Mass What?

The Importance of Communicating the Concept of Mass Spectrometry to Professionals, Media and the Consumer

*Donald H. Chace, O. David Sparkman, *Neo Gen Screening, Pittsburgh, PA and University of the Pacific, Stockton, CA

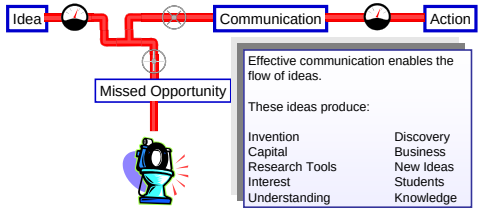
Objective

➢ To improve communication of mass spectrometrists with other professionals, media, and the educated consumer.

➢ To provide simple concepts, tools, and resources to facilitate this communication.

➢ To initiate a serious discussion with regards to our role as mass spectrometrists to accomplish these goals.

Introduction



Statement of the Problem

Mass Spectrometrist's (Scientists) view of the World

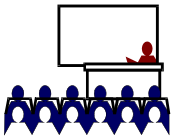
Mass Spectrometrists:
- fail to communicate impact of research
- others would not understand research
- narrow view versus integrated view

World's view of Mass Spectrometrists (Scientists)

Public:
- disliked chemistry, wouldn't understand
- doesn't affect me
- doesn't need to know

Solutions

- Know your audience.
  - *Mass Spectrometrists, Chemists*
  - *Other Scientists, Professionals*
  - *Educated Consumer, Media*



- Engage your audience.
  - *Keep messages simple, direct.*
  - *State the "bottom-line" repeatedly.*
  - *Show why audience should care.*
  - *Provide examples that the audience can relate to.*
- Utilize multiple forms of communication
  - *Supporting documents, brochures, handouts*
  - *Multimedia (slide presentations, video).*
  - *Internet (email, web pages)*
  - *Press (printed, internet, digital, televised)*
- Team Mass Spectrometry
  - *Provide tools that can be shared.*
  - *Enhance education and outreach programs*

Approach (Methods)

➢ Develop materials, illustrations, instructional tools that can be shared within the MS community.

➢ Highlight limitations of current approaches and provide alternative examples.

➢ Use the model of Newborn Screening and Clinical Mass Spectrometry to highlight new approaches.

Concept 1: Mass Spectrometer

[1]Mass Spectrometrist Definition:
A mass spectrometer is an instrument that measures the masses of individual molecules that have been converted to ions, i.e. molecules that have been electrically charged.

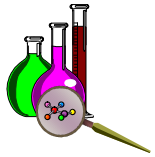
Layperson Understanding:
The terms masses, ions may not be understood.

Simple Definition:
A machine used to weigh molecules.
A molecular scale.

Concept 2: How is a mass spectrometer used?

[1]Mass Spectrometrist Definition:
Mass spectrometry is a powerful analytical technique that is used to identify unknown compounds, to quantify known materials, and to elucidate the structure and chemical properties of molecules.

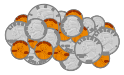
Layperson Understanding:
Powerful compared to what? Quantify? Elucidate?

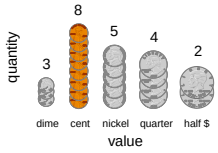


Simple Definition:
A mass spectrometer is used to help scientists:
1. *identify molecules present in solids, liquids and gases.*
2. *determine the quantity of each type of molecule.*
3. *determine which atoms comprise a molecule and how they are arranged.*

Concept 3: Mass Analysis

- Sorting and Counting
  - *Pocket change (mixture of coins)*
  - *Penny, dime, nickel, quarter, half $*
  - *Sorting change by value or size*
  - *Concept of visual interpretation*
  - *Mixture of molecules.*
  - *Molecules of different weight, size*
  - *Separation by mass spectrum*





Concept 4: Ions and Charge

1. *An ion is an electrically charge molecule.*

2. *An ion can be positively (+) charged or negatively (-)charged. Consider the poles on a battery.*

3. *Molecules must be charged to be measured by a mass spectrometer.*

4. *A mass spectrometer "weighs" molecules electronically by attracting and repelling ions. Consider magnets. Opposites attract. Like charges repel.*

Concept 5: Ionization Techniques

[1]Mass Spectrometrist Definitions:

Electrospray:
formation of charged liquid droplets from which ions are desolvated or desorbed.

MALDI: *(matrix assisted laser desorption ionization.) impact of high energy photons on a sample imbedded in a solid organic matrix.*

Layperson Understanding:
None. How does this relate to weighing molecules?

Simple Definition:
Ionization is a process of charging a molecule. Molecules must be charged in order to measure them using a mass spectrometer. "It makes a molecule fly in a mass spectrometer."

Electrospray

MALDI

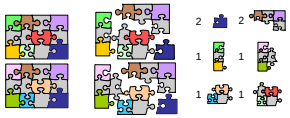
Home – target, support Dirt – compound
Paint – matrix Pressurized Water, Sand – Laser

Concept 6: Tandem Mass Spectrometry

Simple Definition:
Two mass spectrometers joined by a chamber than breaks apart molecules.
This definition is appropriate for tandem-in-space but not for tandem-in-time.

- Puzzle analogy

MS #1	Fragmentation Chamber	MS #2
Sorting molecules	*Breaking molecules*	*Sorting Pieces*



- Word Analogy

Words	Molecules
Comprised of letters.	Comprised of atoms.
Arrangement of letters gives words meaning.	Arrangement of atoms gives molecules function.
Special groups of letters make syllables.	Special groups of atoms make functional groups.
Common endings = suffixes	Common side chains = acids
Talking Writing Playing	$H_2NCH_2COOC_4H_9$ $H_2NCH(CH_2)COOC_4H_9$ $H_2NCH(C_6H_5)COOC_4H_9$

List all words containing "ing" in the book of abstracts.

Use a computer to search for the string "ing" and it displays all words containing "ing."

Detect all molecules containing a butyl formate functional group from an α-amino acid.

Use a NL scan function to detect only molecules that lose a butylformate function

Concept 7: Quantification via IDMS

Simple Definition:
It is a method that measures how much compound X is present in a liquid, solid or gas. This method uses non-radioactive elements called stable isotopes to make a comparison of compound X with the standard that contains the stable isotope. Since the amount of stable isotope standard is known we can calculate how much compound X is present.

- Jelly Bean Analogy

How many Cherry Jelly Beans are in the jar?

How much phenylalanine is present in Blood

1. Add a marker or standard

10 Blueberry Jelly Beans

10 picomoles d_5 Phenylalanine

2. Obtain a sample.

1 oz

10 uL (1 drop)

3. Analysis.

Sort jelly beans in the cup by flavor/color
Count how many.

Sort Phenylalanine by MS/MS
Count how many.

3. Calculations

a.) 3 Cherry Red, 2 Blueberry in 1 oz
b.) 3/2 ratio of Cherry to Blueberry
c.) 10 Blueberry added to 1 oz.
d.) 10 x 3/2 = 15
e.) 15 Cherry Red Jelly Beans in Jar

a.) 2,000 Phe, 1,000 i.s.
b.) 2/1 ratio of Phe to I.S.
c.) 10 pmol i.s. added to 1 mL blood
d.) 10 x 2/1 = 20 pmol
e.) 20pmol Phe per mL of blood

Concept 8: Accuracy and Precision

Mass Spectrometrists always say:
Mass Spectrometry is very accurate and precise.

Reality:
Mass Spectrometrist confuse accuracy and precision.

- Dart Board Analogy
  - *Simple Concept.*
  - *Visual*
  - *Easily remembered*
  - *Educational, Fun*


Accurate & Precise


Precise, Not Accurate


Accurate, Not Precise


Not Accurate, Not Precise

Summary

➢ Presented simple concepts, ideas that can foster other suggestions on communication.

➢Mass Spectrometry can be interesting, enjoyable and fun.

➢ We need to develop more resources to support communication, especially with media, etc. Why? *When a new method using MS to screen for ovarian cancer is called a computer method by the popular press, it is clear there is work to do.*

➢Where to go from here? ASMS, ACS

➢dhchace@neogenscreening.com

References:
1. What is Mass Spectrometry? http://www.asms.org/whatisms