

From: Mikki Kressbach [winter\_penguins88@hotmail.com]  
Sent: Friday, February 18, 2005 4:08 PM  
To: jchowning@nwabr.org  
Subject: RE: MM\_SC\_Kressbach

I'm using apple works, so I guess I'll just paste it into my email. sorry about all this.

Caffeine and its Affects on Receptor Cells  
By Mikki Kressbach

Shorecrest High School  
Molecular Modeling  
Susan White

Caffeine. The most widely used drug. Today so much is consumed that you'd think that people don't realize what it is. The numerous energy drinks, cups of coffee and cans of soda we drink seems almost endless; and for what? That little buzz that you just can't seem to live without. Especially here in Seattle, what may be the birth place of the gourmet quick caffeine fix, there is evidence that many consider this "harmless" drug a part of their everyday life. It just seems to get you going; an instant blast of energy. But what really happens when you get that familiar feeling?

Perhaps the reason caffeine is so prevalent through out the world is

because of its presence in so many foods and medicines people take in on a daily basis. The drug is found in the seeds or leaves of over sixty different plants . When in its purist form, caffeine is a white crystal like powder. In the past, its bitter flavor has been used as a prime example when identifying taste. As for structure, caffeine, or 1, 3, 7-trimethylxanthines, is similar to that of purine, a chemical, whose structure is composed of nitrogen and carbon atoms and is found in DNA, as well as being the neurotransmitter, adenosine. Its awakening power is what draws people in and makes them keep going back. Without it, it's been said that our convenient lifestyles would cease to exist. With it, we run the risks of anxiety, depression and increased heart rate, not to mention studies have shown that users have a higher risk of kidney and bladder cancer. It seems as if we've made our choice and sacrificed health for the modern world.

In order for any drug to have an effect on us, there must be a reaction taking place on receptor cells. The location of which chemicals are able to interact with the cell are at "sites," where a small protein protrudes from the exterior membrane of a cell. Each receptor is designed for a specific neurotransmitter and when the two interact with each other, a reaction similar to a lock and key system occurs. As the two

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encounter one another, the protein changes shape, setting off a chain of reactions within the cell. Because these cells are often next to others, they have the ability to control the chemical release of neighboring receptors. In addition to controlling adjacent cells, the location of the proteins allows management of enzymes and the flow of materials in and out of the membrane. Some examples of chemicals released naturally by your body as a result of receptor stimulation, are dopamine, adrenaline and serotonin.

The neurotransmitter directly affected by caffeine is adenosine. It is your brain's natural sleeping pill, produced by daily activity. When the chemical comes in contact with its corresponding receptor, drowsiness and fatigue is brought on. Nerve firing in the brain, organ activity and response time are slowed as well, which all play part in the natural impulses you experience when tired. To counter act these effects, people guzzle down caffeine in order to obtain a few more precious hours of consciousness.

For caffeine to have its awakening effect, it too must react with a receptor. Although they are antithetical, the structure of caffeine and adenosine are so similar that the drug is able to interact with receptor. When caffeine is introduced into your system, it blocks the adenosine receptor. As your body then releases adenosine naturally, there is no receptor to harbor the chemical.

Caffeine's effects on your body are numerous, once the drug has bound to

the receptor, a chain of reactions is set off. As you recall, adenosine caused a decrease in nerve firing, caffeine increases it. It also causes the blood vessels in the brain to contract. Your pituitary gland recognizes the nerve firing as an emergency and responds by releasing adrenaline. The hormone initiates many physical reactions, such as, dilation of pupils, increased heart rate, and the tightening of muscles. Your

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liver also begins to release sugar into the bloodstream. The drug also causes your body to increase dopamine release, the same reaction your body has when amphetamines are taken.

The neurotransmitter dopamine interacts directly with your brain's pleasure center. It is a chemical associated with reward and when released, is noted in your brain, thereby associating whatever caused the introduction with pleasure. This can create a regular want for the sensations felt during use if there is continued consumption of the drug. It is seriously thought of as the major cause for addiction of caffeine.

Soon after the drug wears off, your body experiences a downward spiral of effects. Especially after long-term use, users will go through periods of depression and fatigue. Many caffeine addicts complain of headaches, which are caused by the dilation of blood vessels in the brain. In order to relieve the pain, they may either consume more caffeine or take some aspirin. The reason aspirin is so effective is because it too contains caffeine, which then starts the chain of reactions all over again.

The biggest problem associated with regular caffeine use is its effects on daily sleep habits. Heavy users often suffer from insomnia because of the amount of time caffeine stays in your system. Even if you only have small amounts left in your body, and are able to fall asleep, you don't receive the proper deep sleep required every day.

Since the drug is considered "generally recognized as safe" by the FDA, people seem to assume it's ok and have very little drive to quit. If addicts have experienced what it's like without caffeine, they go through such stress and anxiety, that it pushes them even farther from completely giving it up. Studies have shown that without the drug, brain activity is drastically lowered. Without it they are irritable, experience

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immense fatigue and cannot function normally. Because caffeine affects you both mentally and physically, addicts would have to give up what they've known as a "normal" life in order to rid themselves completely of caffeine.

With the bad, there seems to be a silver lining. Studies of the negative effects are also countered by the positive. Research has shown that there are benefits toward human health. Mentally, it can improve your reaction

time, performance and alertness. It has been shown that it can increase the ability to do tasks such as, driving, solving simple math problems and entering data. Because caffeine is a stimulant, it has the ability to brighten your mood. In today's busy, work driven world, it comes down to whether you'll sacrifice health for your "normality". As you weigh out the positives and the negatives, you have to ask yourself, "Is it worth it?"

The theory of adenosine blockage is very recent. Scientists today are researching the specifics of the actual physical shape of a receptor. For now all they can do is make educated guesses based on what they know about the characteristics of the proteins that make them up. To understand receptors it is important to create models. The folding and twisting shown in receptor models is a physical way scientists are able to conceive where a chemical may interact with it.

Without scientific models many of the things we take for granted today, would not be possible. Perhaps the biggest breakthrough when it comes to modeling is the designer drug. For years we had no way to create medicines made of anything but the things we found in nature. Thanks to modeling scientists have created drugs using chemicals, rather than plants. Taking an unknown and testing it through a model is essential to the successful development of anything. There is a point where you can only research and brainstorm so much and the only way to discover if your hypothesis is correct, is to create a test.

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Computers have played a huge role in recent scientific breakthroughs. They have drastically decreased the amount of time it takes to test a hypothesis.

Now, chemical structures, proteins, or test results are at the tip of your fingers. Thanks to computers, new techniques such as crystallography are available for many. Through scientific modeling, with the help of modern technology, we can keep digging deeper and deeper into a world scientists today have only dreamt of.

Though the minor details of caffeine's effects have yet to be official, it certainly seems as if we've made progress in discovering more about drugs and our brains. Really, we've only begun to understand how it works, but not too long ago, we didn't even know what receptor cells were. Through research, modeling and scientific ideas many of our minds cannot even grasp, we've started to see how we actually work and answered some of our list of never ending "why" questions. Thanks to this research and new developments, we now have necessary information for us to make the decision of whether to use caffeine or not. It does end up down to your own opinion, but at least you have the necessary scientific facts to back it up.

\*5\*

## Annotated Bibliography

### Written Sources:

Connell Henderson, Elizabeth. *Understanding Addiction*. Jackson: University Press. 2000.

This is a credible source although can be considered a “self help” book, does contain scientific information and has been recently published.

Gilbert, Steve. *A Small Dose of Toxicology*. Boca Raton: CRC Press. 2004.

This book is credible because it has been recently published and I found similar facts to those in this source.

Weinberg, Bennet Alan and Bealer, Bonnie K. *The World of Caffeine*. New York: Routledge. 2001.

This book is a credible source because it was recently published.

### Internet Sources:

Spencer, Berry. “Frequently Asked Questions”. *Caffeine and Migraine*. February 18, 2004. October 17, 2004. <[www.batnet.spencer/faq1.html](http://www.batnet.spencer/faq1.html)>

This source is credible because it offers only facts diagrams.

“Purine”. *Britanica Online*. 2005. *Britanica Encyclopedia*. January 27, 2005. <[www.britanica.com/eb/article?tocid=9061952](http://www.britanica.com/eb/article?tocid=9061952)>.

This is a source used world wide and offers up to date facts and information.

“Why Does Caffeine Keep You Awake?”. *How Stuff Works*. 2004. *HSW Media Network*. October 17, 2004. <[science.howstuffworks.com/question531.htm](http://science.howstuffworks.com/question531.htm)>.

This source is a well known reference for commonly asked questions.

### Interviews:

Gilbert, Steve. Telephone Interview. January 3, 2005.

This particular person was my mentor, he is also a scientist working at the

White, Susan. Personal Interview. January 6, 2005.

She is a credible source because she is my science teacher and has experience with the subject.

Articles:

Reid, T.R. "Caffeine". National Geographic. January 2005: 2-32.

This is a very recently published article written in a well known, scientific and factual magazine.

\*6\*

Mentorship

Steve G. Gilbert, PhD, DABT

Director

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sgilbert@innd.org

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For this project I was assigned to work with Steve Gilbert, director of the Institute of Neurotoxicology and Neurological Disorders, or INND. I mainly corresponded with Mr. Gilbert through e-mail as well as a phone interview. I asked for his help as I was doing my research and came upon questionable facts, theories, subjects, ect.

Mr. Gilbert was of help to me because he was able to answer more in depth on questions I had so I could really go beyond the "big picture". With his help, I had little details sorted out, to make sure that my research went smoothly. His book was of much help to me. It provided me with a source that had an overview of facts on caffeine, that otherwise could have taken a lot of time to research. As I look back on my conversations with my mentor I wish that I could have used him a bit more, but unfortunately I didn't have a whole lot of questions about my subject. I do appreciate the help of Mr. Gilbert greatly and I know that without him I would not be as prepared for the expo.

Emails:

#1- October 6th

HI Mikki,

Nice to meet you. I am looking forward to being you mentor and helping

you out for the Boitech expo. I understand you are interested in Caffeine. I wrote a book called "A Small Dose of Toxicology" and one of the chapters is on caffeine. I have a web site with a PowerPoint presentation and reference on caffeine - see [www.asmalldoseof.org](http://www.asmalldoseof.org).

More information on the book is below - we can exchange info by e-mail - let me know how I can help.

All the best -- Steve

I wanted to make you aware of my book - "A Small Dose of Toxicology". I worked for many years doing research on child health, particularly related to lead and mercury. I tried to create a book about toxicology that is fun,  
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interesting, relevant, and accessible to a broad range of people. I also wanted the book to be a tool and a resource - the web site [www.asmalldoseof.org](http://www.asmalldoseof.org) has references and PowerPoint presentations for each chapter. The book is meant for a broad audience - health care professional, environmentalist, regulators, workers, K-12 teachers, undergraduates or the interested public that wish to know more about the health effects of common chemicals. Below is some additional information on the book. I hope "A Small Dose of Toxicology" and related resources will be useful in your work.

"A Small Dose of Toxicology – Health Effects of Common Chemicals", by Steven G. Gilbert, PhD, DABT, is now available. More information including PowerPoint presentations and references for each chapter are available at [www.asmalldoseof.org](http://www.asmalldoseof.org). Published by CRC Press, A Member of the Taylor Francis Group, 2004. pp. 266. \$35.95. (Available on Amazon at [www.asmalldoseof.org](http://www.asmalldoseof.org))

Brief synopsis of book:

"A Small Dose of Toxicology – Health Effects of Common Chemicals"  
Make better decisions about your health and the health of your family with the information found in "A Small Dose Of Toxicology." Learn about caffeine, alcohol, lead, mercury, pesticides and other common chemicals in an easily accessible way. This book is aimed at a broad audience from undergraduates to the general public interested in learning more about the chemicals in their daily lives. Additional information including extensive references and PowerPoint presentations are available at:  
[www.asmalldoseof.org](http://www.asmalldoseof.org).

Steven G. Gilbert, PhD, DABT

Director

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E-mail: [sgilbert@innd.org](mailto:sgilbert@innd.org) Book – “A Small Dose of Toxicology” –

[www.asmalldoseof.org](http://www.asmalldoseof.org)

-----Original Message-----

From: Mikki Kressbach [ [mailto:winter\\_penguins88@hotmail.com](mailto:winter_penguins88@hotmail.com) ]

Sent: Tuesday, October 05, 2004 2:05 PM

To: [sgilbert@innd.org](mailto:sgilbert@innd.org) Cc: [susan.white@shorelineschools.org](mailto:susan.white@shorelineschools.org) Subject:

Mentorship

Hi Mr. Gilbert,

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I'm Mikki Kressbach and I was informed that you will be my mentor for the BioTech expo. I just wanted to get in touch with you and say that I'm very excited to be working with you. If we could work out when we could meet or how we'll stay in touch that would be great. Unfortunately I don't have very much information of the expo at this time, so I'm not sure when we should begin. I'll keep you informed. Thanks so much. I look forward to working with you.

~Mikki Kressbach

#2- November 27th

Hi Mikki,

Good to hear from you. What is the goal or theme of your presentation?

With regard to you question - about models - there are no "caffeine cells". As you know both caffeine and adenosine are chemicals that affect the so called adenosine receptor. It might be better show the chemicals structures and then have a cartoon that explains how caffeine interacts with the adenosine receptor and results in stimulation. Adenosine has a calming affect - caffeine blocks the adenosine effect causing stimulation.

Will you have a chart of caffeine in different beverages? Explain caffeine's other effects? It metabolism?

Let me know how I can help. Did you look at the caffeine chapter on my web site - it has a number links to caffeine related material.

Hope thanks giving was a good one -- Steve

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E-mail: [sgilbert@innd.org](mailto:sgilbert@innd.org) Book – “A Small Dose of Toxicology” –  
[www.asmalldoseof.org](http://www.asmalldoseof.org)

-----Original Message-----

From: Mikki Kressbach [ [mailto:winter\\_penguins88@hotmail.com](mailto:winter_penguins88@hotmail.com) ]  
Sent: Wednesday, November 24, 2004 11:40 AM  
To: [sgilbert@innd.org](mailto:sgilbert@innd.org) Subject: Research

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Hi, I'm sorry I haven't written in a while, but I'm just getting started on my research. I'm having trouble finding up to date information in books on the effects of caffeine on receptor cells. I was wondering if you had any books to recomend. I was also wondering if you knew where I could find pictures of the caffeine cell and adenosine receptor cells (not pictures of the chemicals that make them up), so I could begin my models. Thanks so much! Happy Thanksgiving!

~Mikki

#3- December 6th  
Mikki,

How is your project going? Are you building the models?

Steve

Steven G. Gilbert, PhD, DABT  
Director

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E-mail: [sgilbert@innd.org](mailto:sgilbert@innd.org) Book – “A Small Dose of Toxicology” –  
[www.asmalldoseof.org](http://www.asmalldoseof.org)

-----Original Message-----

From: Mikki Kressbach [ [mailto:winter\\_penguins88@hotmail.com](mailto:winter_penguins88@hotmail.com) ]  
Sent: Sunday, November 28, 2004 8:47 PM  
To: [sgilbert@innd.org](mailto:sgilbert@innd.org) Subject: RE: Research

Hello, Thanks for the quick response. About the chemical models, my teacher was telling me that the chemicals have "folds" or something that give them shape and make them unique to their receptor and that was the picture that I was referring to. I'm planning to do my 3D models in ceramic so I'm not sure how I would show chemicals. As for my paper it seems to have a very standardized form that we're supposed to follow, but I was considering writing about not only the effects on the receptors but other element of your body. I havn't quite come up with a theme yet, but as I come up with things and make a decision I'll keep you posted. Thanks!

~Mikki

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#4- December 20th  
Hi Mikki,

I have some experience with scientific models but it depends on what kind of models. It is important to set up a hypothesis to test with your model. What kind of models are thinking of? I suggest we discuss over the phone. My number is below.

Steve

Steven G. Gilbert, PhD, DABT  
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E-mail: [sgilbert@innd.org](mailto:sgilbert@innd.org) Book – “A Small Dose of Toxicology” –  
[www.asmalldoseof.org](http://www.asmalldoseof.org)

-----Original Message-----

From: Mikki Kressbach [ [mailto:winter\\_penguins88@hotmail.com](mailto:winter_penguins88@hotmail.com) ]

Sent: Sunday, December 19, 2004 10:30 PM

To: [sgilbert@innd.org](mailto:sgilbert@innd.org) Subject: Scientific Models

Hi Happy Holidays. I hope you've been well. I was just wondering if you have any experience or opinions on scientific models, because for my paper I need to explain the importance of them in research. If you do and don't mind me asking you about it or know someone who I could interview about it that would be great!

Thanks. Mikki

#5- January 1st

Hi Mikki

I am pretty free on Monday, so just give me all in the afternoon when you have a chance.

Steve

Steven G. Gilbert, PhD, DABT

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\*11\*

Ph: 206.527.0926

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E-mail: [sgilbert@innd.org](mailto:sgilbert@innd.org) Book – “A Small Dose of Toxicology” –  
[www.asmalldoseof.org](http://www.asmalldoseof.org)

-----Original Message-----

From: Mikki Kressbach [ [mailto:winter\\_penguins88@hotmail.com](mailto:winter_penguins88@hotmail.com) ]

Sent: Wednesday, December 29, 2004 12:00 PM

To: [sgilbert@innd.org](mailto:sgilbert@innd.org) Cc: [susan.white@shorelineschools.org](mailto:susan.white@shorelineschools.org) Subject: RE:  
Scientific Models

Hi, I hope your holidays went well. Sorry it took me so long to respond. Sure I could call and dicuss over the phone. Is there a time that would be best for you? I probably wont be able to until next monday. If you could just give me a good time frame (I can't call until after 2pm), that would be helpful. Thanks, Mikki

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>From: Jeanne Chowning <jchowning@nwabr.org>  
>Reply-To: Jeanne Chowning <jchowning@nwabr.org>  
>To: Mikki Kressbach <winter\_penguins88@hotmail.com>  
>Subject: RE: MM\_SC\_Kressbach  
>Date: Fri, 18 Feb 2005 01:02:40 -0500 (EST)

>  
>This is a .bin file. Also can't read this. Tell me what kind of word  
>processing software you are using. If you are using wordperfect or works,  
>you may have to save it as a text file in wordpad or notepad. Or paste it  
>into the body of your email.  
>Also, name your file itself MM\_SC\_Kressbach.  
>Thanks!  
>Jeanne

>  
>---- Mikki Kressbach <winter\_penguins88@hotmail.com> wrote:

>>  
>> Sorry about that I'm not sure if the new one is the right format, please  
>> email me back if it's not. This is the final, it's just an old file  
>name.

>>  
>>  
>>>From: "Jeanne Chowning" <jchowning@nwabr.org>  
>>>To: "Mikki Kressbach" <winter\_penguins88@hotmail.com>  
>>>Subject: RE: MM\_SC\_Kressbach  
>>>Date: Wed, 16 Feb 2005 20:10:43 -0800  
>>>  
>>>Mikki, this is not a format I can read. It is a .dat file. Can you  
>send a  
>>>word document?  
>>>Also, is this a final project? The file name is rough draft.  
>>>Jeanne

>>>  
>>>  
>>>-----Original Message-----  
>>>From: Mikki Kressbach [mailto:winter\_penguins88@hotmail.com]  
>>>Sent: Wednesday, February 16, 2005 7:58 PM  
>>>To: jchowning@nwabr.org  
>>>Subject: MM\_SC\_Kressbach

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