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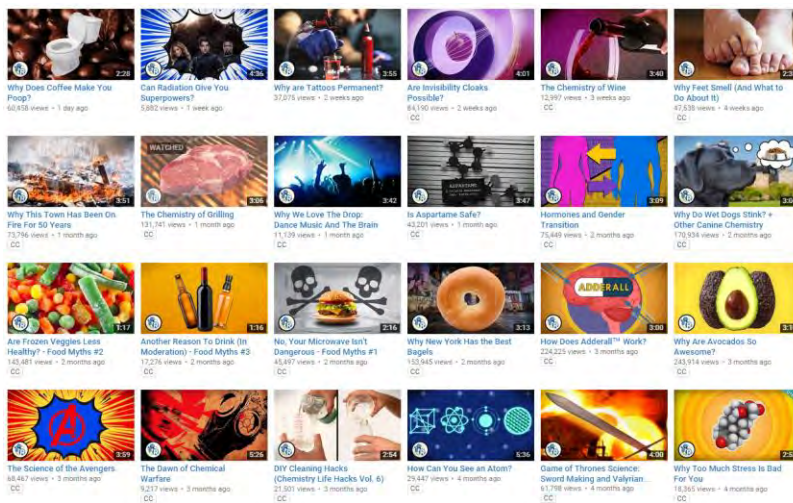
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Thursday, August 27, 2015

**“Choices and Trends in Solid Dosage Form Section: Salt, Cocrystal, Prodrug or Amorphous?”**

**Scott Trzaska**, Principal Scientist, J-Star Research  
**Ronald Smith**, Distinguished Scientist, Merck



Thursday, September 10, 2015

**“How to Create a Safer and More Sustainable Lab Through Green Chemistry”**

**Jeffrey Whitford**, Director of Global Citizenship, Sigma-Aldrich  
**David C. Finster**, Professor of Chemistry, Wittenberg University

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*“Science Communication: Visual Chemistry by Design”*



**Adam Dylewski**  
Creator, ACS Reactions  
Manager, ACS Productions



**Andy Brunning**  
Creator, Compound Interest

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# SCIENCE COMMUNICATION

## VISUAL CHEMISTRY BY DESIGN

ACS Webinars – August 13, 2015  
Andy Brunning



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## VISUAL CHEMISTRY BY DESIGN

- Why communicate chemistry visually?
- How can we communicate chemistry to a non-specialist audience?
- How can we engage a non-specialist audience?
- What resources can be used to create infographics?



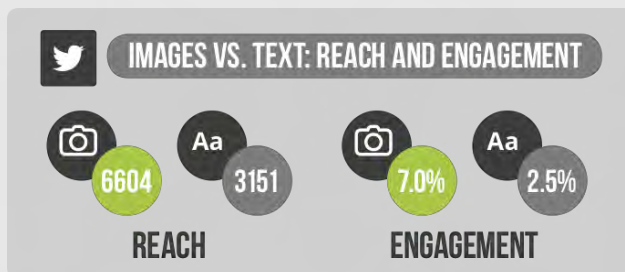
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## WHY COMMUNICATE CHEMISTRY VISUALLY?

- Chemical structures lend themselves to a visual approach.
- Provides clear and succinct summary of topics.
- Higher online engagement – images achieve greater reach and engagement than text.



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## AUDIENCE INTERACTIVE POLL

### WHERE DO YOU USUALLY GET YOUR CHEM NEWS?

(You may choose multiple sources)

- Chemistry/Science-based news sites (e.g. C&EN, Chemistry World, Nature News, New Scientist)
- General news sites
- Scientific journals
- Social media-based sites (e.g. IFLS)



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## COMMUNICATING RESEARCH VISUALLY

- Some research articles and chemistry news articles include graphical abstracts or summaries, but they tend to be under-utilised.



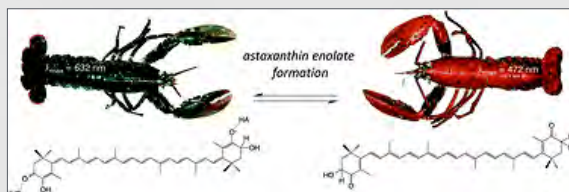
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## GRAPHICAL ABSTRACTS— COMPARE & CONTRAST




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## GRAPHICAL ABSTRACTS


**COOKED CRUSTACEAN COLOUR CHANGES**



**Blue**

**ASTAXANTHIN: BOUND FORM**

In uncooked crustaceans, the compound astaxanthin is bound to the protein crustacyanin. The negatively charged enolate ion this creates is blue in colour.



**Red**

**ASTAXANTHIN: UNBOUND FORM**

The crustacyanin protein denatures when cooked, which releases the astaxanthin from its bound state, leading to a red-orange colouration.

#TWCHEM: <http://goo.gl/u7R1z1>    COMPOUNDCHEM.COM



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## POLL: WHICH INFO IS QUICKEST AND EASIEST TO INTERPRET?

Color	Metal	Example compounds
Red	Strontium (intense red)	$\text{SrCO}_3$ (strontium carbonate)
	Lithium (medium red)	$\text{Li}_2\text{CO}_3$ (lithium carbonate)
Orange	Calcium	$\text{CaCl}_2$ (calcium chloride)
Yellow	Sodium	$\text{NaNO}_3$ (sodium nitrate)
Green	Barium	$\text{BaCl}_2$ (barium chloride)
Blue	Copper	$\text{CuCl}_2$ (copper chloride)
Indigo	Cesium	$\text{CsNO}_3$ (cesium nitrate)
Violet	Potassium	$\text{KNO}_3$ (potassium nitrate)
	Rubidium (violet-red)	$\text{RbNO}_3$ (rubidium nitrate)
Gold	Charcoal, iron, or lampblack	
White	Titanium, aluminum, beryllium, or magnesium powders	

A

B

<b>ELECTRIC WHITE</b> white-hot metal flakes	<b>ORANGE</b> calcium salts	<b>BRIGHT RED</b> strontium carbonate
<b>TURQUOISE</b> copper chloride	<b>PURPLE</b> strontium (red) & copper (blue)	<b>SILVER SPARKLE</b> burning aluminum or magnesium flakes
<b>GREEN</b> barium chloride	<b>GOLD</b> glowing iron or charcoal powder	<b>YELLOW</b> sodium chloride

C



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## POLL: WHICH INFO IS QUICKEST AND EASIEST TO INTERPRET?

**THE CHEMISTRY OF FIREWORKS**

Colour in fireworks is produced by pyrotechnic 'stars', which produce coloured light when ignited. The stars contain fuel, oxidising agents, and metal salts. Metal salts are used to produce colour, a fuel is needed to allow the star to burn, an oxidising chemical provides oxygen for the combustion of the fuel, a chlorine-donating compound helps strengthen some colours, and a binding chemical holds the mixture together.

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[bit.ly/FireworkChemistry](http://bit.ly/FireworkChemistry)

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### FLAME TEST COLOURS

A flame test is an analytical procedure used by chemists to detect the presence of particular metal ions, based on the colour of the flame produced. When heated, the electrons in the metal ion gain energy and can jump into higher energy levels. Because this is energetically unstable, the electrons tend to fall back down to where they were before, releasing energy as they do so. This energy is released as light energy, and as these transitions vary from one metal ion to another, it leads to the characteristic colours given by each metal ion.

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### pH INDICATOR COLOURS

UNIVERSAL INDICATOR RANGE: 0 - 14

PHENOLPHTHALEIN RANGE: 8.2 - 10

METHYL ORANGE RANGE: 3.1 - 4.4

THYMOL BLUE RANGE: 1.2 - 2.8, 8.0 - 9.6

BROMOTHYMOL BLUE RANGE: 6.0 - 7.6

PHENOL RED RANGE: 6.4 - 8.0

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### THE CHEMISTRY OF WHISKY

**PREPARATION** Mashing Fermenting Distilling Aging Bottling

Whisky contains hundreds of different compounds. These can be influenced by the type of fish and grain used, the distillation process, and the wood used in the barrels used in the ageing process. Whilst it's impossible to list all the compounds that contribute, here's a look at some that impact whisky's flavour.

**WHISKY LACTONES**  
 C10 & MYRISTIC & OCTANOIC  
 FURAN & METHYL & OCTANOIC

**PHENOLIC COMPOUNDS**  
 GUAIACOL & SYRINGOL  
 CATECHOL, GUAIACOL & CATECHOL

**ALDEHYDES**  
 ETHYLACETALDEHYDE & VANILLIN  
 FURFURAL & HEXANAL

**ESTERS**  
 ETHYL ACETATE  
 ETHYL BUTYRATE

**OTHER COMPOUNDS**  
 DIMETHYL SULPHIDE & DIMETHYL SULPHIDE  
 DIMETHYL SULPHIDE & DIMETHYL SULPHIDE

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### THE CHEMISTRY OF GIN

**COMPOUND GIN** **POT DISTILLED GIN** **COLUMN DISTILLED GIN**

Gin comes from a number of different berries, with subtly varying chemical compositions. This stems from the different botanical ingredients that can be included. All gins must be primarily flavoured by juniper berries, but many other ingredients, including coriander, dry citrus peels, almonds, and nutmeg, can also be incorporated.

**JUNIPER BERRY COMPOUNDS**  
 PINENE & BISSABOLONE  
 PINENE  
 BISSABOLONE

**CORIANDER COMPOUNDS**  
 LINALOOL  
 LINALYL ACETATE  
 TERPENE ALCOHOLS

**TONIC WATER**  
 QUININE  
 QUININE

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# THE CHEMISTRY OF ICE CREAM

Ice cream is a combination of air, ice crystals, fat globules, and a liquid syrup. These are combined to make a colloid, a solution with very small insoluble particles suspended in it. This graphic looks in detail at the components of this colloid, and some molecules that produce ice cream flavours.

### FATS, PROTEINS, & EMULSIFIERS

**FAT (OLEIC ACID)**

CCCCCCCC=CCCCCCCC

**EMULSIFIER MOLECULES**

- LIPOID FAT
- MILK PROTEINS
- FAT CRYSTALS

Fats are important for the creaminess of ice cream. Proteins from milk form a membrane around the fat droplets, making it harder for them to coalesce and contact with each other. Emulsifiers replace some milk proteins on the surface of the fat droplet. As ice cream is made, some of the fat in the droplet solidifies, and the fat "needer" that form help droplets to partially cluster. These clusters, along with milk proteins, help stabilise air bubbles in the ice cream.


### FLAVOURS AND COLOURS

**Vanillin** CC(=O)OC1=CC=CC=C1 **Vanillin**

**Vanillin** CC(=O)OC1=CC=CC=C1 **Vanillin**

**Vanillin** CC(=O)OC1=CC=CC=C1 **Vanillin**

Natural ice cream flavours contain a number of flavour-contributing compounds. Flavouring can also be achieved artificially. Artificial vanilla flavouring is often simply vanillin; other artificial flavours are more complex. Other compounds can be used as flavour enhancers – an unusual example is diacetyl, also found in breads, but which has a floral odour at lower concentrations. Colours can be added artificially; anthocyanins from plants are among the colouring agents used.



### THE STRUCTURE OF ICE CREAM

ICE CRYSTALS	3%
AIR BUBBLES	25%
FAT DROPLETS	1%
LIQUID SYRUP	6%

During freezing, most water is frozen into ice. Small ice crystals are needed for smooth ice cream. Bumping and aeration occur at the same time as freezing to form small air bubbles, stabilised by de-aerated fat. Air makes up 30-50% of ice cream's total volume. Sugar lowers the ice cream's freezing point, and the fat "needer" that form help droplets to partially cluster. These clusters, along with milk proteins, help stabilise air bubbles in the ice cream.

### STABILISERS

**GLUCOSE**

OC[C@H]1OC(O)[C@H](O)[C@@H](O)[C@H]1O

Stabilisers are added in small amounts (~0.2%) to ice cream. Often extracted from plants, a common example is soluble alginate, the sodium salt of alginic acid, extracted from brown seaweeds. Stabilisers reduce the rate at which ice cream melts, and smoothness, and increase the viscosity of the liquid phase of ice cream. Use of multiple stabilisers can produce synergistic effects.

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## THE CHEMISTRY OF BLACKCURRANTS

### COLOUR & HISTORY

**Anthocyanin** C15=CC=C2C(=C1)N(C)C(=C2)C

The purple colour of blackcurrants is due to the presence of anthocyanins. These are water-soluble pigments that give plants their characteristic colour.

### BLACKCURRANTS & CAT URINE

Blackcurrants have a very tart flavour. Due to a chemical called anthracene, the urine of cats that have eaten blackcurrants has a strong, pungent odour. This is due to the presence of a compound called anthracene. Anthracene is a tricyclic aromatic hydrocarbon. It is a solid at room temperature and is found in coal tar. Anthracene is also found in the urine of cats that have eaten blackcurrants.

## THE CHEMISTRY OF WATERMELON

### COLOUR & AROMA

**Cucurbitacin** C1=CC=C2C(=C1)N(C)C(=C2)C

The green colour of watermelon rinds is due to the presence of cucurbitacins. These are bitter-tasting compounds that are found in the rinds of many cucurbit vegetables.

### EXPLODING WATERMELONS

Watermelons can explode if they are cut and then left in the sun. This is due to the presence of a compound called cucurbitacin. Cucurbitacin is a tricyclic aromatic hydrocarbon. It is a solid at room temperature and is found in coal tar. Cucurbitacin is also found in the rinds of many cucurbit vegetables.

## THE CHEMISTRY OF BRUSSELS SPROUTS

### THE BITTER TASTE OF SPROUTS

**Sulforaphane** C1=CC=C2C(=C1)N(C)C(=C2)C

Brussels sprouts have a bitter taste due to the presence of sulforaphane. This is a sulfur-containing compound that is found in many cruciferous vegetables.

### POTENTIAL BENEFITS OF SULFORAPHANE

Sulforaphane has been shown to have potential health benefits. It is a powerful antioxidant and has been shown to have anti-inflammatory and anti-cancer properties.

## THE CHEMISTRY OF HONEY

### HOW DO BEES MAKE HONEY?

Bees make honey from nectar. Nectar is a sugary liquid that is produced by flowers. Bees collect nectar and then process it in their stomachs to produce honey.

### WHY DOES HONEY GO OFF?

Honey can go off if it is not stored properly. This is due to the presence of water and oxygen. Honey is a natural preservative, but it can still go off if it is not stored properly.

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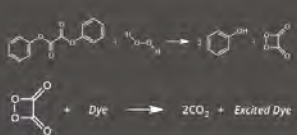
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# THE CHEMISTRY OF GLOW STICK COLOURS



When glow sticks are bent, the inner glass tube is broken, releasing hydrogen peroxide solution. This then reacts with a diphenyl oxalate, producing 1,2-dioxetanedione; this product is unstable & decomposes to carbon dioxide, releasing energy. The energy is absorbed by electrons in dye molecules, which subsequently fall back to their ground state, losing excess energy in the form of light.

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## A Rough Guide to SPOTTING BAD SCIENCE

Being able to evaluate the evidence behind a scientific claim is important. Being able to recognise bad evidence regarding health or scientific studies, is equally important. These 12 points will help you separate the science from the pseudoscience.

- 1. SENSATIONALISED HEADLINES**  
Articles headlined with superlatives (such as 'first', 'best', 'new', 'breakthrough') are often designed to attract attention rather than to inform. They tend to be more sensational than they are.
- 2. MISINTERPRETED RESULTS**  
There is often a tendency to exaggerate the results of a study for the sake of a 'big headline'. This is often done by taking the results of a study and applying them to a much larger population than the study actually included.
- 3. CONFLICTS OF INTEREST**  
Some commercial and other interests may have a vested interest in the results of a study. This may lead to biased reporting of the results.
- 4. CORRELATION & CAUSATION**  
The fact that two things are correlated does not mean that one causes the other. Correlation does not imply causation. The fact that two things are correlated does not mean that one causes the other.
- 5. UNSUPPORTED CONCLUSIONS**  
The authors of a study may draw conclusions that go beyond what the data actually support. This is often done by making broad generalisations from a limited set of data.
- 6. PROBLEMS WITH SAMPLE SIZE**  
In order to be able to generalise from a study, the sample size must be large enough to be representative of the population being studied.
- 7. UNREPRESENTATIVE SAMPLES USED**  
A common mistake is to use a sample that is not representative of the population being studied. This can lead to biased results.
- 8. NO CONTROL GROUP USED**  
In order to be able to compare the results of a study to a control group, a control group must be used. This is often done by using a group of people who are not being studied.
- 9. NO BLIND TESTING USED**  
In order to be able to avoid bias, a study should be conducted in a blind manner. This is often done by not telling the participants which group they are in.
- 10. SELECTIVE REPORTING OF DATA**  
The authors of a study may only report the results that support their conclusions. This is often done by ignoring the results that do not support their conclusions.
- 11. UNREPLICABLE RESULTS**  
The results of a study should be able to be replicated by other researchers. This is often done by not providing enough detail about the methods used.
- 12. NON-PEER REVIEWED MATERIAL**  
The results of a study should be reviewed by other experts in the field. This is often done by not submitting the study to a peer-reviewed journal.

## A Rough Guide to TYPES OF SCIENTIFIC EVIDENCE

Being able to evaluate the evidence behind a claim is important. The scientific evidence is a hierarchy of evidence. The following types of scientific evidence are ranked and described, particularly those relevant to health and medical claims.

**INCREASING STRENGTH OF EVIDENCE**

- ANECDOTAL & EXPERT OPINIONS**  
Anecdotal evidence is a collection of personal experiences or expert opinions. It is often used to support a claim, but it is not considered strong evidence.
- ANIMAL & CELL STUDIES**  
Animal and cell studies are often used to support a claim, but they are not considered strong evidence.
- CASE REPORTS & CASE SERIES**  
Case reports and case series are often used to support a claim, but they are not considered strong evidence.
- CASE-CONTROL STUDIES**  
Case-control studies are often used to support a claim, but they are not considered strong evidence.
- COHORT STUDIES**  
Cohort studies are often used to support a claim, but they are not considered strong evidence.
- RANDOMISED CONTROLLED TRIALS**  
Randomised controlled trials are often used to support a claim, but they are not considered strong evidence.
- SYSTEMATIC REVIEW**  
Systematic reviews are often used to support a claim, but they are not considered strong evidence.



[bit.ly/SpotBadSci](http://bit.ly/SpotBadSci)

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## INFOGRAPHIC GUIDELINES

- Avoid 'long' infographics – square or rectangular dimensions work best.
- A general audience needs a 'hook'.
- Good **balance** of text vs. images.
- Sensible use of **colour**
- Sensibly sized **text** – avoid lower than size 12 where possible.
- **Well-referenced information** – the #ICanHazPDF hashtag is a useful one on Twitter if you don't have access to particular journals containing studies of interest.
- **For general audience:** use technical terms sparingly, or accompanied by explanations.
- Consider **license** graphic will be shared under.

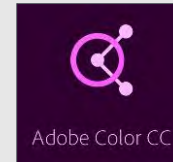
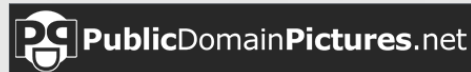
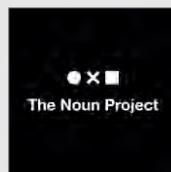


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### AUDIENCE POLL: WHICH OF THESE RESOURCES ARE YOU AWARE OF?



**A** NONE   **B** 1-2   **C** 3-4   **D** 5-6   **E** ALL 7



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## INFOGRAPHIC RESOURCES



### ChemDraw

Chemical drawing program. Also allows tweaking of appearance of chemical structures.



### Adobe InDesign

Desktop publishing program. Other, free desktop publishing programs are also available online.



### Pixabay

Very useful resource for public domain pictures (freely usable). [publicdomainpictures.com](http://publicdomainpictures.com) is another.

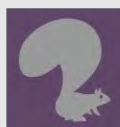


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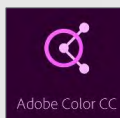
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## INFOGRAPHIC RESOURCES



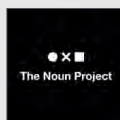
### Font Squirrel

Useful site for free font downloads. [WhatTheFont.com](http://WhatTheFont.com) allows image uploads to identify fonts.



### Adobe Colour CC

Free online colour picker that will also automatically generate complementary colours or shades.



### The Noun Project

Free icons for design projects. Most are CC licensed, though there are some public domain icons as well.



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## TAKE-AWAY IDEAS

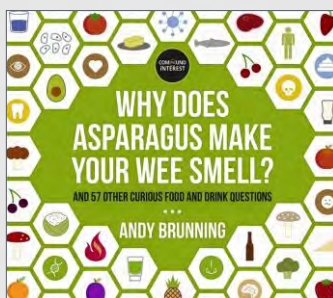
- Consider the use of **simple infographics** to help communicate chemistry topics or research.
- Make use of **free resources online** to help produce visual communications.
- **Avoid over-complication** – keep communication as jargon-free as possible, and don't over-crowd the design.



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### THE COMPOUND INTEREST BOOK

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Focusing on the chemistry of food and drink – clear chemical explanations for strange effects.

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*“Science Communication: Visual Chemistry by Design”*



**Adam Dylewski**  
Creator, ACS Reactions  
Manager, ACS Productions



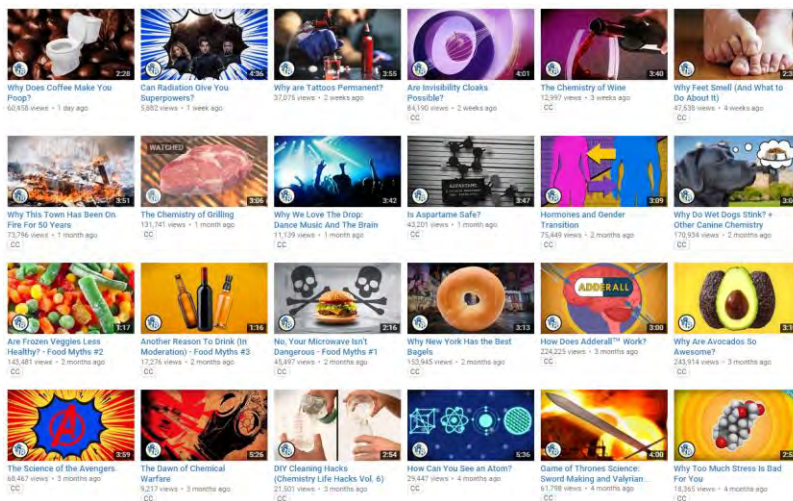
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Thursday, August 27, 2015

**“Choices and Trends in Solid Dosage Form Section: Salt, Cocrystal, Prodrug or Amorphous?”**

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