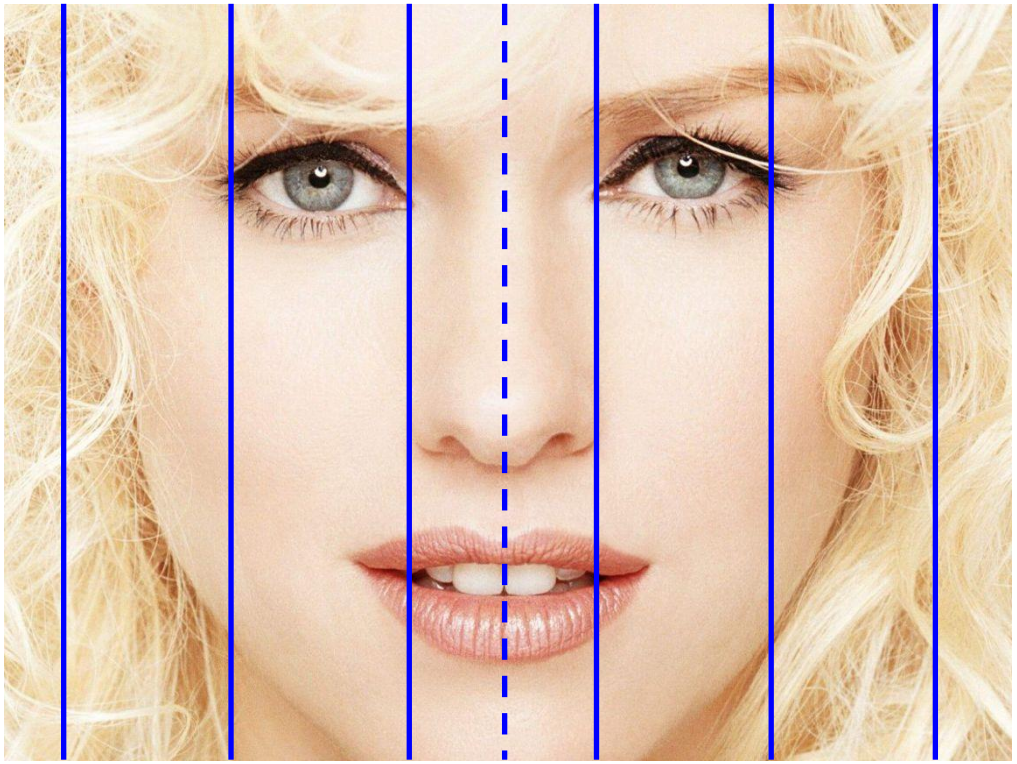
The Mathematics of Beauty



Naomi Watts

- ♥ Facial Symmetry

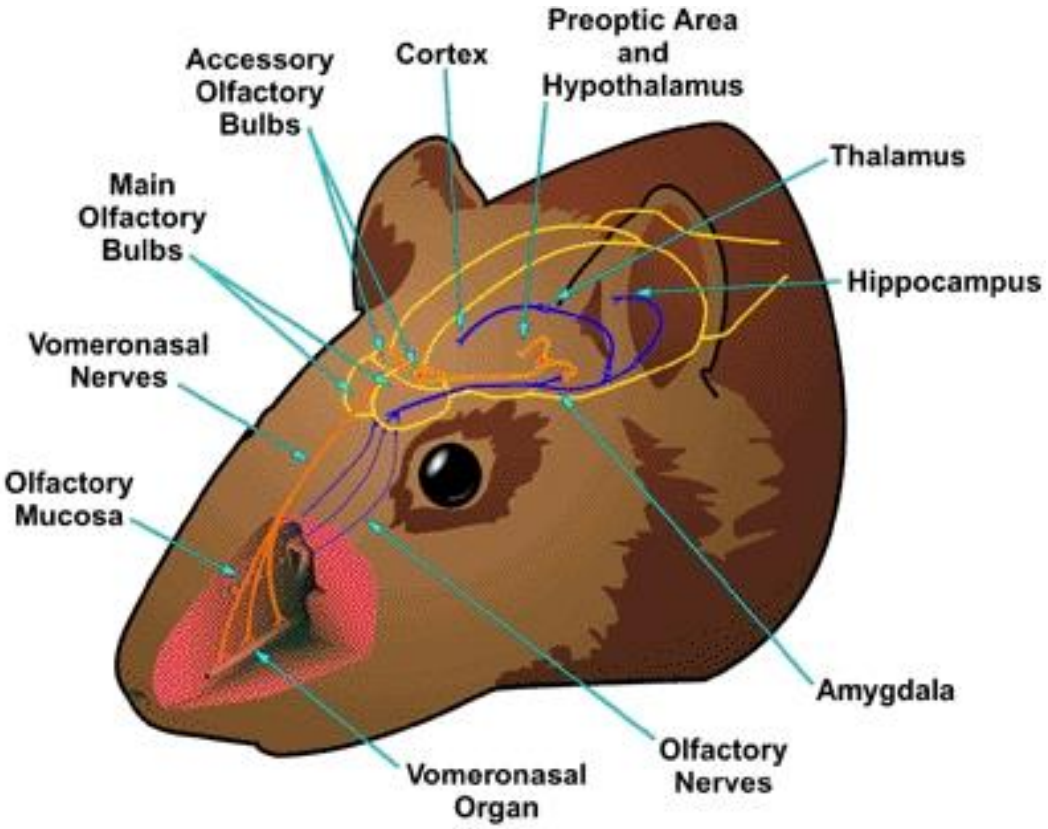
The Mathematics of Beauty



Naomi Watts

- Facial Symmetry
- The Rule of Fifths

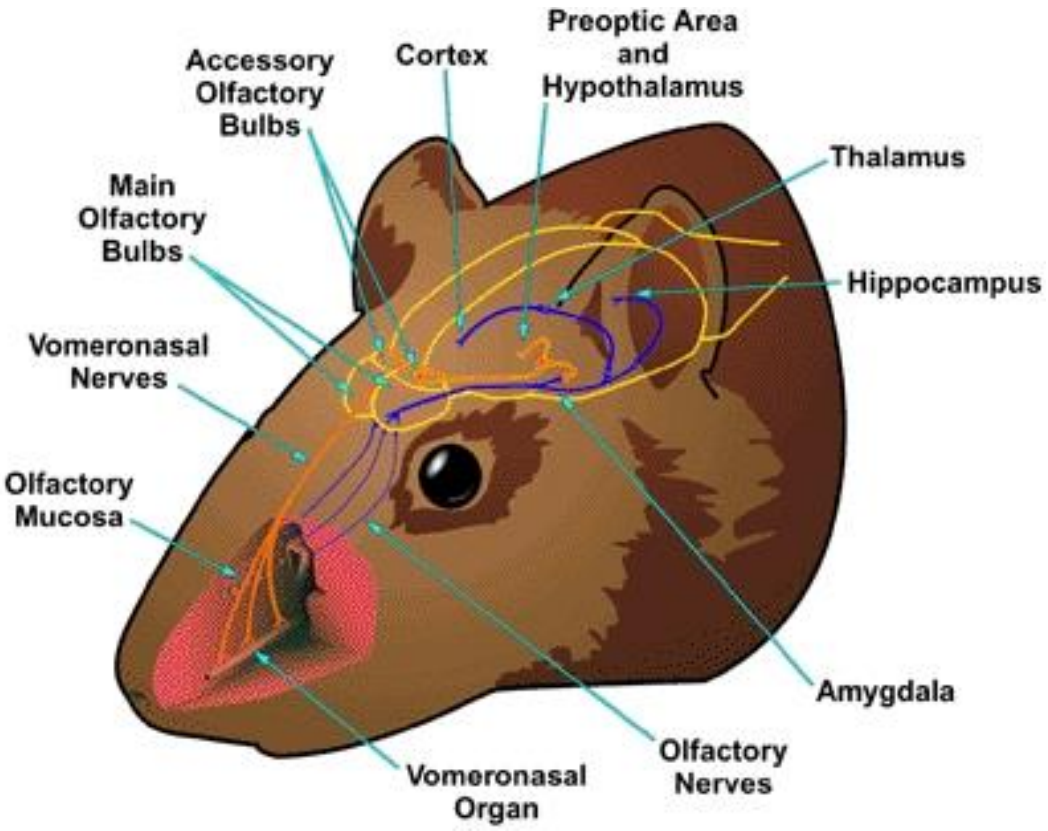
Pheromones



♥ A *pheromone* is any chemical or mixture of chemicals produced by a living organism that transmits a message to other members of the same species.

http://en.wikipedia.org

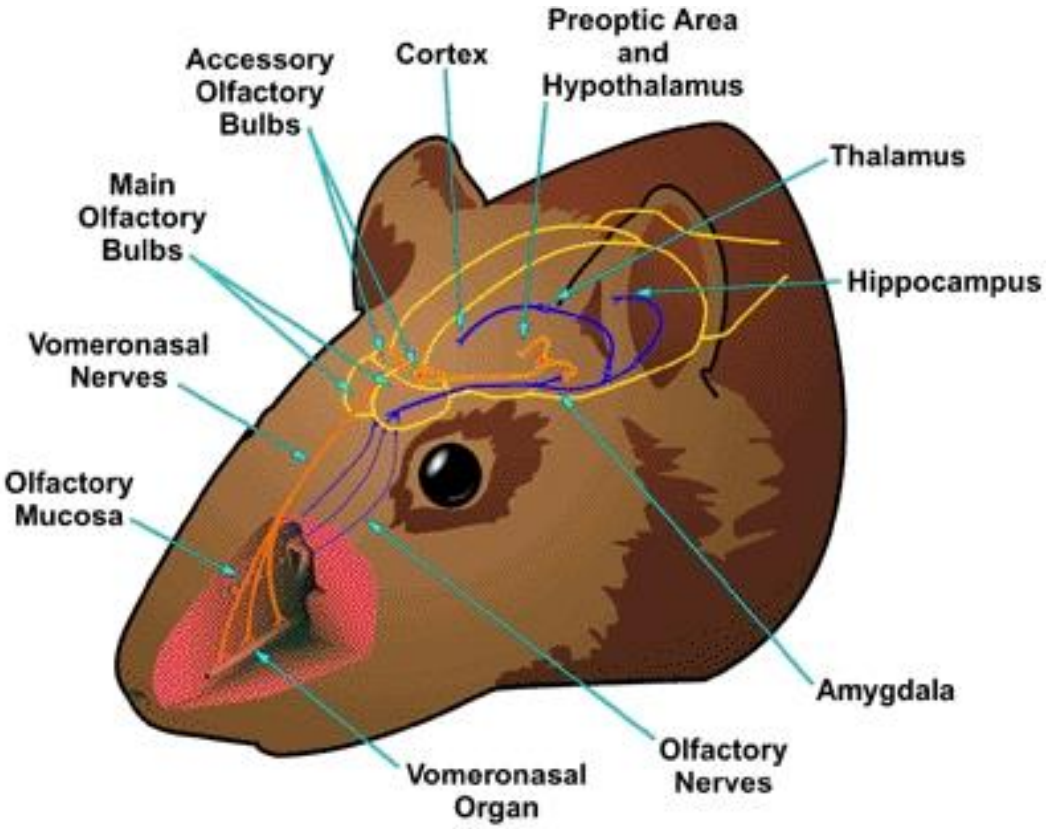
Pheromones



♥ Pheromones in humans are believed to be produced by the *apocrine glands*. These glands become functional after reaching puberty, which could explain why most people develop an attraction for others at that time. Pheromones could also be the reason why a person can sense *chemistry*, or feel an instant attraction or dislike when first meeting someone.

http://en.wikipedia.org

Pheromones



The detection of pheromones in animals had been linked to a specific organ in the nose called the *vomeronasal organ*. However, the same organ has not yet been found in humans.

http://en.wikipedia.org

The Smell of Love

The Smell of Love

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♥ At the University of Bern in Switzerland, a group of male students were given untreated cotton T-shirts to wear as they slept alone for two consecutive nights. They were told not to eat spicy foods, not to use deodorants, cologne, or perfumed soaps. During the day, their sweaty shirts were kept in sealed plastic containers.

http://www.psychologytoday.com/articles/200910/the-smell-love?page=3

The Smell of Love

The Smell of Love

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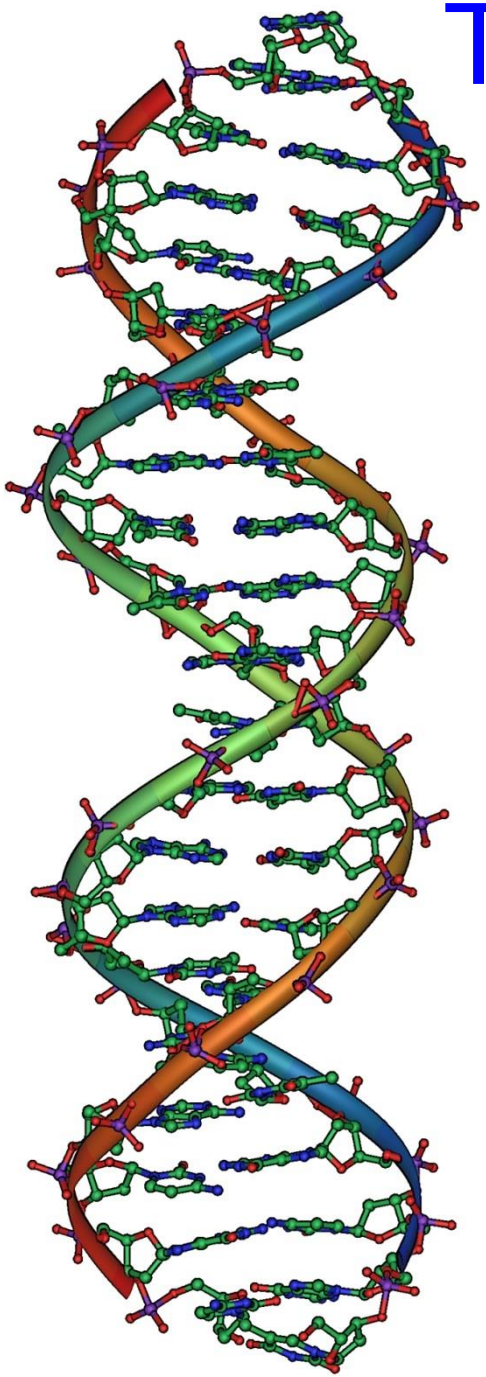
♥ And then came the big smell test. Female university students were put alone in a room and presented with boxes containing the male volunteers' shirts. First they sniffed a new, unworn shirt to control for the scent of the shirts themselves. Then the women were asked to rate each man's shirt for “sexiness,” “pleasantness,” and “intensity of smell.”

http://www.psychologytoday.com/articles/200910/the-smell-love?page=3

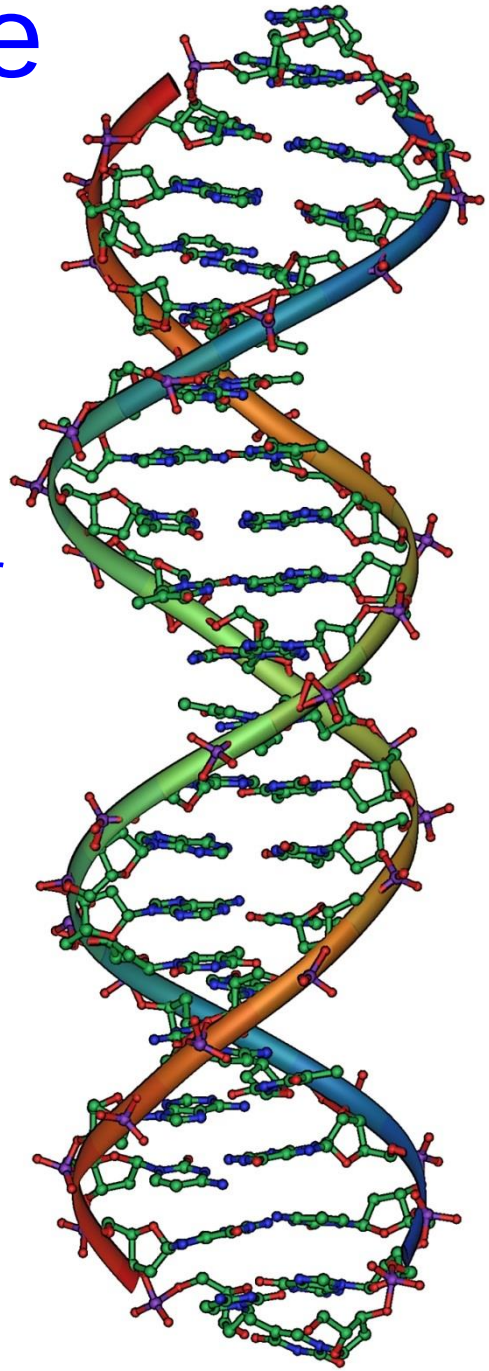
- Blood samples were taken from all of the male and female university students who participated in the research.
- Each student had their own unique DNA fingerprint mapped out.

The Smell of Love

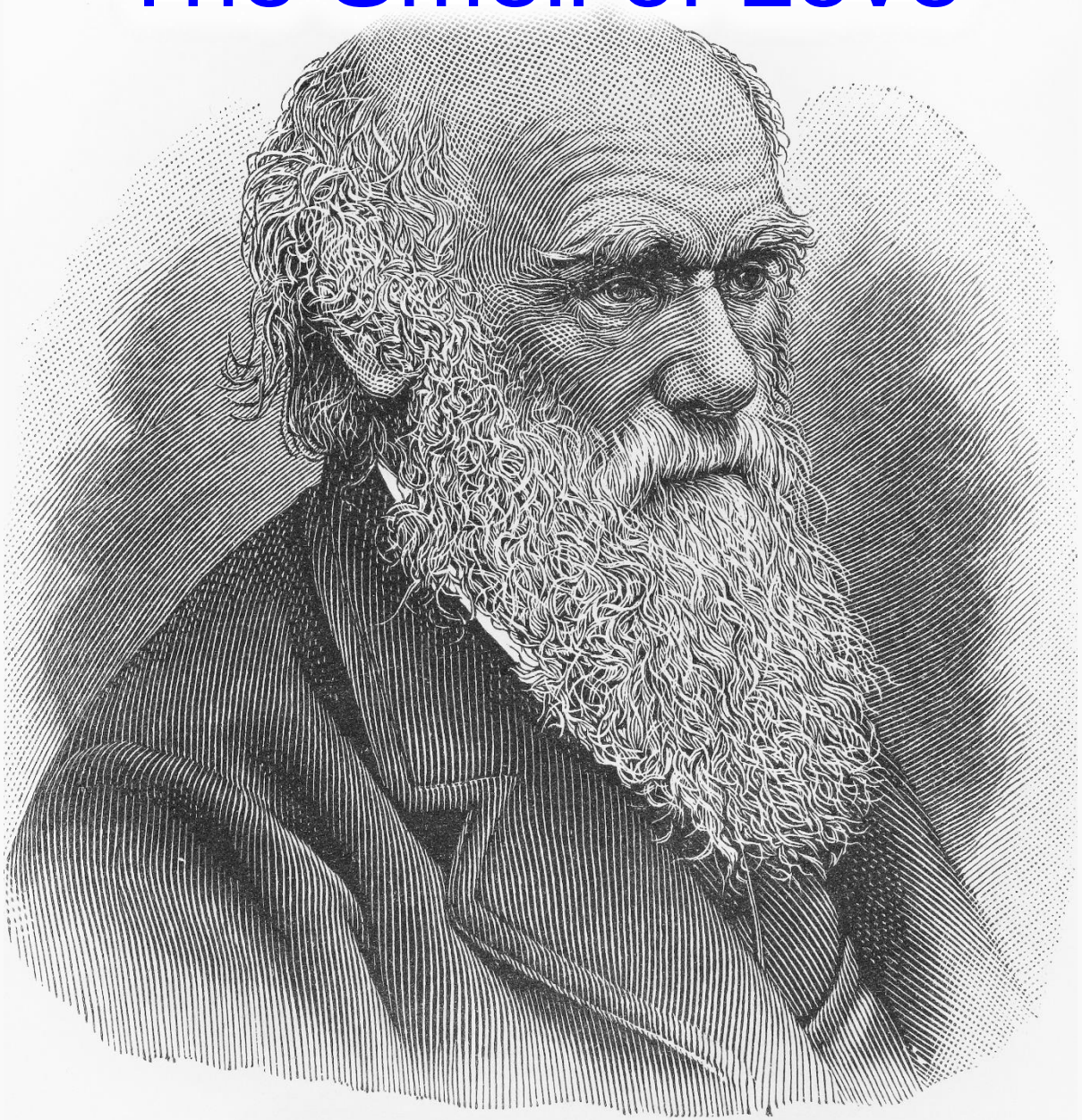


♥ The researchers discovered that how women rate a man's body odor pleasantness and sexiness depends upon how much of their genetic profile is shared. *Overall, women prefer those scents exuded by men whose genetic profiles varied the most from their own*. Hence, any given man's odor could be pleasingly alluring to one woman, yet an offensive turnoff to another.

http://www.psychologytoday.com/articles/200910/the-smell-love?page=3



The Smell of Love

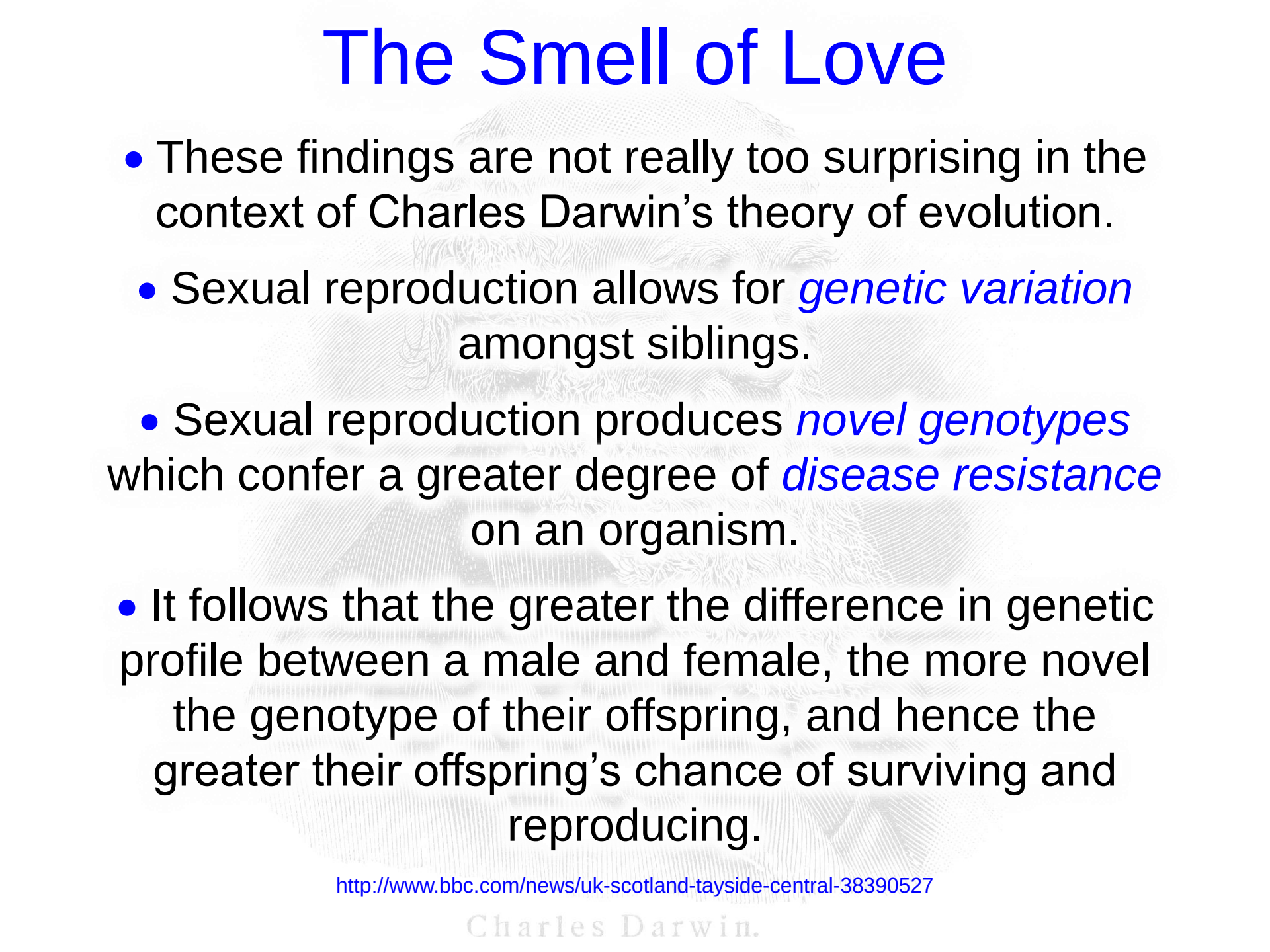


Charles Darwin.

The Smell of Love

- These findings are not really too surprising in the context of Charles Darwin's theory of evolution.
- Sexual reproduction allows for *genetic variation* amongst siblings.
- Sexual reproduction produces *novel genotypes* which confer a greater degree of *disease resistance* on an organism.
- It follows that the greater the difference in genetic profile between a male and female, the more novel the genotype of their offspring, and hence the greater their offspring's chance of surviving and reproducing.

http://www.bbc.com/news/uk-scotland-tayside-central-38390527



The Colour of Love

What is the colour of love?

The Colour of Love

Women who put on a **red** dress before going out with a man may find their date more attentive and generous, according to scientists at the University of Rochester in England. The researchers say that their study is clear evidence that the colour **red** makes men feel more amorous – even if this is only on a subconscious level.

"*It's fascinating to find that something as ubiquitous as colour can be having an effect on our behaviour without our awareness*."

Professor Andrew Elliot
University of Rochester.

http://news.bbc.co.uk/go/pr/fr/-/1/hi/health/7693708.stm
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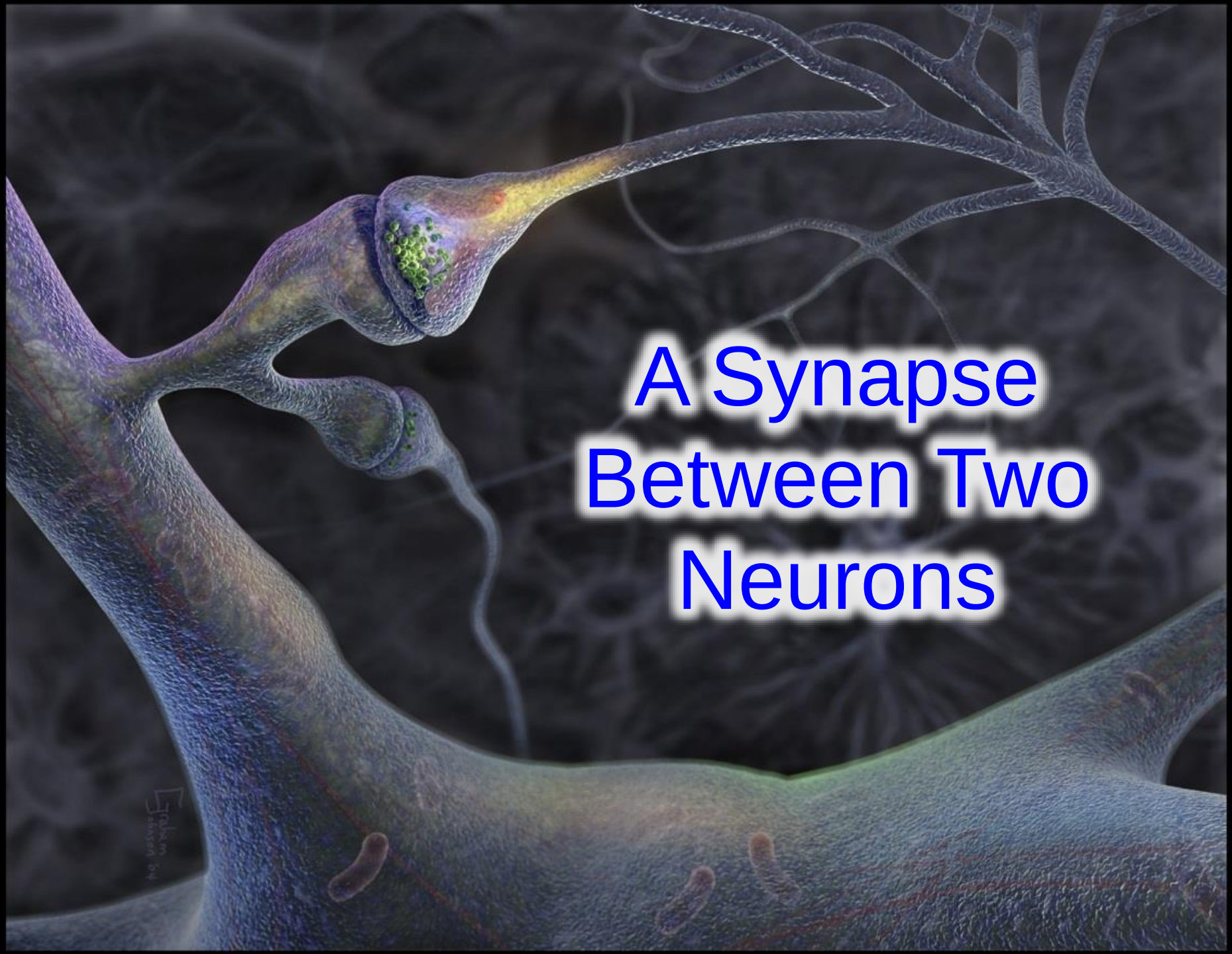
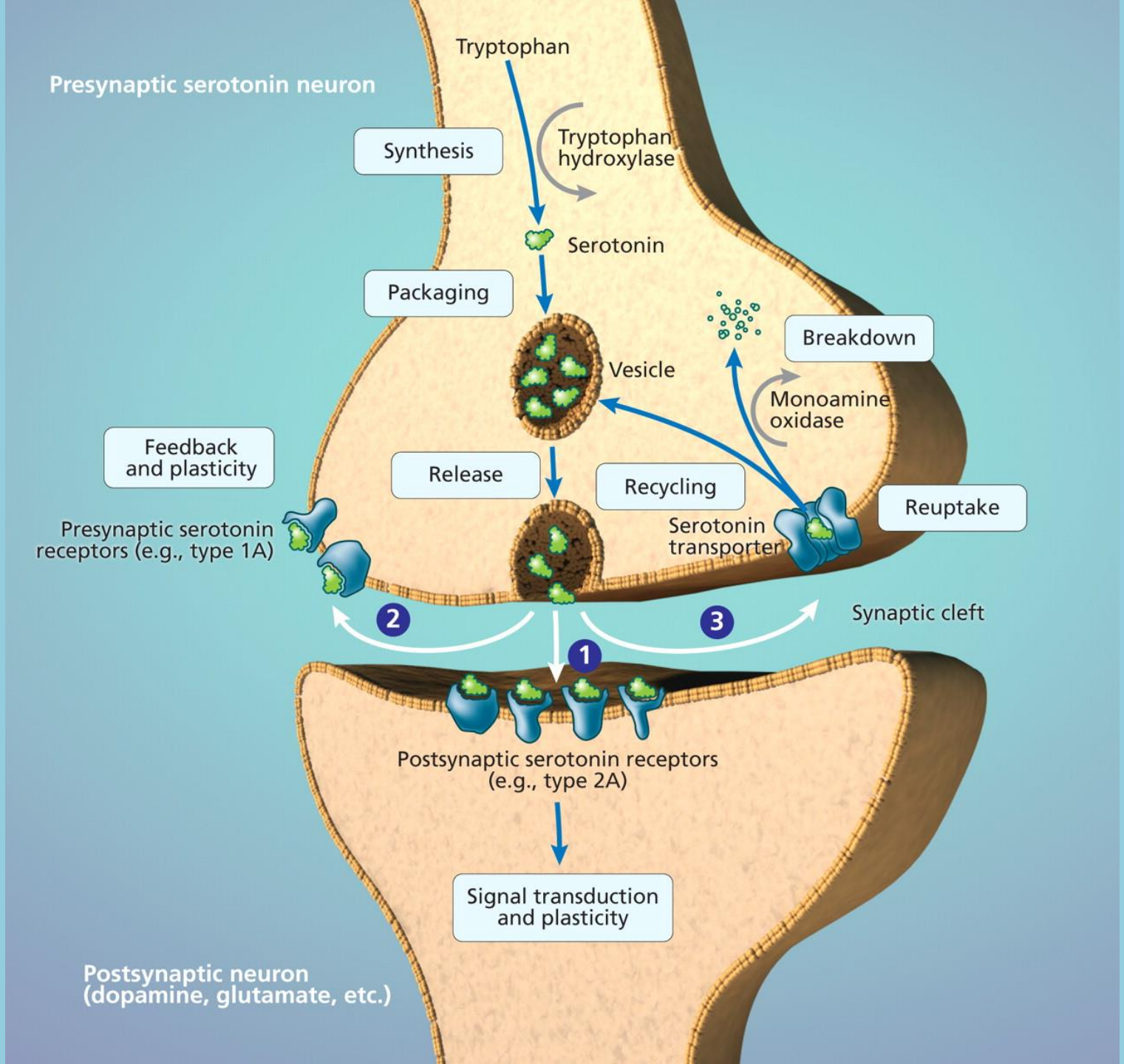
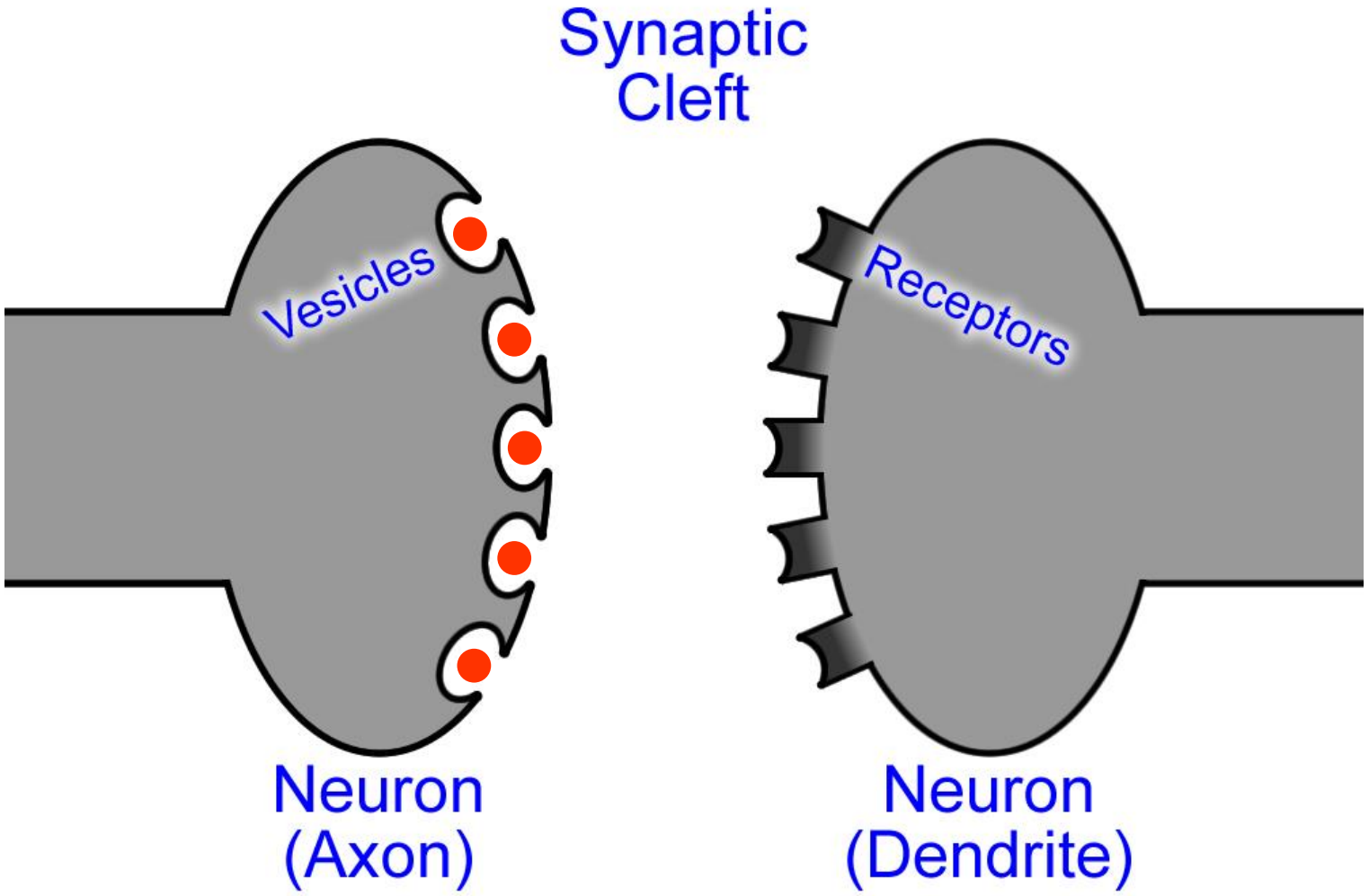
Part Two

True Love

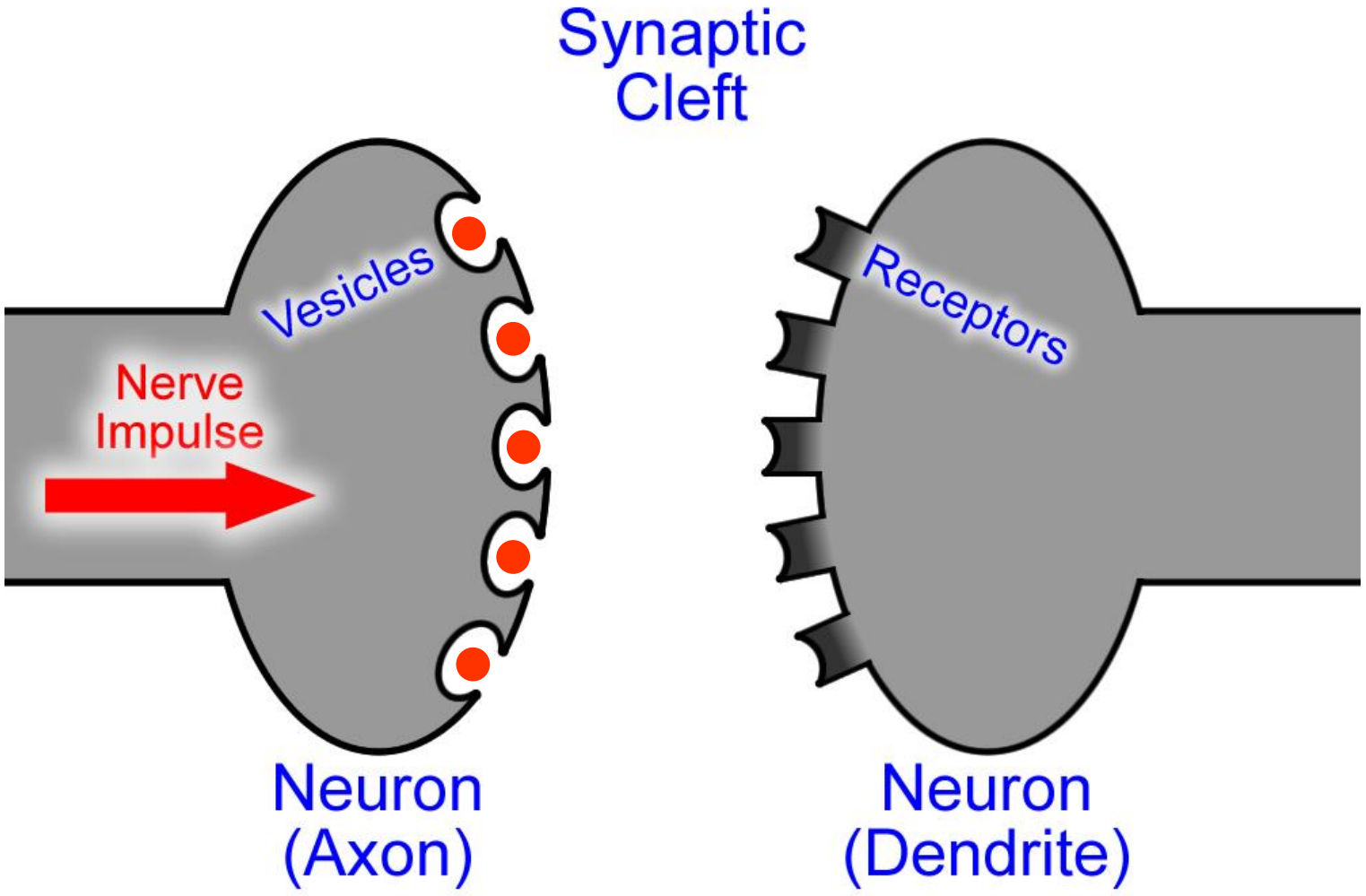

A Synapse
Between Two
Neurons


Presynaptic serotonin neuron
Tryptophan
Synthesis
Tryptophan hydroxylase
Serotonin
Packaging
Vesicle
Breakdown
Monoamine oxidase
Feedback and plasticity
Release
Recycling
Reuptake
Presynaptic serotonin receptors (e.g., type 1A)
Serotonin transporter
2
3
Synaptic cleft
1
Postsynaptic serotonin receptors (e.g., type 2A)
Signal transduction and plasticity
Postsynaptic neuron (dopamine, glutamate, etc.)

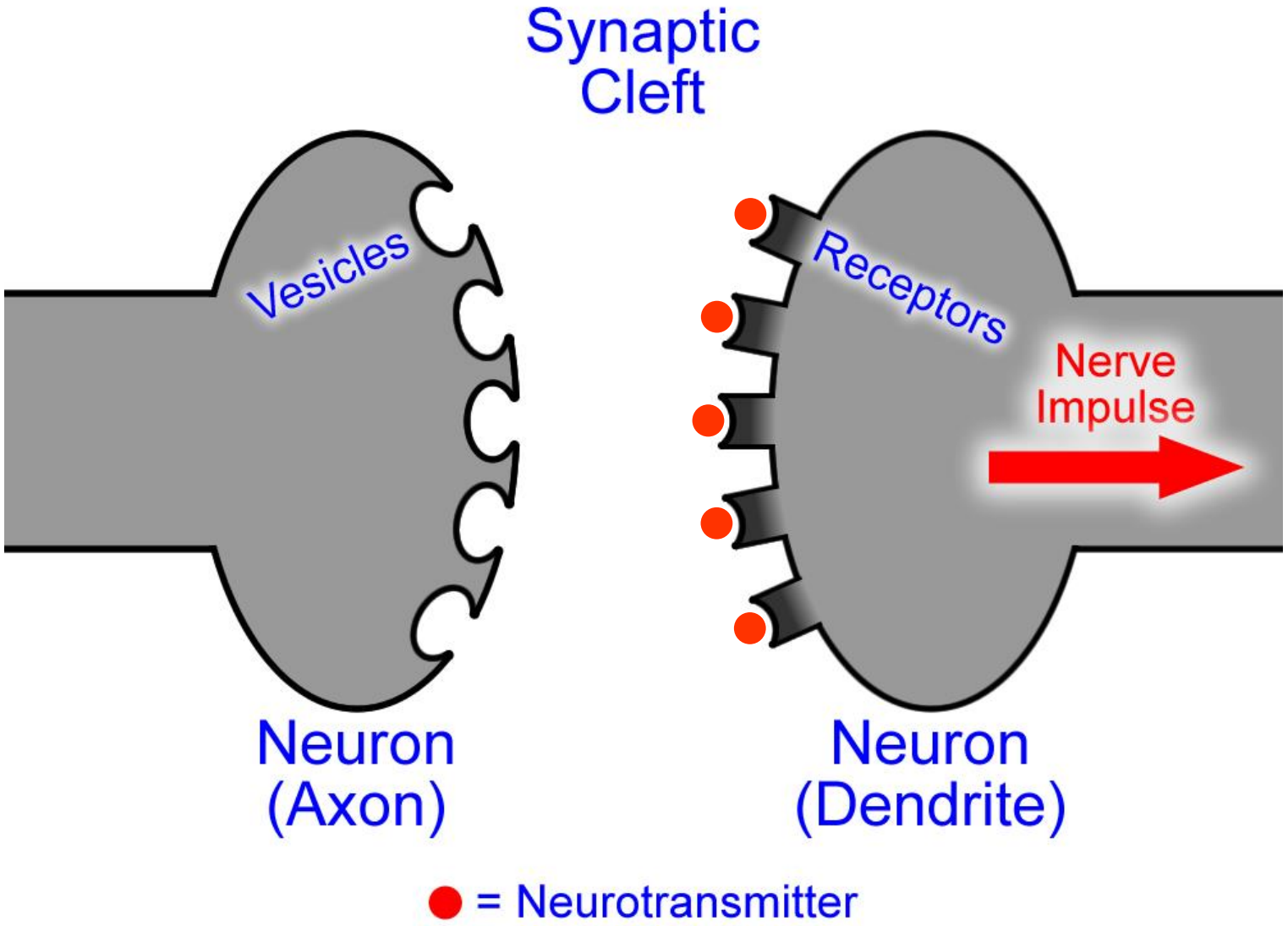
Central Nervous System – Synapse



Central Nervous System – Synapse

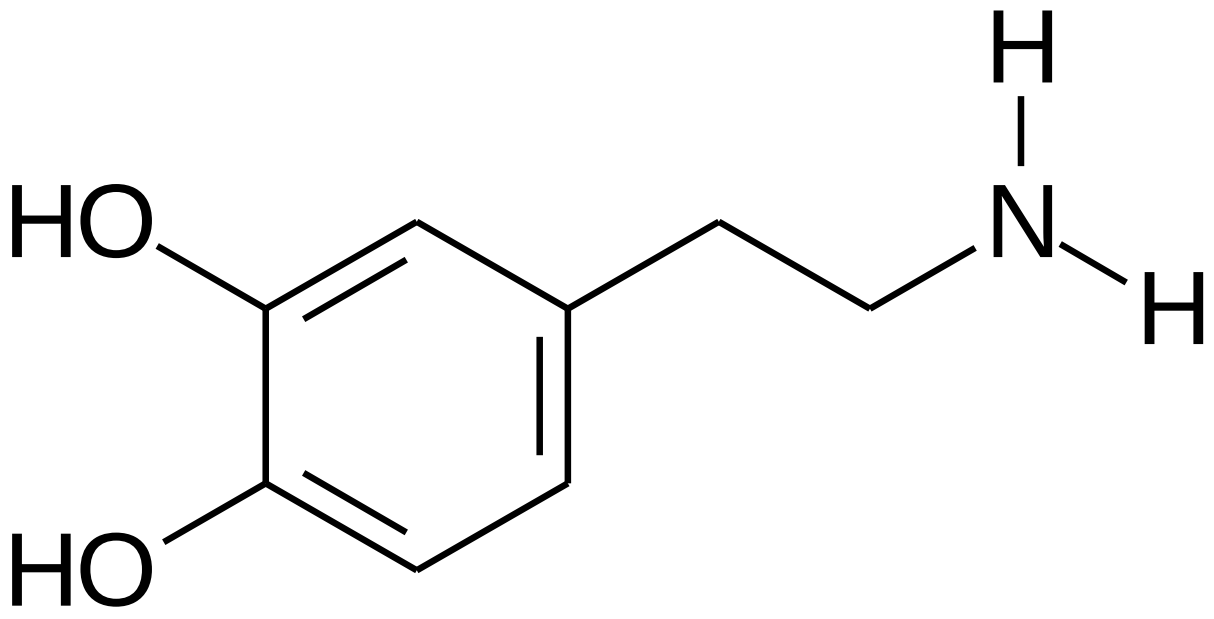


Central Nervous System – Synapse



Love is a Drug

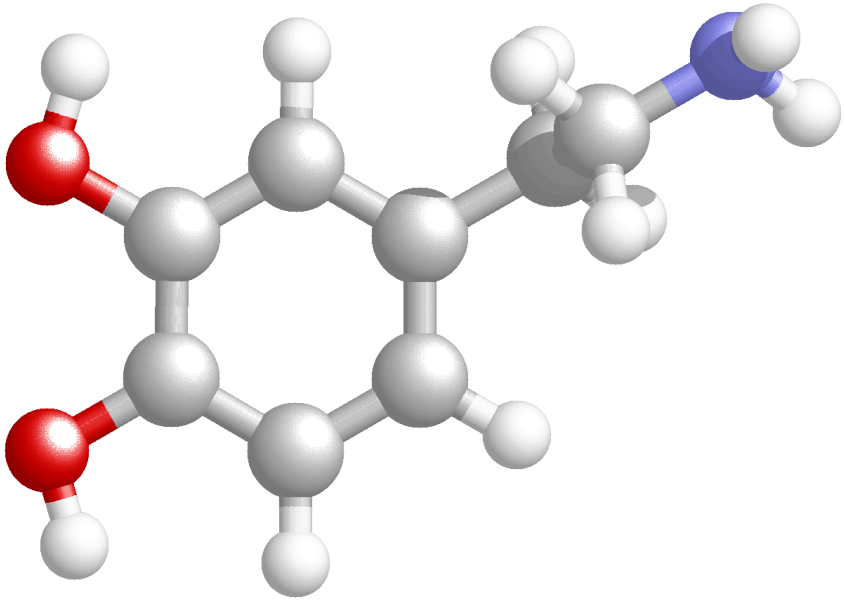
Dopamine



♥ A Florida State University team has found that the brain chemistry responsible for drug addiction also plays a role in love.

http://news.bbc.co.uk/go/pr/fr/-/2/hi/health/4498764.stm

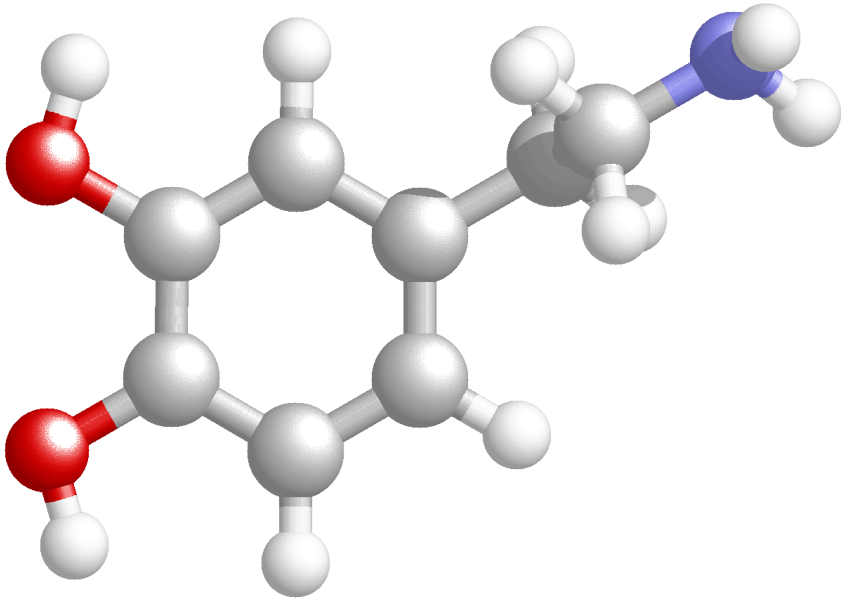
Dopamine



♥ Researchers said the messenger chemical *dopamine*, which stimulates the brain's reward centre, helps to keep animals monogamous.

http://news.bbc.co.uk/go/pr/fr/-/2/hi/health/4498764.stm

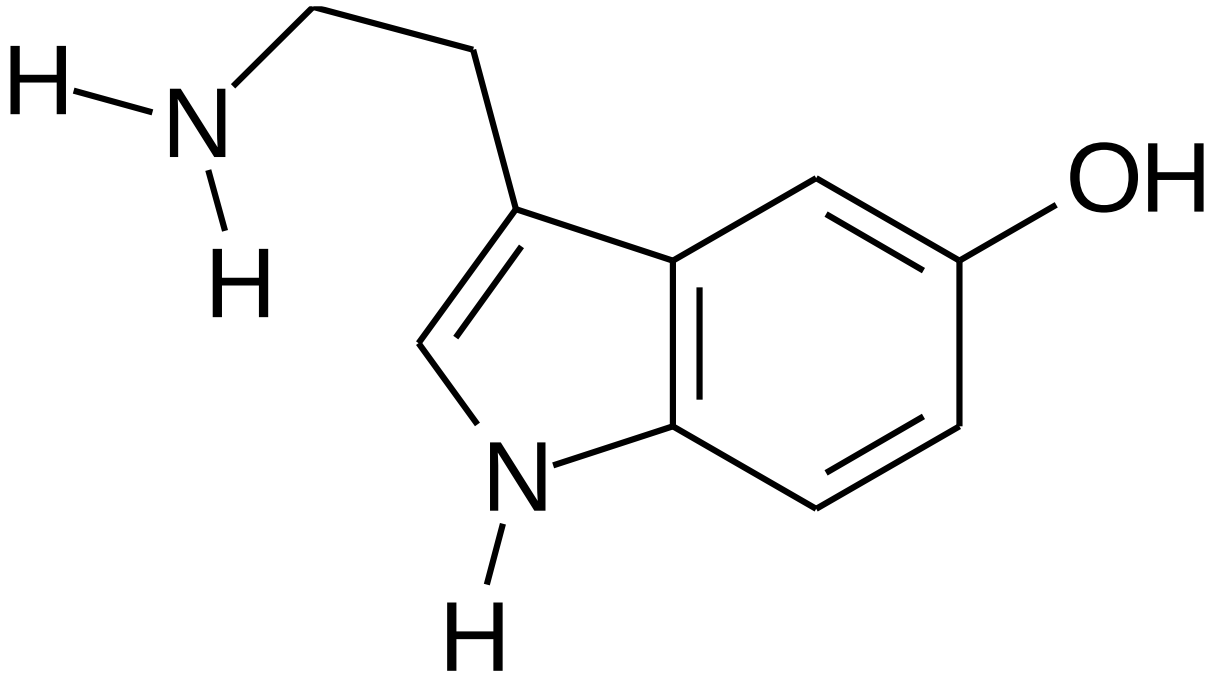
Dopamine



♥ Dopamine plays a key role in attracting people back to sources of pleasure, such as good food. It also acts to keep a drug addict hooked on heroin or cocaine.

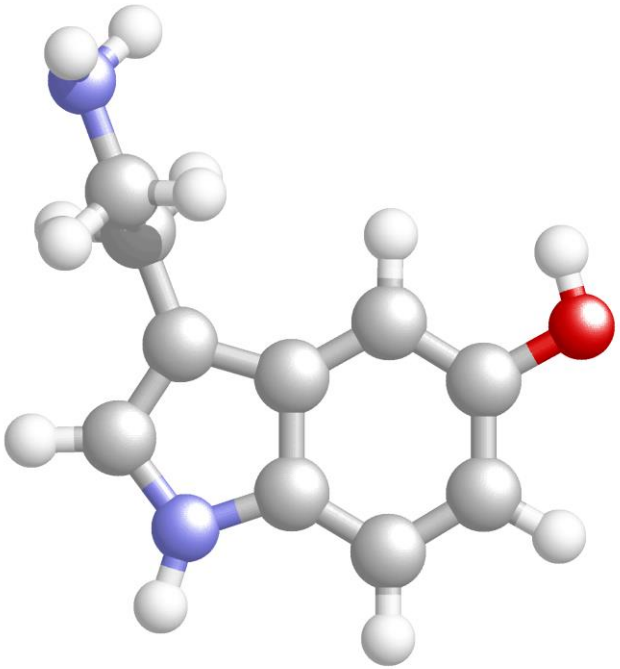
http://news.bbc.co.uk/go/pr/fr/-/2/hi/health/4498764.stm

Serotonin



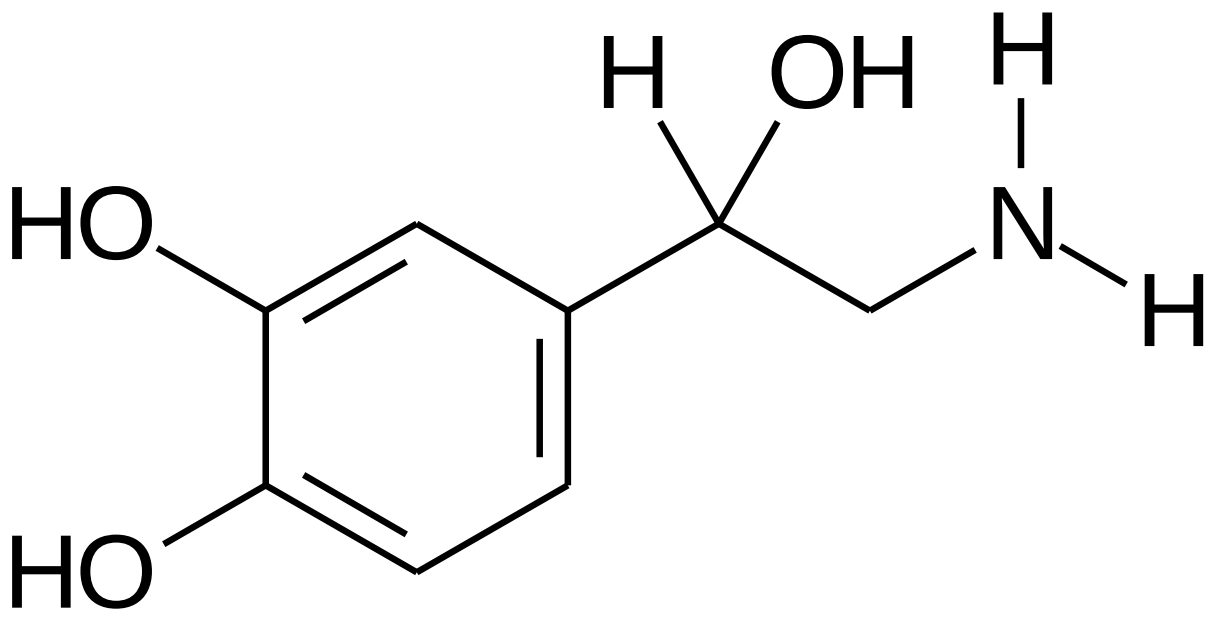
♥ While the release of *dopamine* in the brain causes humans to feel happy, the release of *serotonin* makes humans feel excited.

Serotonin



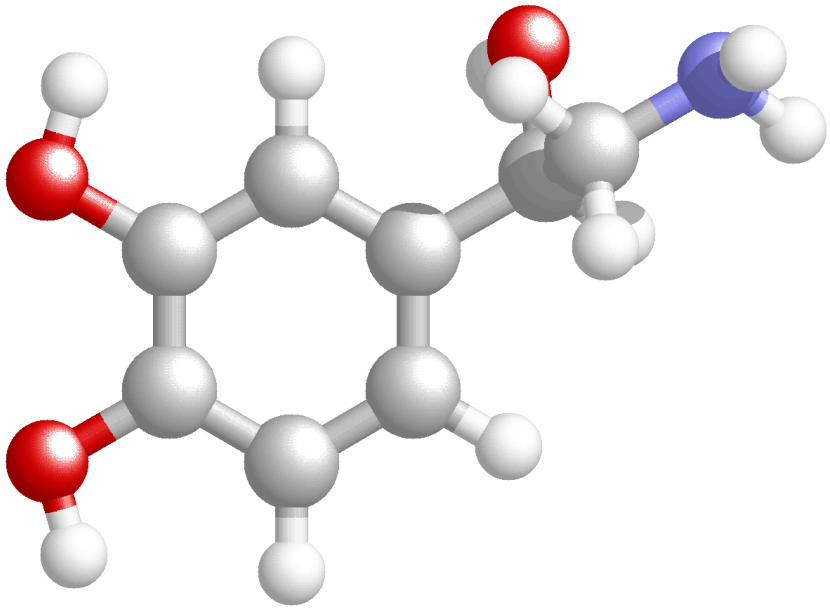
♥ While the release of *dopamine* in the brain causes humans to feel happy, the release of *serotonin* makes humans feel excited.

Norepinephrine



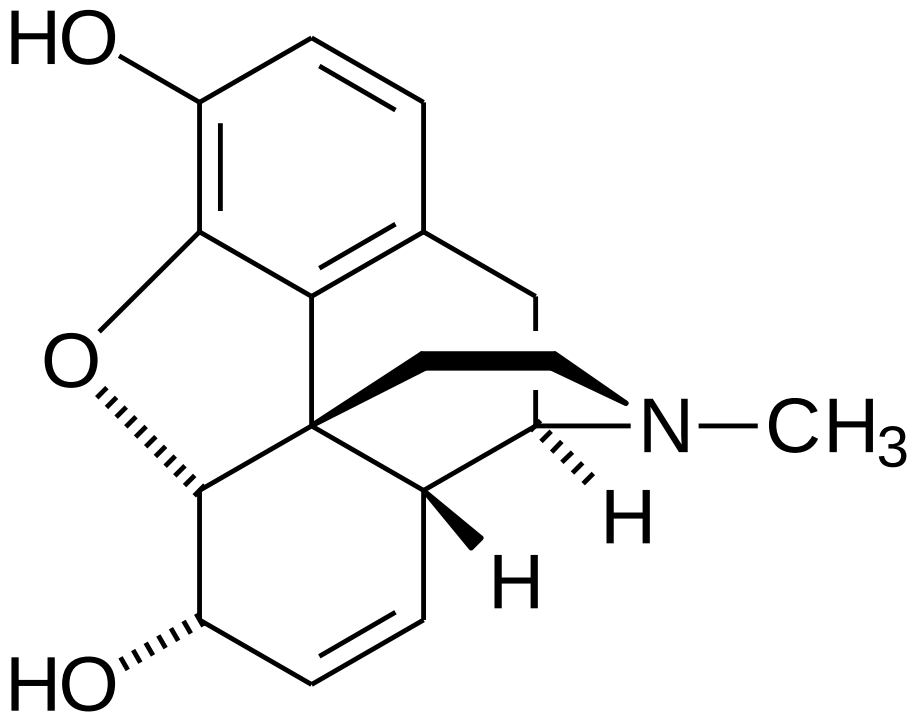
♥ While the release of *dopamine* in the brain causes humans to feel happy, the release of *norepinephrine* makes humans feel excited.

Norepinephrine



♥ While the release of *dopamine* in the brain causes humans to feel happy, the release of *norepinephrine* makes humans feel excited.

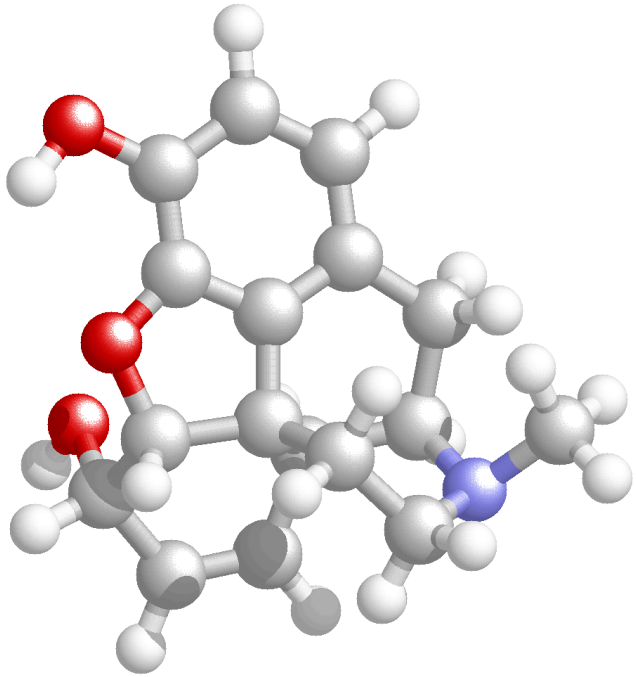
Endorphins



Morphine

♥ Endorphins are *peptides* produced by the *pituitary gland* and the *hypothalamus*. They resemble the *morphine* (shown above) in their abilities to produce analgesia and a sense of well-being.

Endorphins



Morphine

- The term endorphin is an abbreviation of *endogenous morphine*, which literally means *morphine produced naturally in the body*.

The Chemistry of Love

How can I apply my knowledge of chemistry in order to get a second date?

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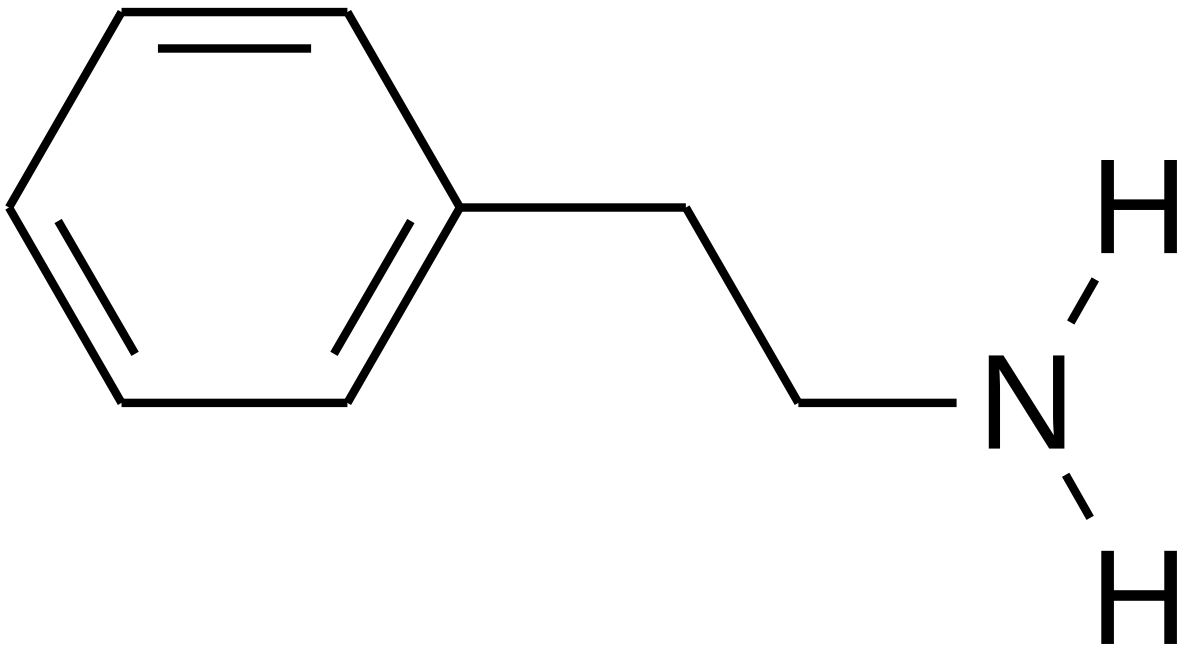
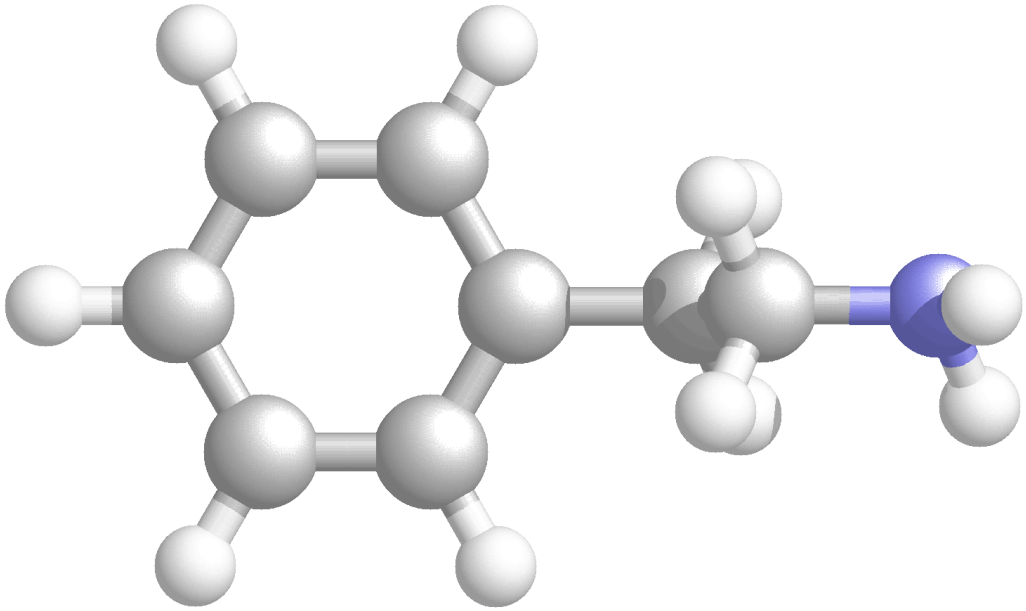
♥ Go on a rollercoaster ride during your *first date*. Your friend will become addicted to the norepinephrine and serotonin that are released in response to all of the excitement, therefore ensuring that you get a *second date*.

Phenylethylamine



♥ *Phenylethylamine* is believed to control the release of *dopamine*, *norepinephrine* and *serotonin* in the brain.

Phenylethylamine



♥ *Phenylethylamine* is believed to control the release of *dopamine*, *norepinephrine* and *serotonin* in the brain.

Phenylethylamine

Phenylethylamine is a minor component of which food?

Phenylethylamine

Chocolate is Better than a Kiss
Researchers at the University of Sussex have discovered that chocolate, left to melt on the tongue, has a greater effect on brain activity and heart rate than a kiss. The reason? Chocolate contains *phenylethylamine* which can raise levels of *endorphins* (chemicals responsible for pleasure) in the brain.
It also contains *caffeine* which has a stimulatory effect on the brain.

http://news.bbc.co.uk/go/pr/fr/-/2/hi/health/6558775.stm

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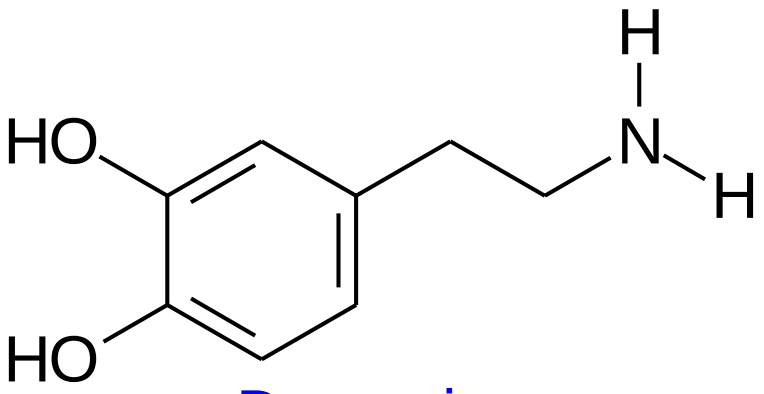
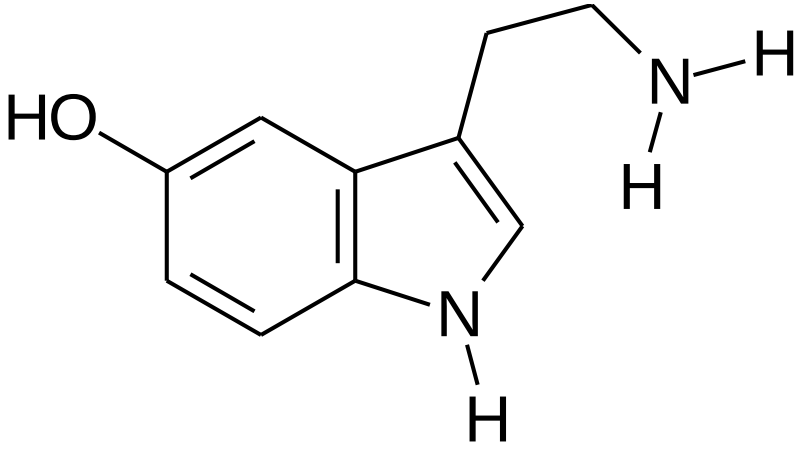
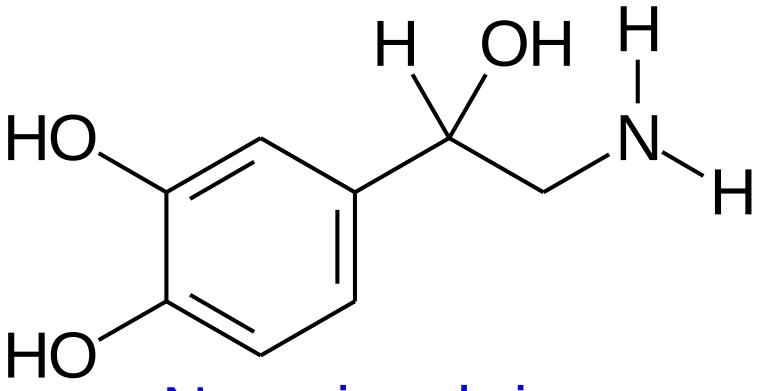
Compare and Contrast the Structures of the Neurotransmitters



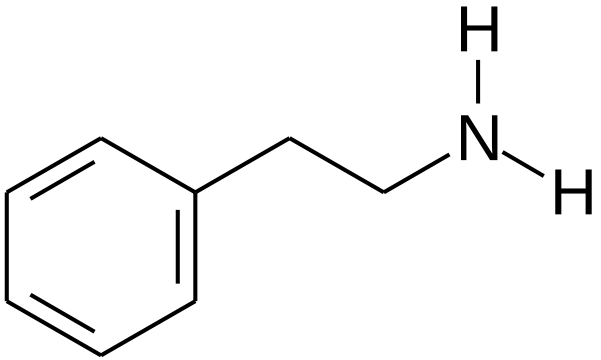
Dopamine



Serotonin

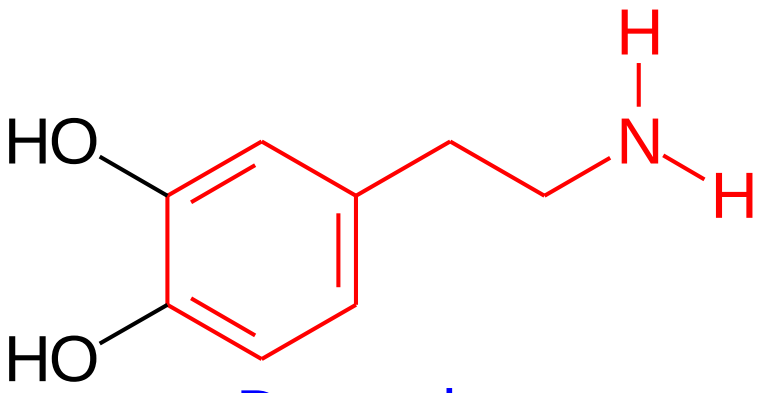


Norepinephrine

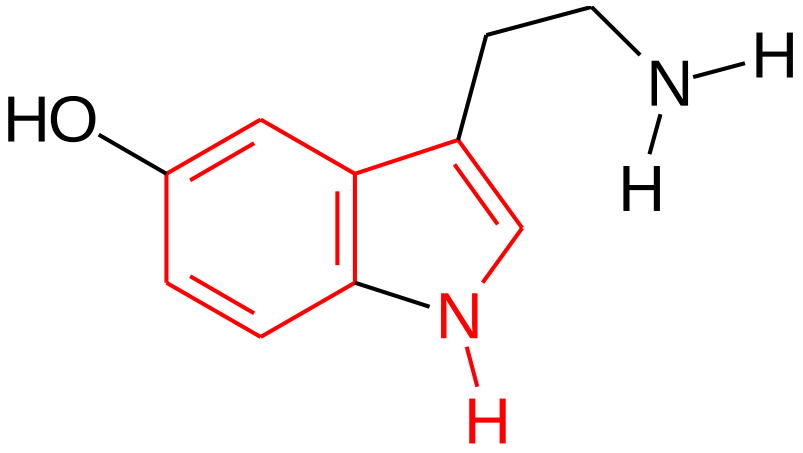


Phenylethylamine

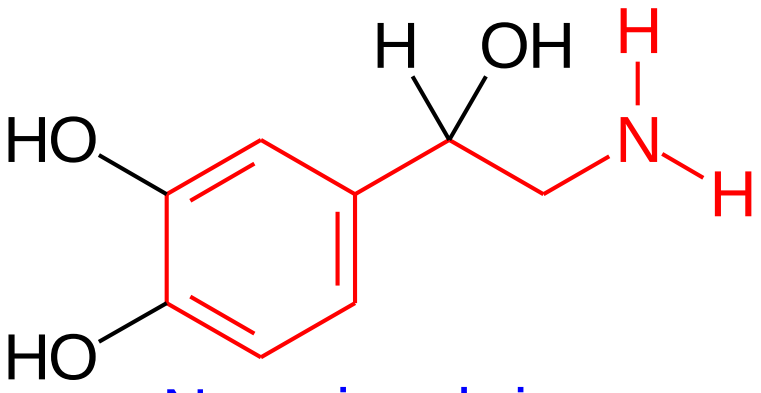
Compare and Contrast the Structures of the Neurotransmitters



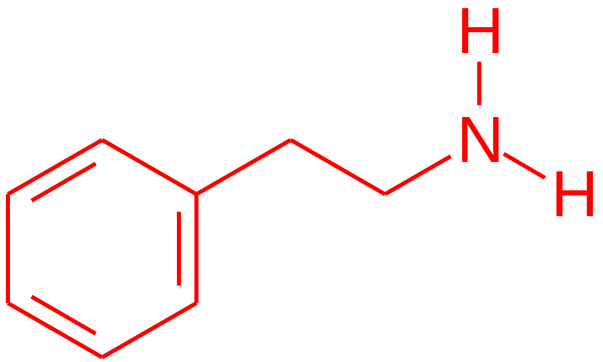
Dopamine



Serotonin



Norepinephrine

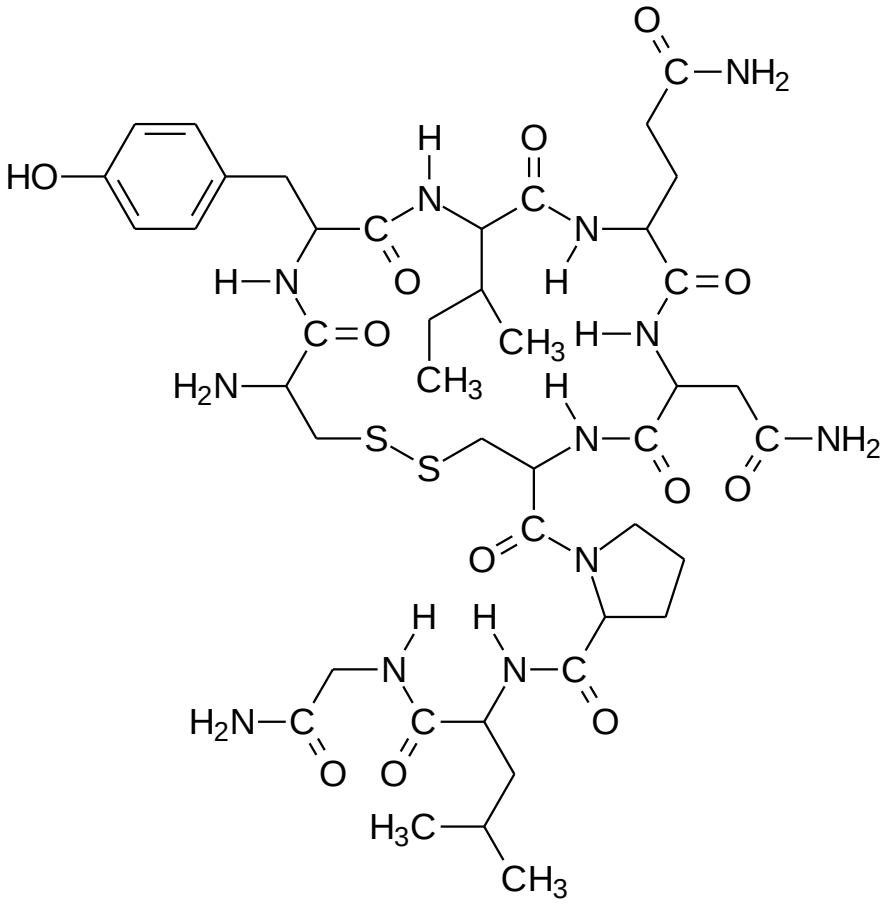


Phenylethylamine

Part Three

Affection

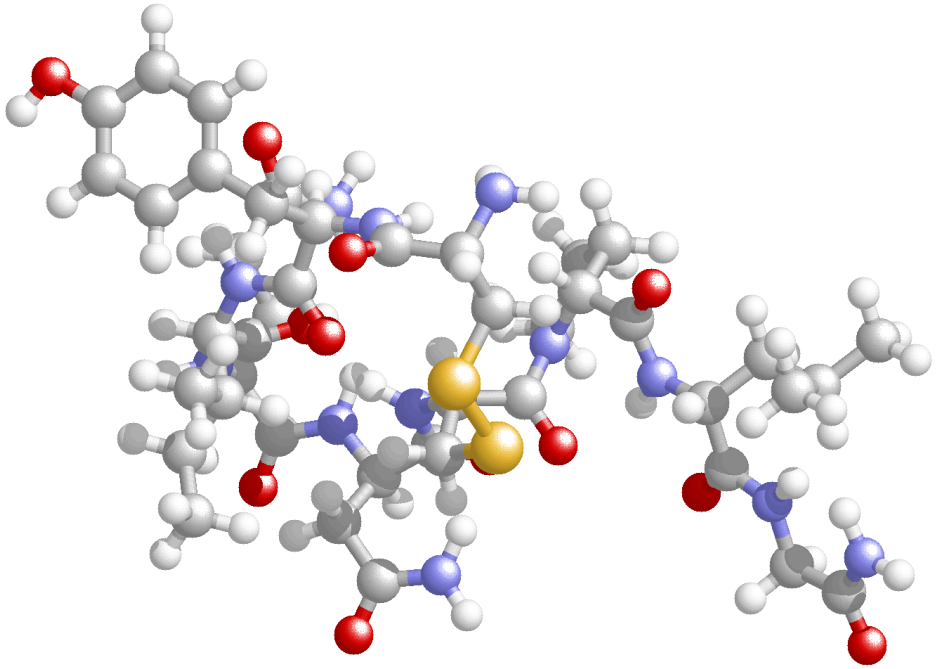
Oxytocin and Vasopressin



Oxytocin

♥ *Oxytocin* is the *cuddling chemical*. Not only does it increase the bond between a couple, it is also responsible for the contractions of childbirth and increases the bond between a mother and her child during breastfeeding.

Oxytocin and Vasopressin



Oxytocin

♥ *Vasopressin* is the *monogamy chemical*. Only three per cent of mammals are monogamous, mating and bonding with one partner for life.

Addicted to Love

Prairie Vole

♥ Before mating, the prairie vole is friendly to both male and female voles alike. Within 24 hours of mating, the prairie vole is devoted to his partner and defends her jealously. The post sexual production of *vasopressin* is responsible for this amorous behaviour. If a chemical that blocks the effect of vasopressin is given to a mating pair of prairie voles, they rapidly lose their devotion to each other.

Scientific American, June 1993.

Miscellaneous

The Mathematics of Dating

What is the probability of me getting a date for Valentines Day?

The Mathematics of Dating

$$\frac{W + G + 2A_Y}{3A_H} - \frac{R^2}{20} = A_{sk}$$

Equation derived by Garth Sundem, an American Professor of Mathematics and author of the book *Geek Logik: 50 Foolproof Equations for Everyday Life.*

W = Witty

G = Aggressive

A_y = Your Attractiveness

A_H = His / Her Attractiveness

R = His / Her "Amount" of Current Relationship

All variables from 1 - 10 with 10 being high.

♥ If A_{sk} is *less than zero* you should lower your standards.

♥ If A_{sk} is *between 0 and 1*, you don't have much chance.

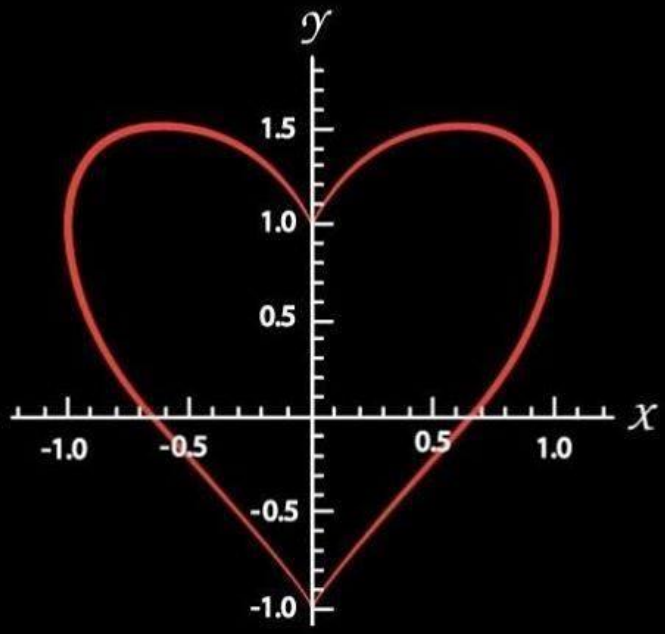
♥ If A_{sk} is between *1 and 10*, go ahead an ask for a date!

♥ If A_{sk} is *greater than 10*, consider his / her more attractive friend instead!

The Mathematics of Dating

THE LOVE FORMULA

$$x^2+\left(y-\sqrt[3]{x^2}\right)^2=1$$

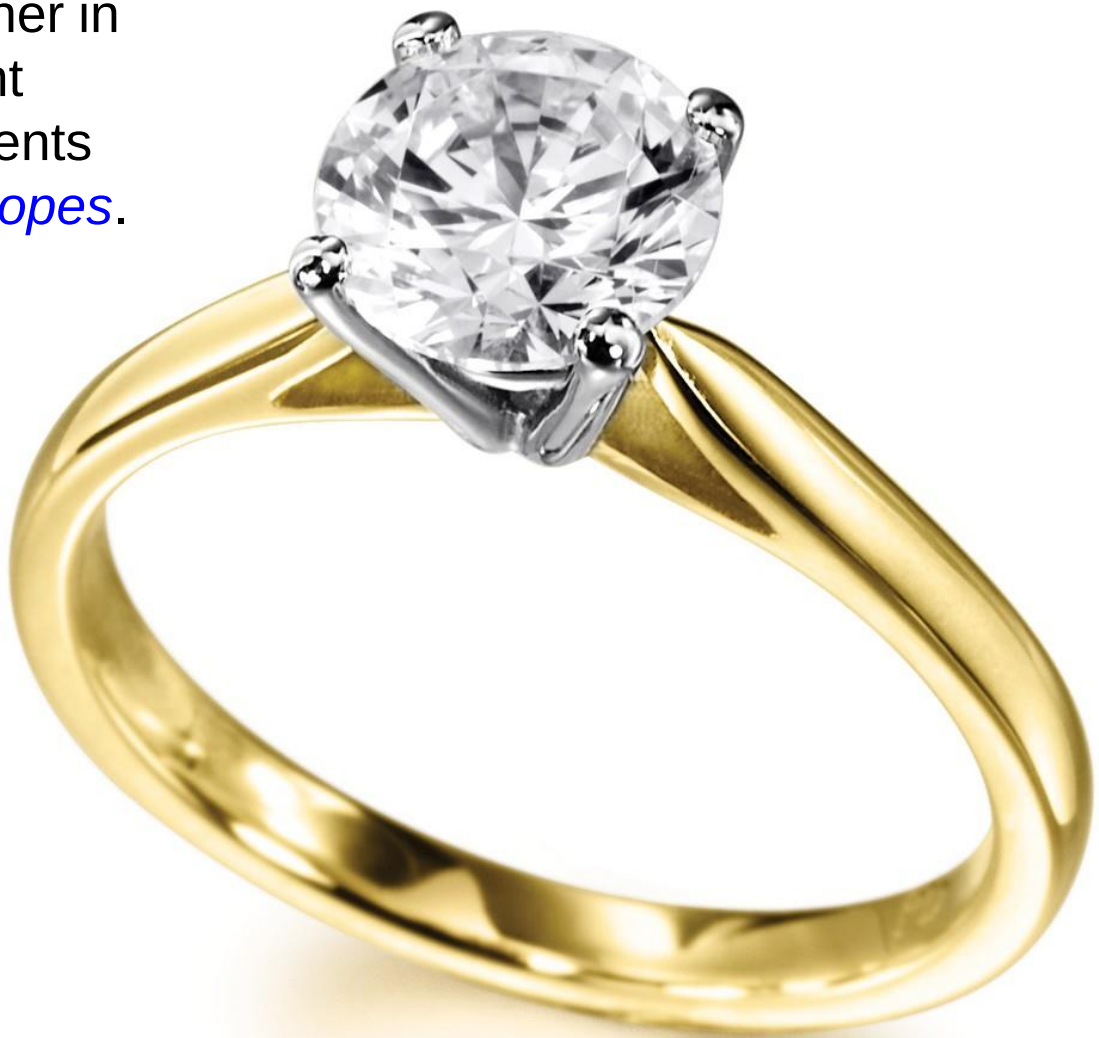


Eternal Love

Is the diamond in my engagement ring *really* forever?

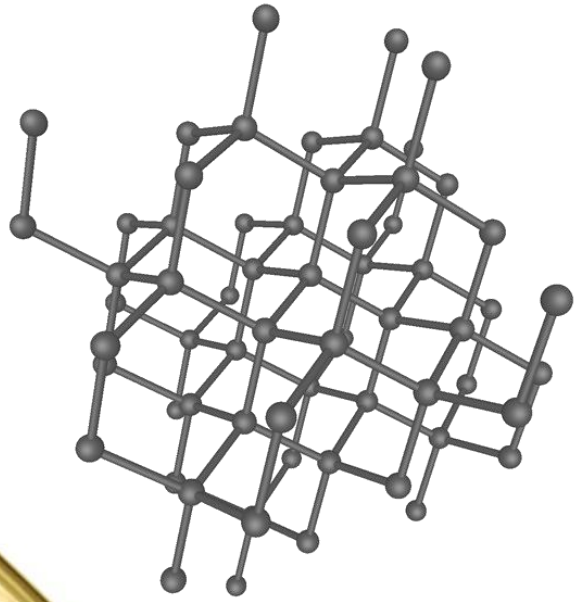
Eternal Love

Carbon atoms can bond together in different arrangements called *allotropes*.



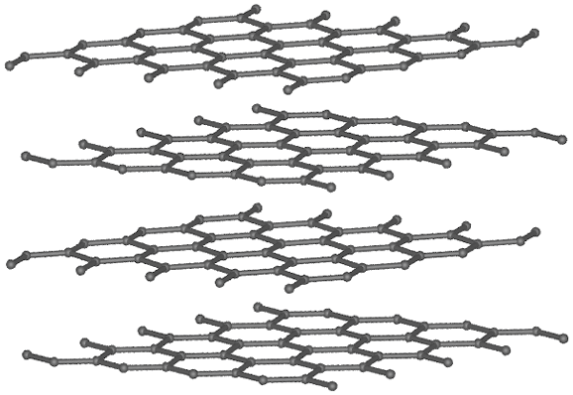
Eternal Love

One allotrope of carbon is *diamond*, formed deep within the Earth's crust at high temperatures and pressures.



Eternal Love

Unfortunately, at room temperature and pressure, the more stable allotrope of carbon is *graphite*.



Drop Dead Gorgeous

What are the chemical components of my makeup? Are they safe?

Drop Dead Gorgeous

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Drop Dead Gorgeous

♥ Throughout history, women have poisoned themselves in an attempt to look beautiful – *drop dead gorgeous*.

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Drop Dead Gorgeous

- In ancient Japan.

Drop Dead Gorgeous

♥ And Elizabethan England, women wanted to have pale skin. Pale skin indicated that they were not working class people who spent their time outside in the sunlight.

Drop Dead Gorgeous

♥ Women can still buy skin whitening cosmetics today, but they are a lot less toxic than the ones that were used several hundred years ago.

Drop Dead Gorgeous

♥ The skin whitening cosmetics used several hundred years ago contained chemicals such as *lead(II) carbonate* and even *arsenic*.

CAUTION

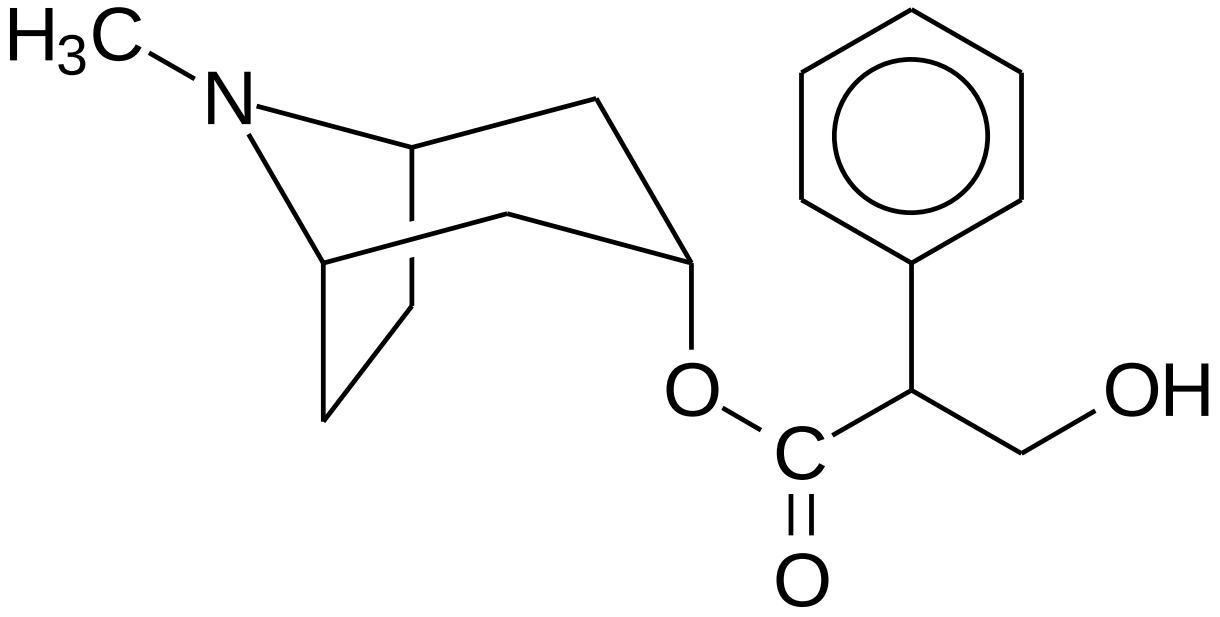
RADIOACTIVE

Drop Dead Gorgeous

♥ If you thought that applying compounds of lead to your skin was bad, in the early twentieth century, companies in London and Paris sold cosmetics that contained *radioactive elements* such as *thorium* and *radium*. The radiation was supposed to kill bacteria and give women a "*natural glow*".


Drop Dead Gorgeous

Drop Dead Gorgeous

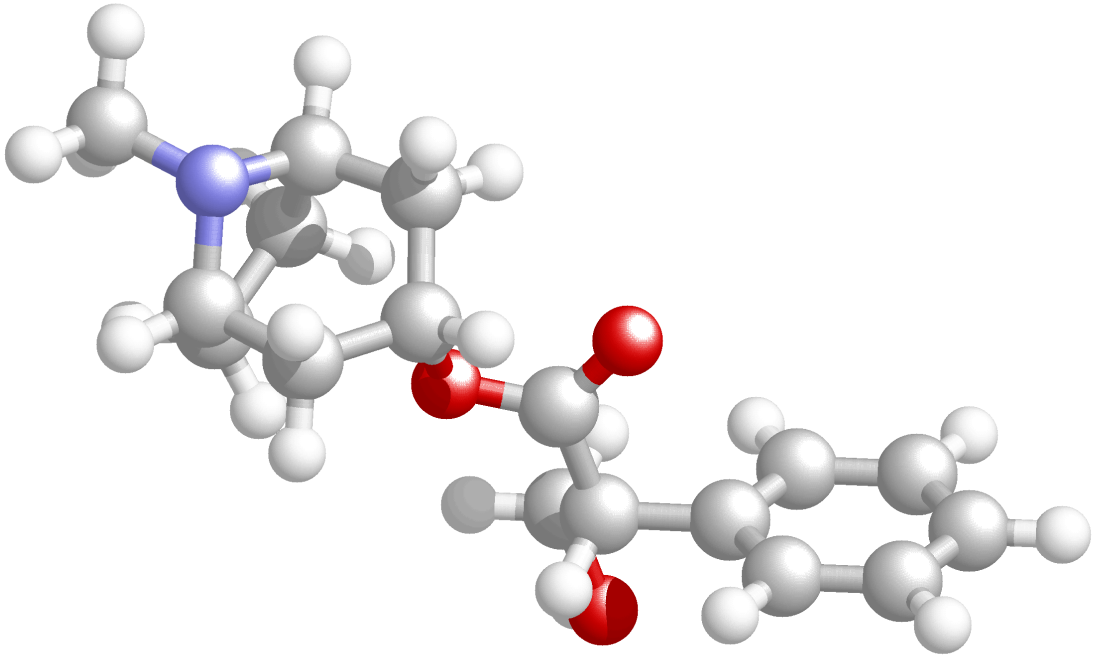


Atropine

♥ Did you realise that your *pupils dilate* when you see something that you *like*? In addition, people are (at a subconscious level) *attracted* to people with dilated pupils. Where is this made use of?


Drop Dead Gorgeous

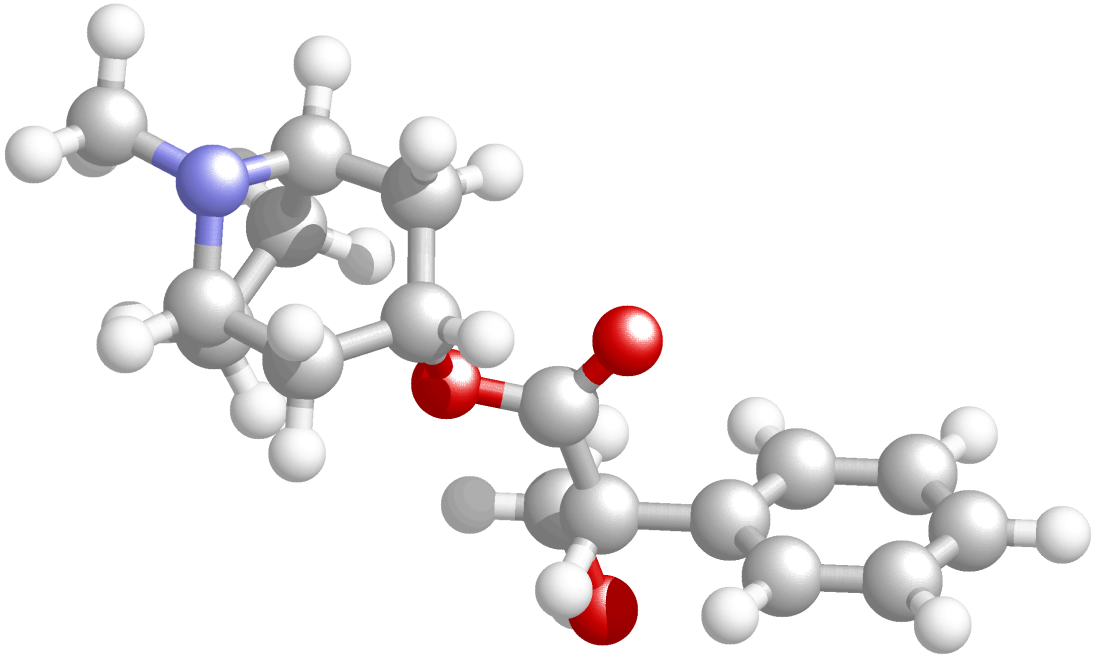
Drop Dead Gorgeous



Atropine

♥ Atropine is a naturally occurring tropane alkaloid that is extracted from the plant *Deadly Nightshade* (Latin name: *Atropa belladonna* or *beautiful woman*).

Drop Dead Gorgeous



Atropine

♥ When added to eyes, atropine causes the pupils to dilate. *Queen Cleopatra* is rumoured to have used atropine to make herself more alluring. Atropine is poisonous, and excessive use can prove fatal.

COSMETIC CHEMISTRY – RED LIPSTICK

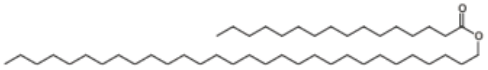
65% CASTOR OIL | 15% BEESWAX | 10% OTHER WAXES | 5% LANOLIN | 5% DYES, PIGMENTS & PERFUME

Note that these figures are for an average composition. Actual composition varies from brand to brand, and there is likely to be some deviation from these percentages.

WAXES & OILS

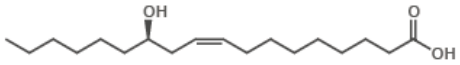
Waxes provide the structure of lipstick. A number of different natural waxes are used, including beeswax, Carnauba wax, and Candelila wax. Carnauba wax has the highest melting point of any wax, and is therefore important to prevent lipstick from melting too easily. Waxes also give emollient properties and glossiness.

284 THE APPROXIMATE NUMBER OF CHEMICAL COMPOUNDS THAT MAKE UP BEESWAX.



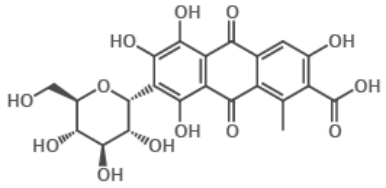
TRIACONTYL PALMITATE
One of the principal chemical components of beeswax

Oils give lipstick its gloss, and also provide lubrication for the application of the lipstick. Castor oil is the most common, though other synthetic oils are also used.

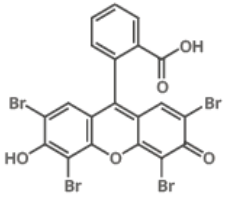


RICINOLEIC ACID
Major component of castor oil (90% of fatty acid content)

PIGMENTS & DYES



CARMINE RED

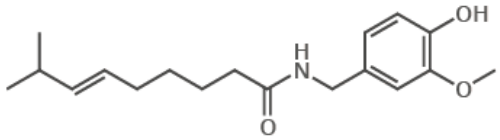


EOSIN

Lipstick colour originates from a range of different pigments and dyes. Carmine red is a pigment derived from scale insects. Eosin, also known as D&C Red No. 22, is a dye which reacts with the amino groups in the proteins of the skin to produce a deep red colour. Titanium dioxide can be used to dilute colours and give pink shades.

OTHER COMPOUNDS

A number of other compounds are also added to lipstick; this can include different fragrances, to mask the smell of the other chemicals present. Also, capsaicin, the compound found in chilli peppers, is sometimes included, as its skin irritant effect can induce plumping of the lips in small quantities.



CAPSAICIN
Major capsaicinoid compound found in chilli peppers

LOVE

chemistry

www.shutterstock.com

Presentation on

The Chemistry of Love

Created by
Dr. Chris Slatter
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Updated 26th December 2016