Effects of wildfire aerosols to human health

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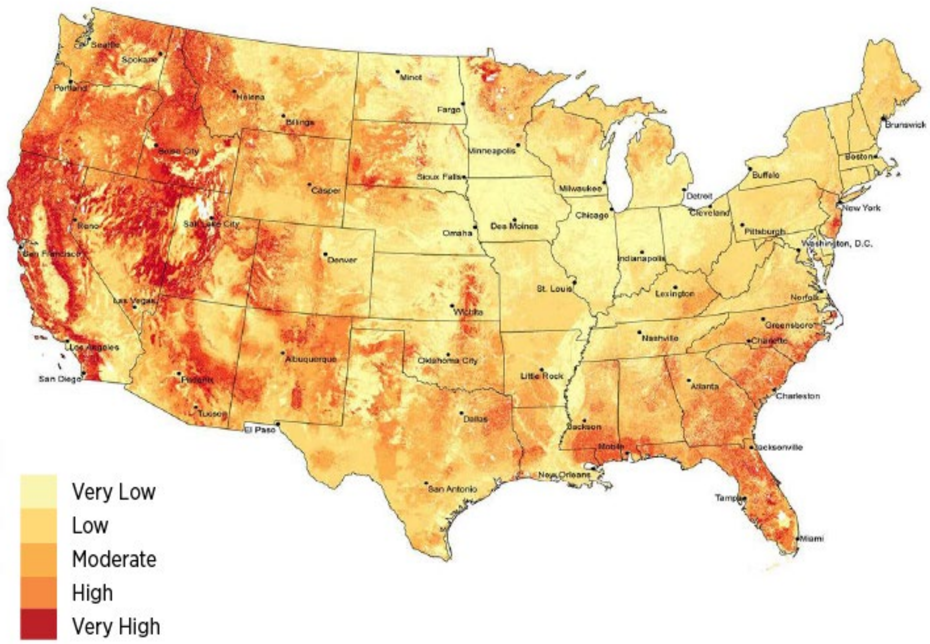
UCLA

Virtual Symposium on "Wildfire Induced Air Pollution Mitigation & Assessment"
Monday, March 23rd, 2020

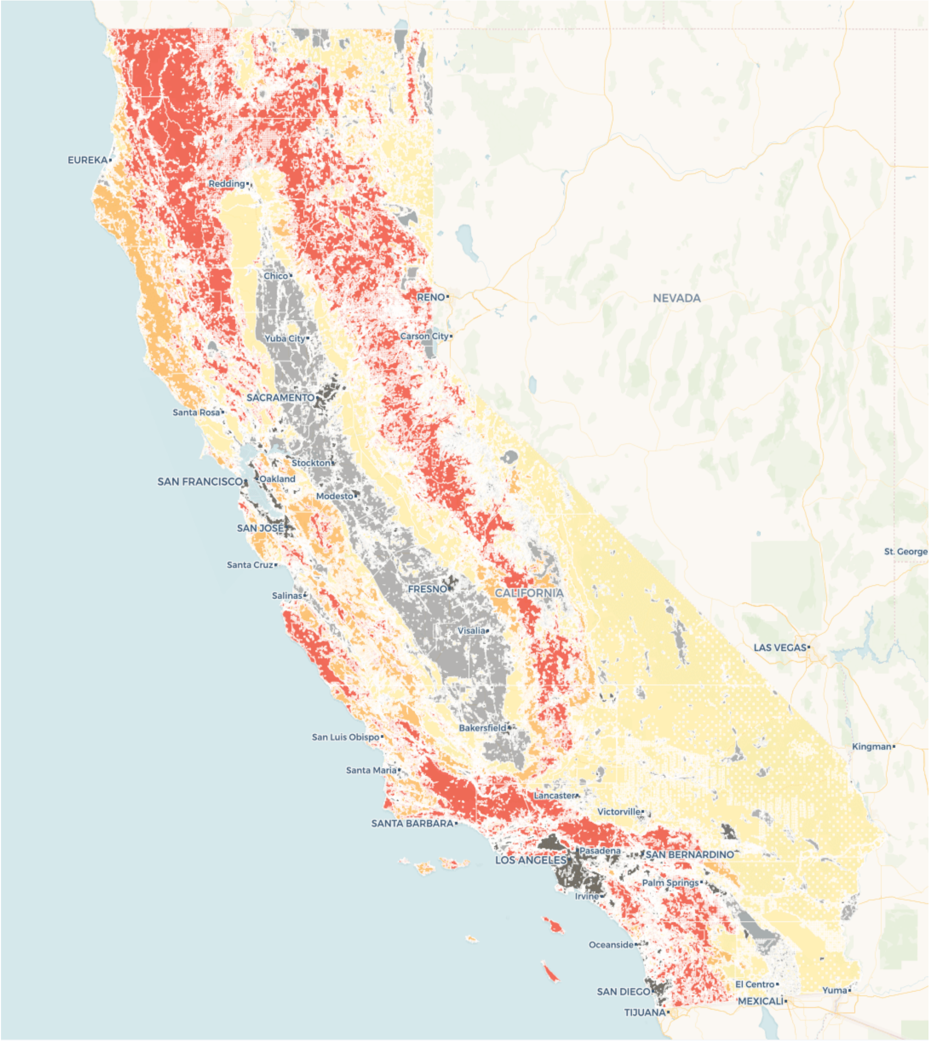
WILDFIRE RISK

Know the likelihood of experiencing wildfire in your area.



This is a general representation of risk associated with wildfires. It is not intended to predict wildfire occurrences. Source: U.S. Department of Agriculture Forest Service, Fire Modeling Institute

Wherever you live, you can take action to reduce your risk of wildfire losses.
Visit our Disaster and Recovery Center to learn more.



USAA 2019

California Fire Hazard Zones. Credit: KQED

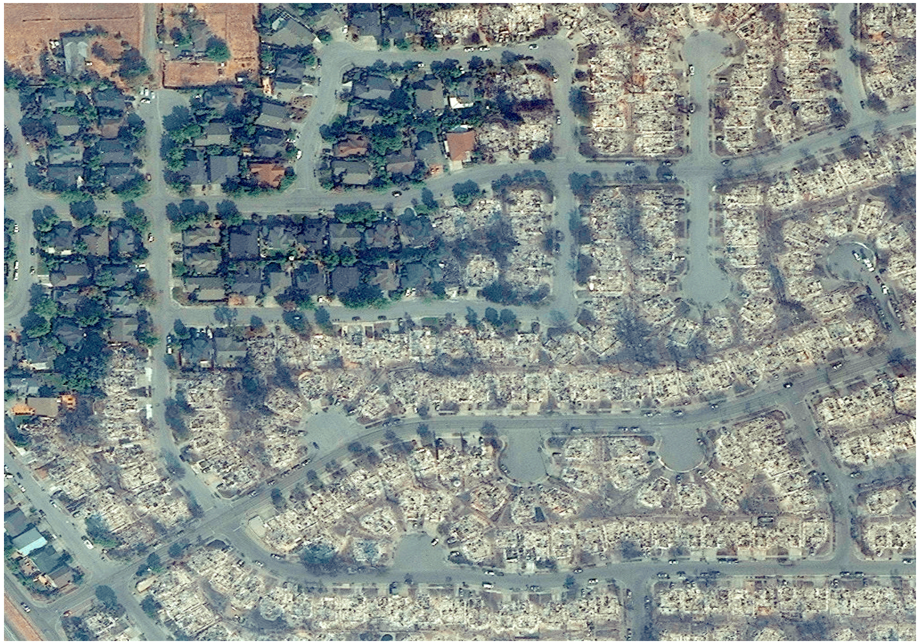
Wildfire will generate air pollution

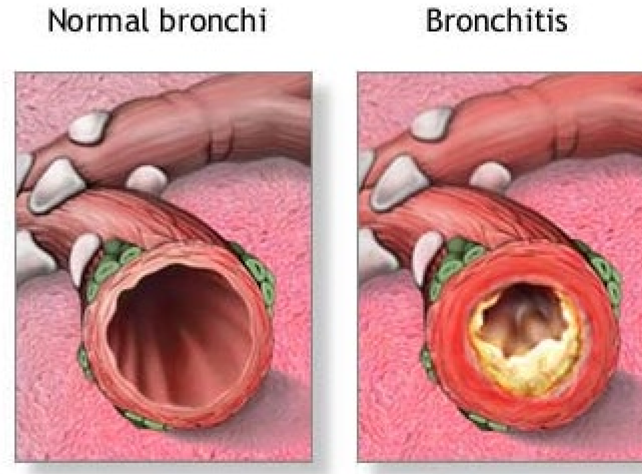
Types and Sources of Air Pollution

<u>Air Pollution</u> = gases, liquids, or solids present in the atmosphere in high enough levels to harm humans, other organisms, or materials.

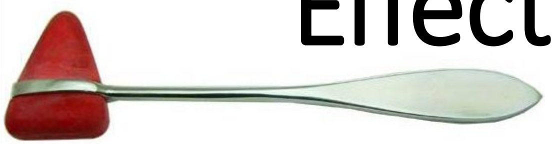
- **Natural pollution (lightning causes forest fires, volcanic eruptions)**
- **Human-induced pollution** (***<u>ANTHROPOGENIC</u>***)

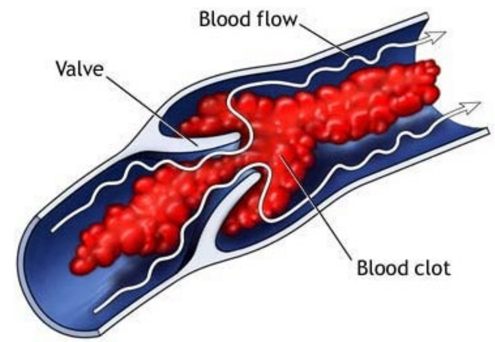
Wildfire is not natural anymore





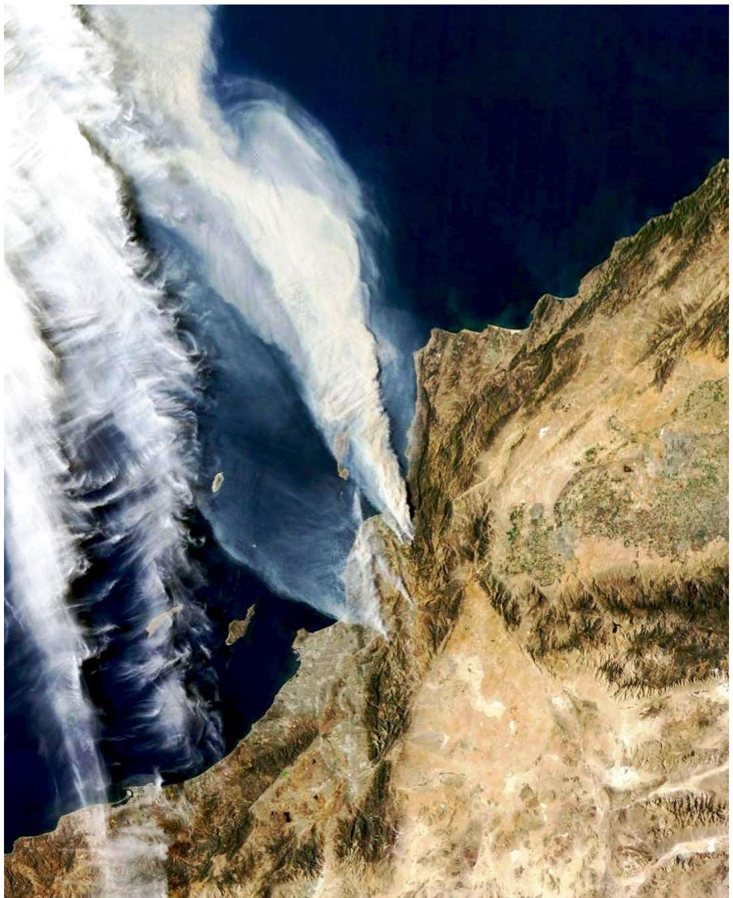
Effects of Air Pollution

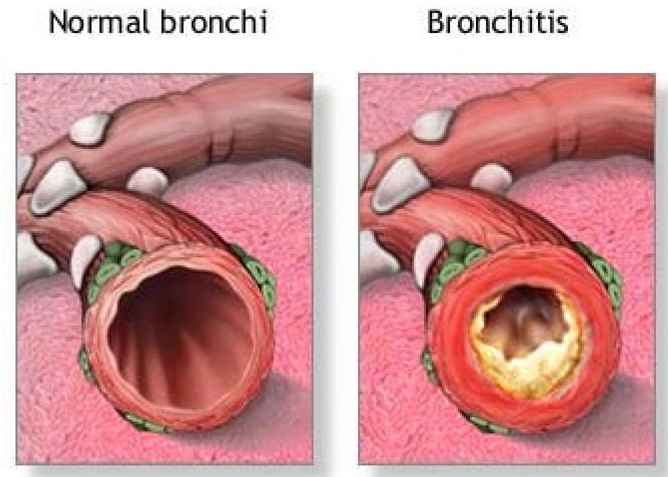




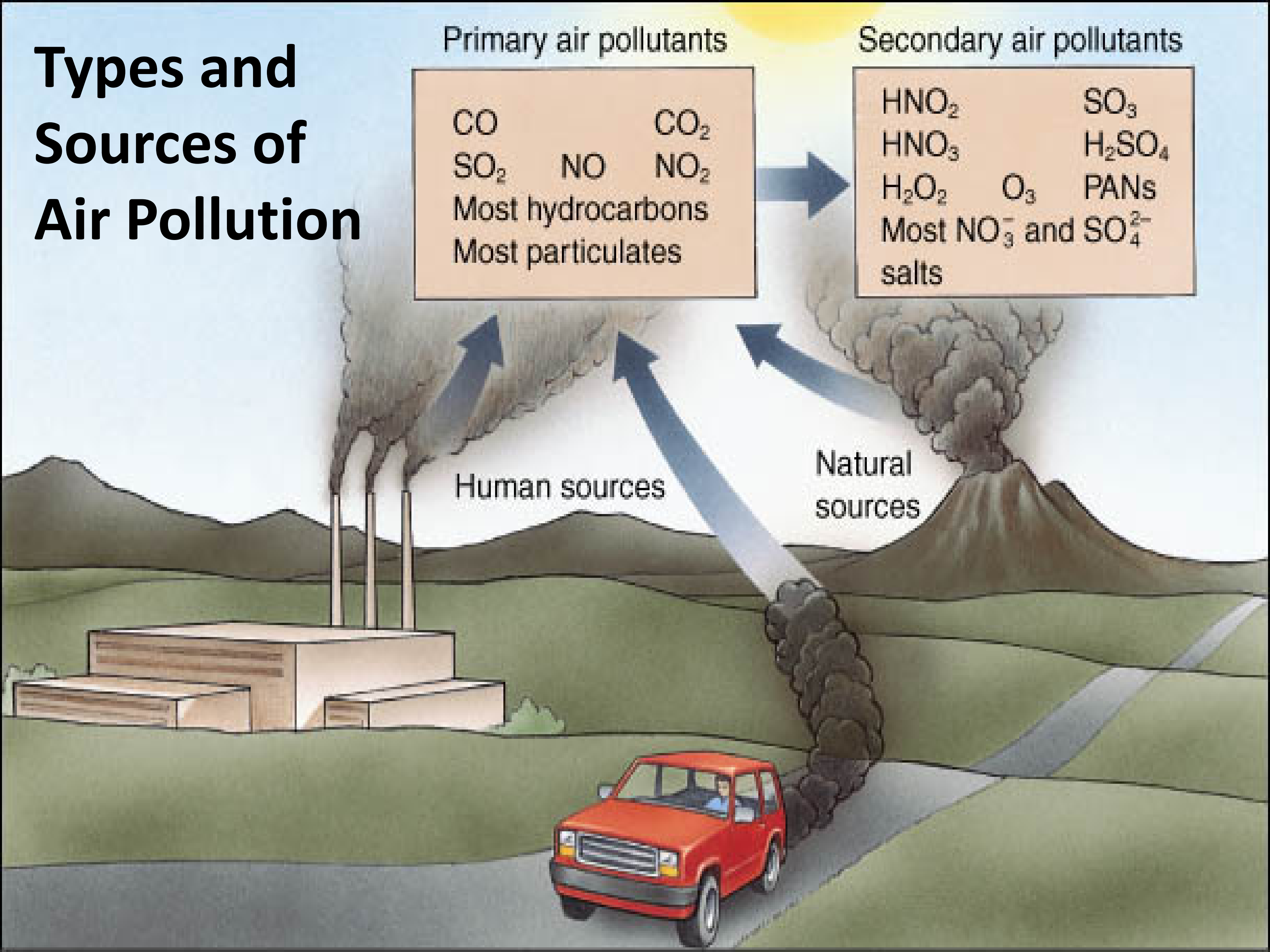
How to study the wildfire induced toxicity?

1. Know the wildfire aerosols
2. Understand how they induce toxicity

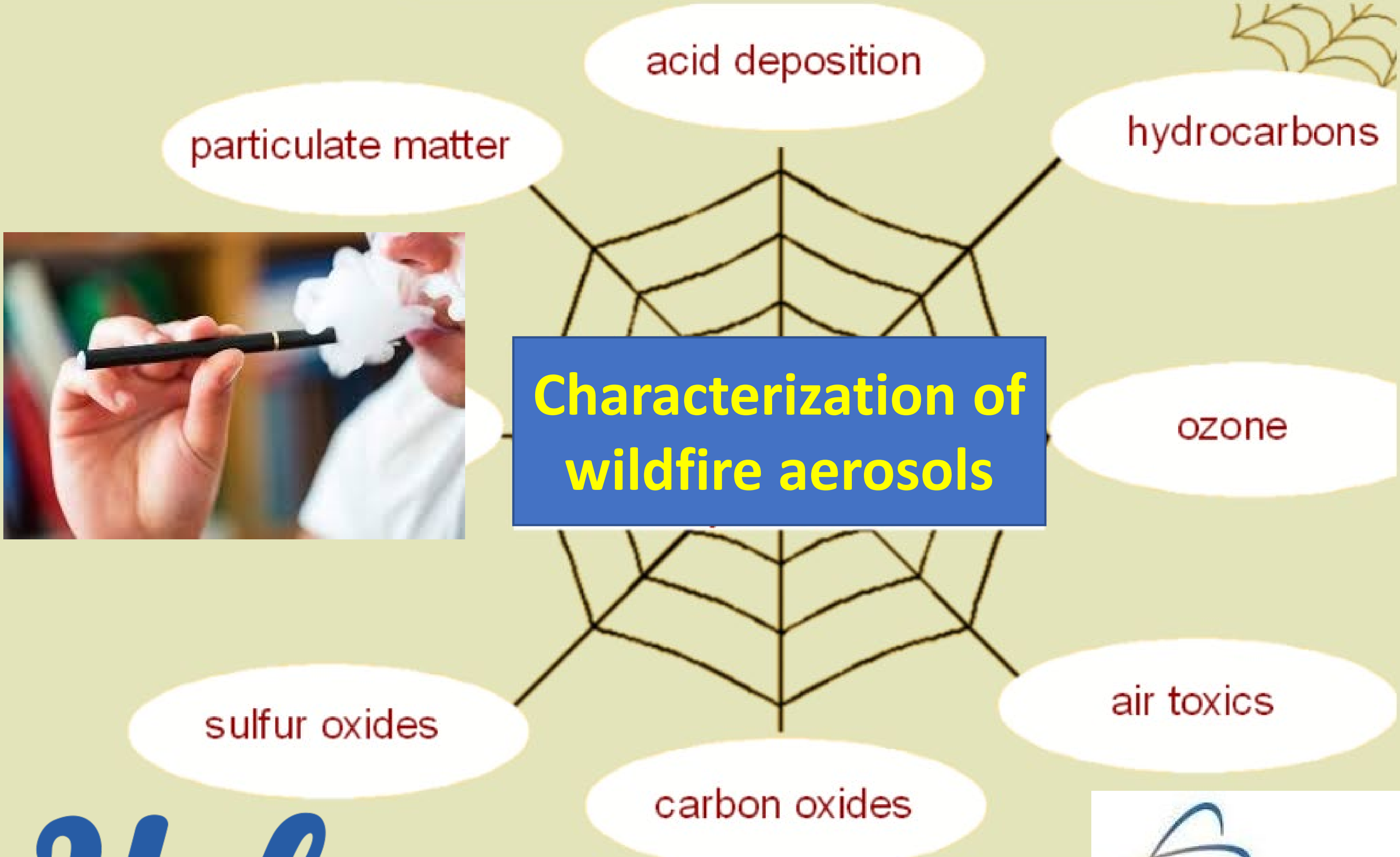




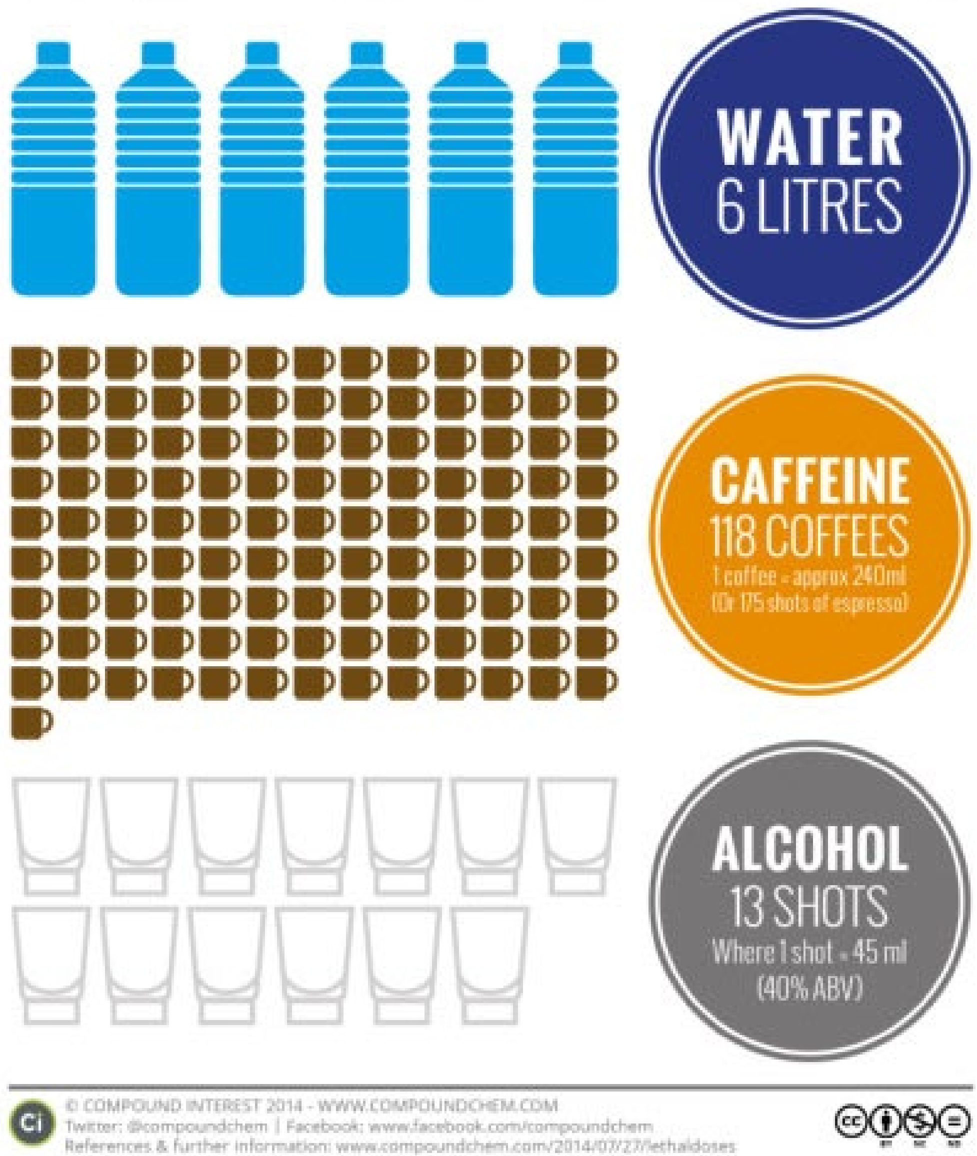
Types and Sources of Air Pollution



Physicochemical characterization of wildfire aerosols



The Dose makes the poison



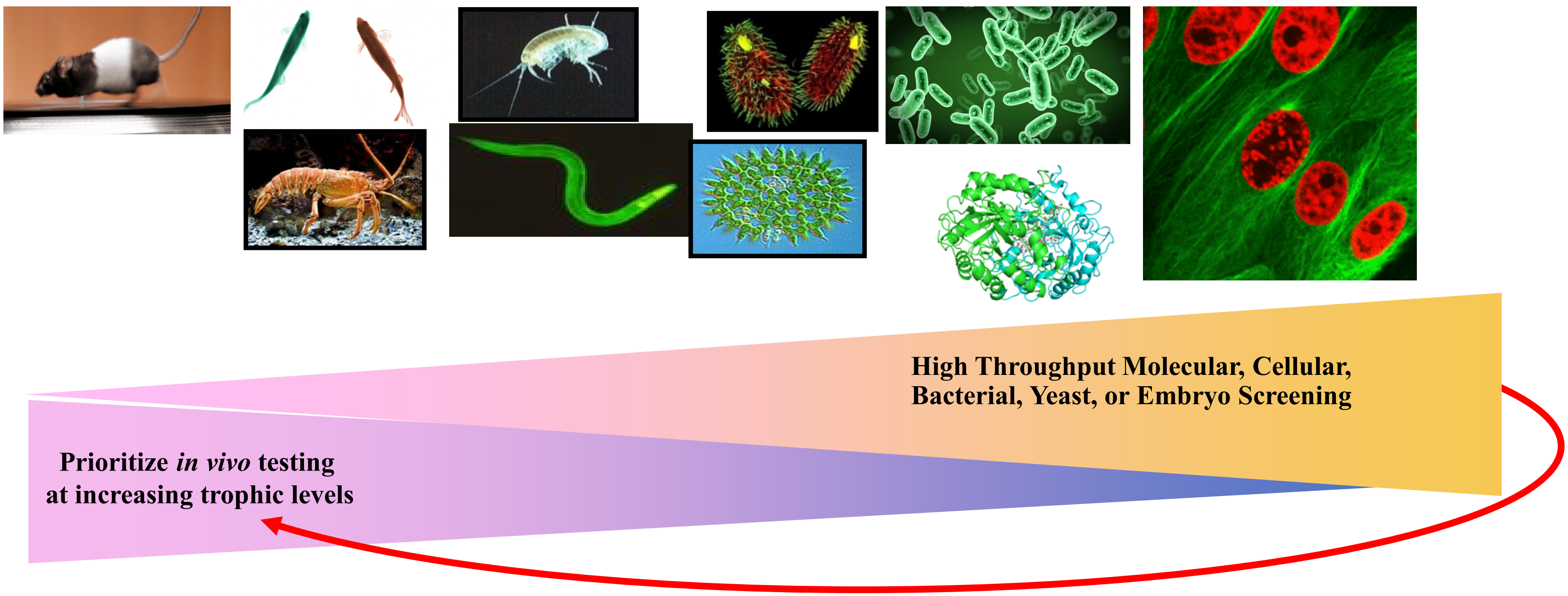
How to test toxic effects? Lessons from Conventional Chemical Safety Assessment

"Out of 80,000 chemical s registered in USA, only 200+ has undergone systematic toxicity testing out of which only five has been banned" (Toxic America, CNN).

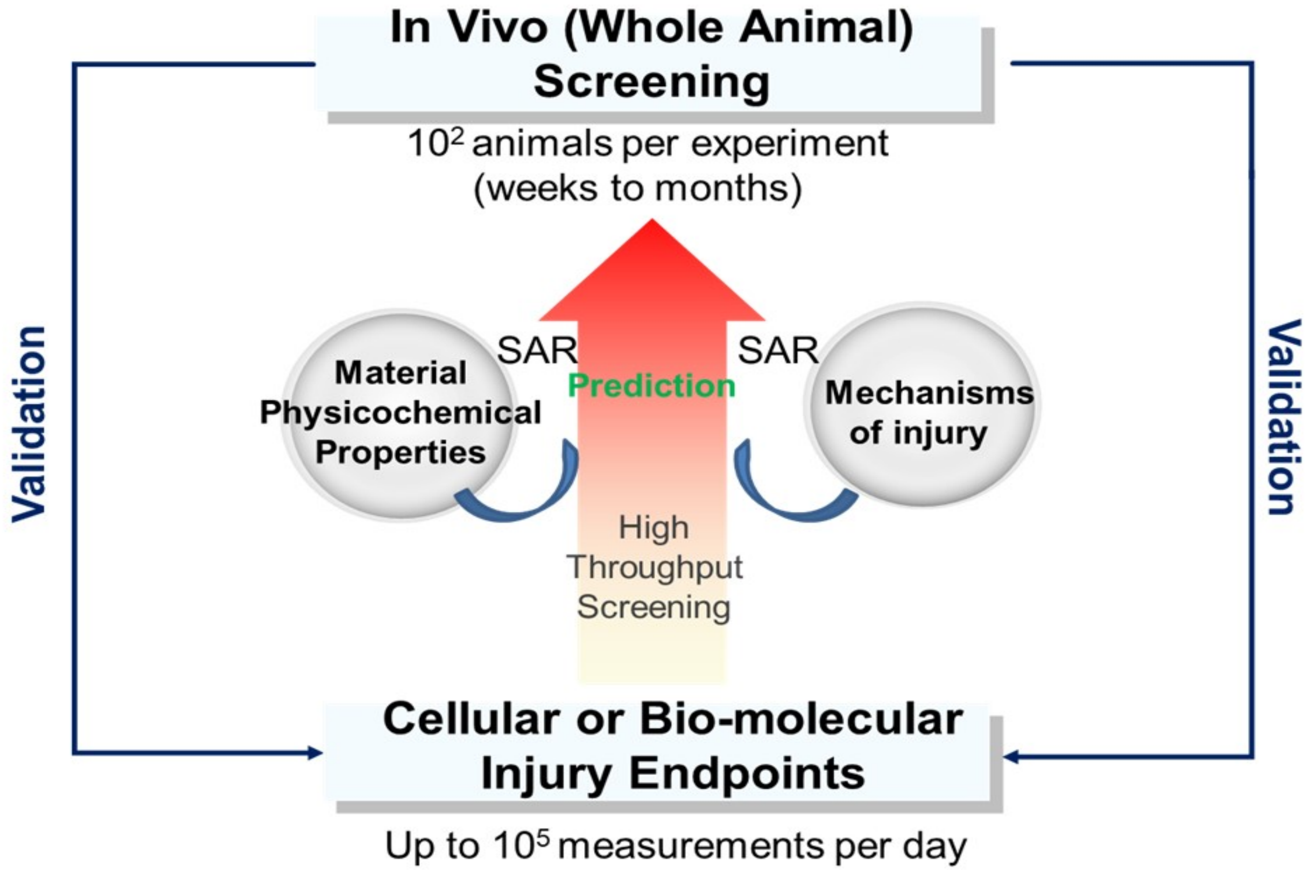
	Conventional assay (Animal Model)
Time	32 Years for the chemicals so far
Cost	US$14 billion/year [1]
Animal ethics	100 million experimental animals are used every year for toxicological studies[2]
Relevance to human safety	Differences between animal and human responses to chemicals/material [1, 2]

1. Nature 2009, 460, 208-212
2. *Environmental Health Perspectives*, 1999, pp. 83-88

US National Academy of Science (NAS) Report (2007): "*Toxicity Testing in the 21st Century: A Vision and a strategy*"

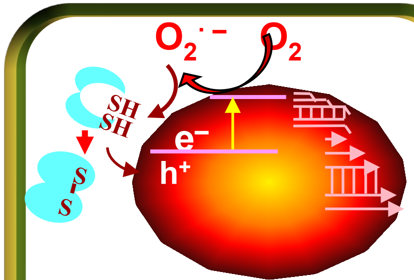


We use a predictive toxicological approach for wildfire aerosol hazard testing

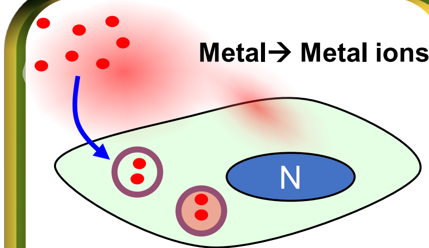


Nel, Xia, et al. ACR, 2012

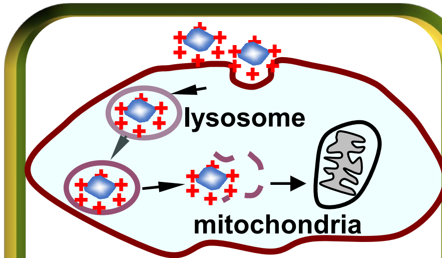
ENM Predictive Toxicological Mechanisms



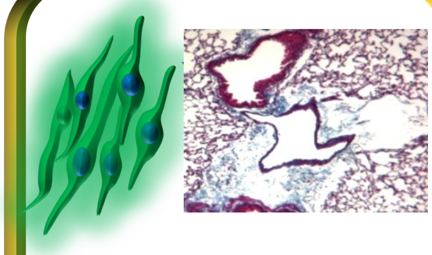
Redox activity and ROS e.g., TiO_2, CuO, CoO



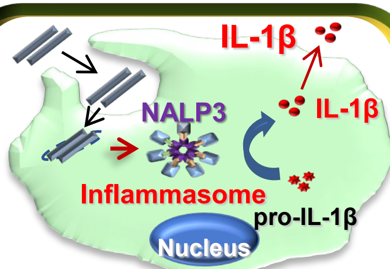
Dissolution, shedding, toxic Ions e.g. ZnO, CuO



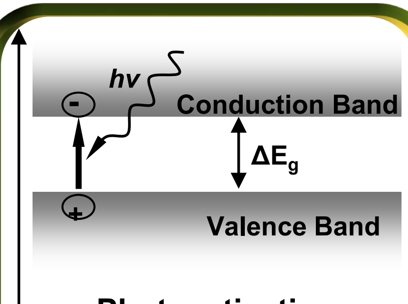
Cationic toxicity, e.g. cationic polystyrene, PEI-MSNP



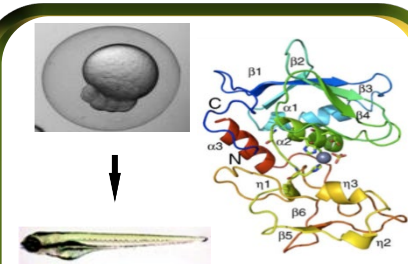
Lung Fibrosis e.g. CNTs



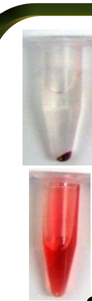
Inflammasome activation e.g., CNT, CeO_2 rods

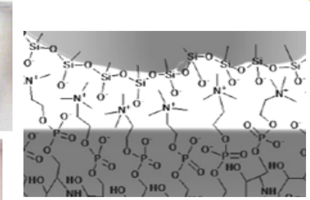


Photoactivation e.g. TiO_2



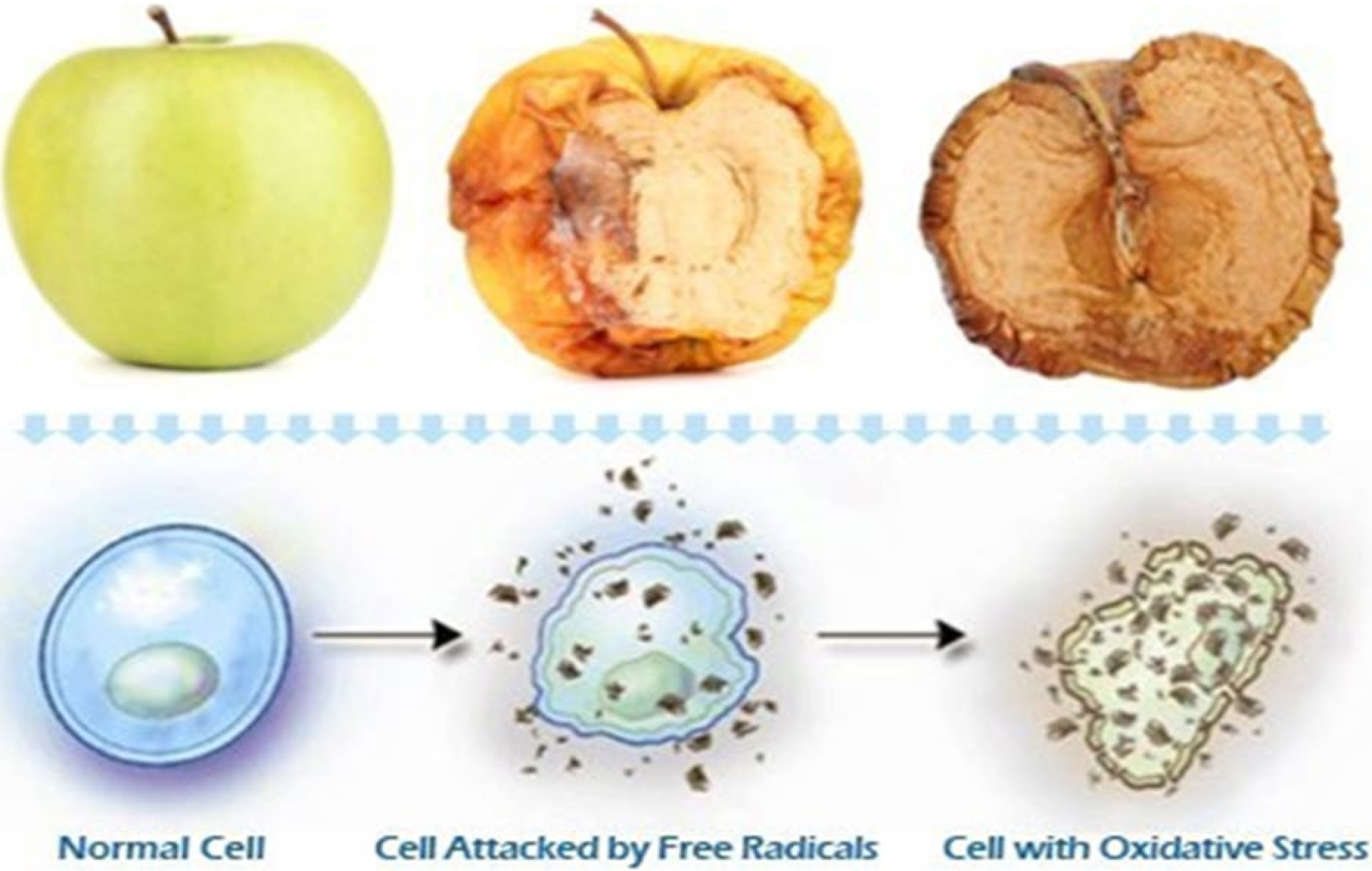
Embryo hatching interference e.g. CuO

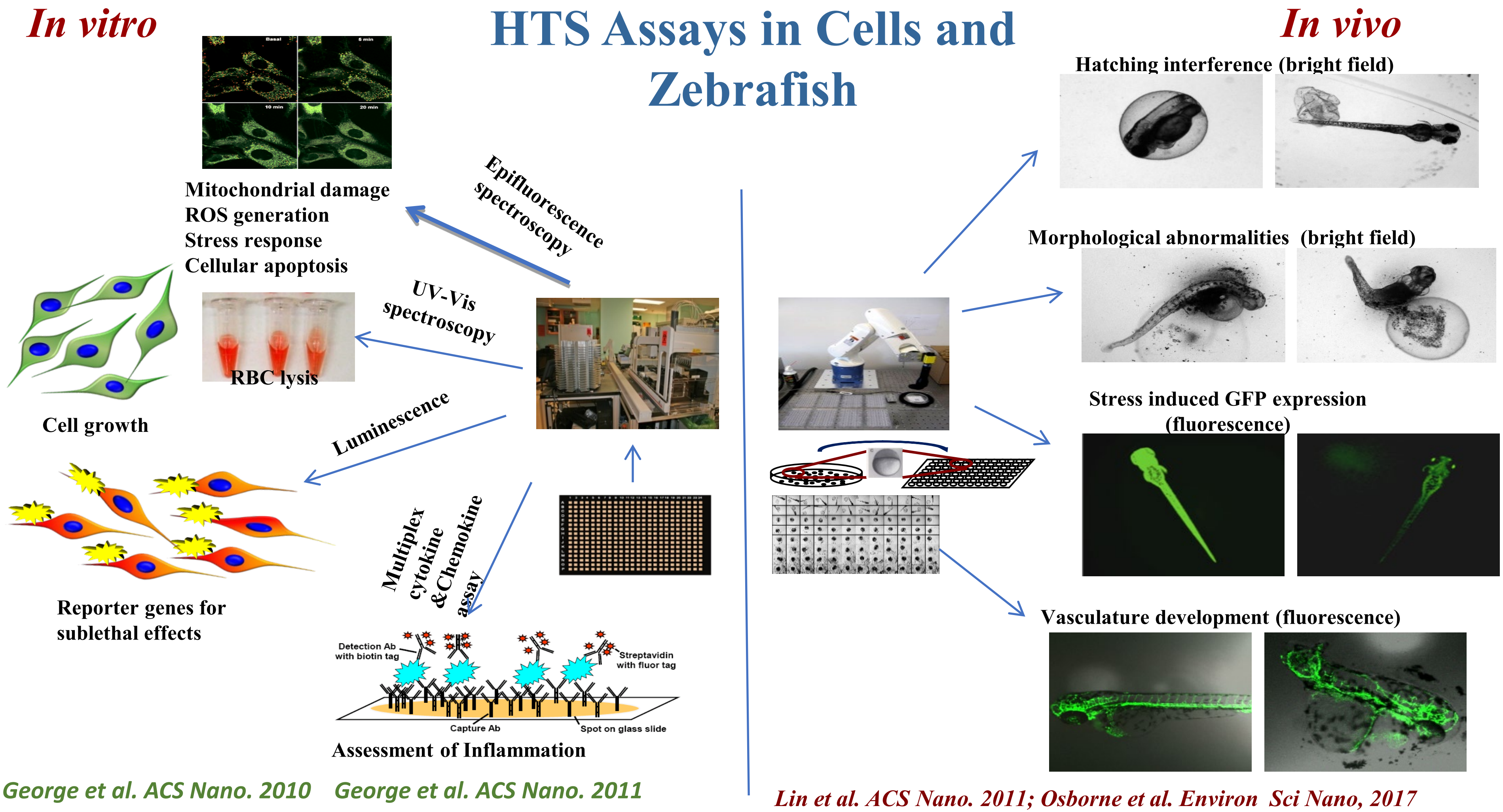




Membrane Lysis e.g. Si nanoparticles, Ag-plates

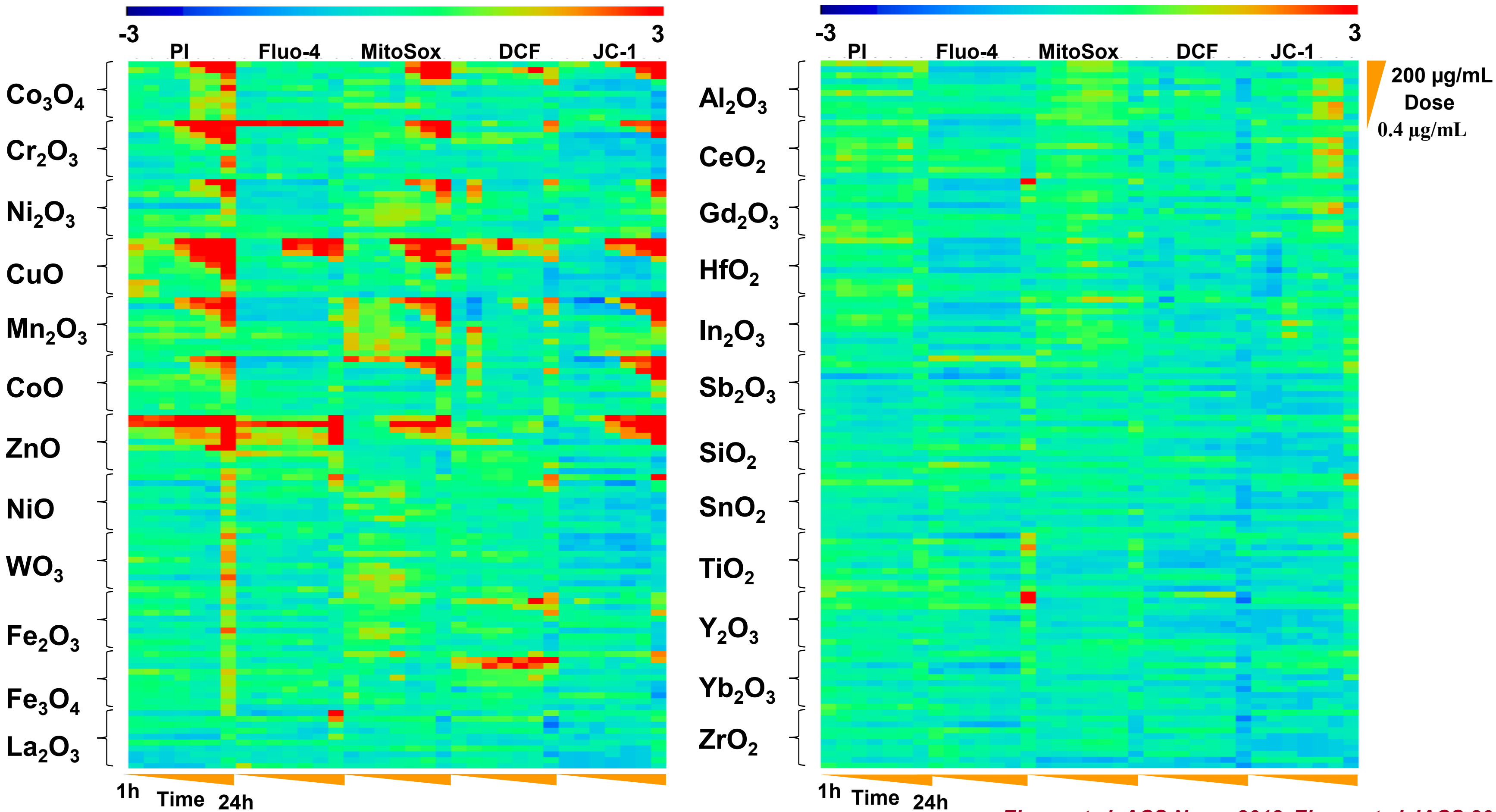
Oxidative stress is the most studied mechanism of toxicity by air pollution





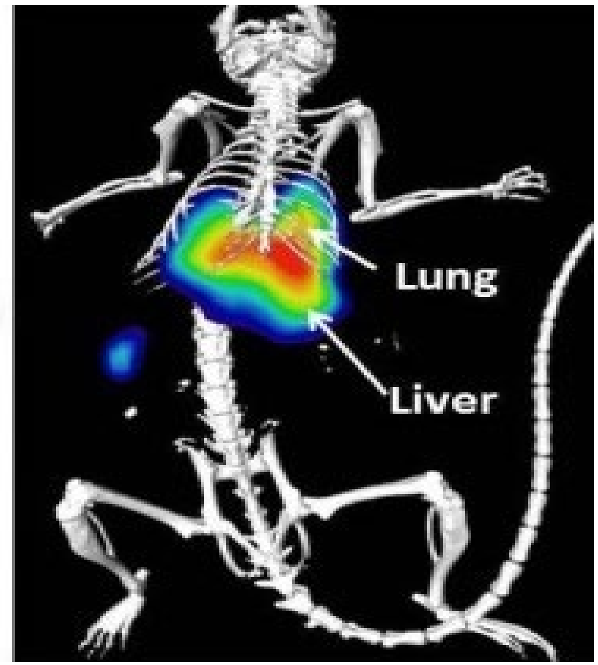
In vitro
HTS Assays in Cells and Zebrafish
In vivo
Mitochondrial damage
ROS generation
Stress response
Cellular apoptosis
Epifluorescence spectroscopy
UV-Vis spectroscopy
RBC lysis
Cell growth
Luminescence
Reporter genes for sublethal effects
Multiplex cytokine &Chemokine assay
Detection Ab with biotin tag
Streptavidin with fluor tag
Capture Ab
Spot on glass slide
Assessment of Inflammation
George et al. ACS Nano. 2010
George et al. ACS Nano. 2011
Hatching interference (bright field)
Morphological abnormalities (bright field)
Stress induced GFP expression (fluorescence)
Vasculature development (fluorescence)
Lin et al. ACS Nano. 2011; Osborne et al. Environ Sci Nano, 2017

Multi-parameter Oxidative Stress Screening



Zhang et al. ACS Nano. 2012, Zhang et al JACS 2014

In vivo validation



PET imaging

Wang, et al, NanoImpact, 2017

Zern et al. ACS Nano. 2013; 7: 2461-9

VAPING

8 Deaths, 530 Illnesses From Vaping: Here's What to Know

By Healthline | Sep. 23, 2019 07:53AM EST

HEALTH + WELLNESS

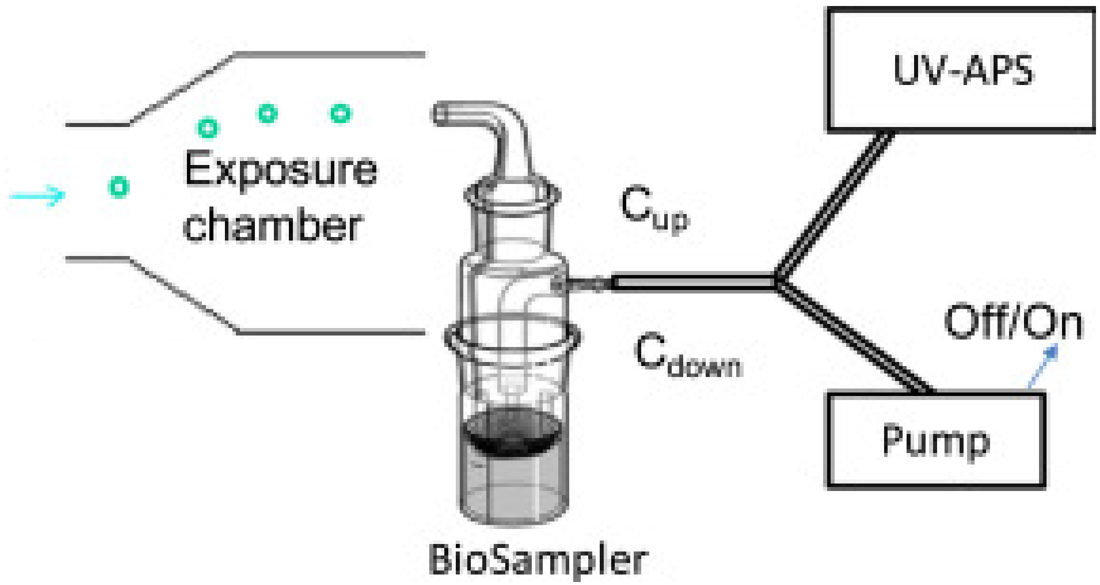
The New York Times

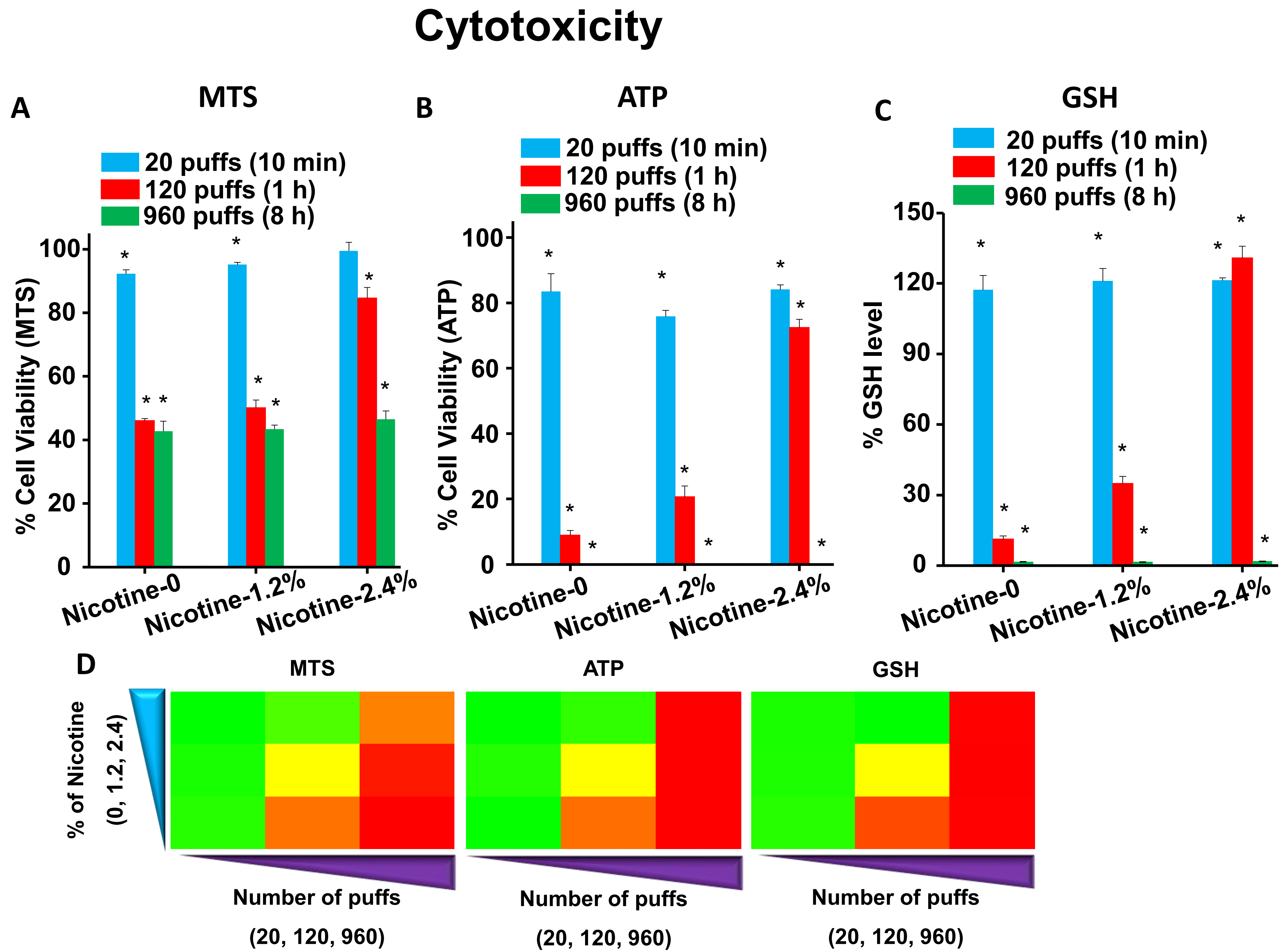
E-Cigarettes Are in Vogue and at a Crossroads

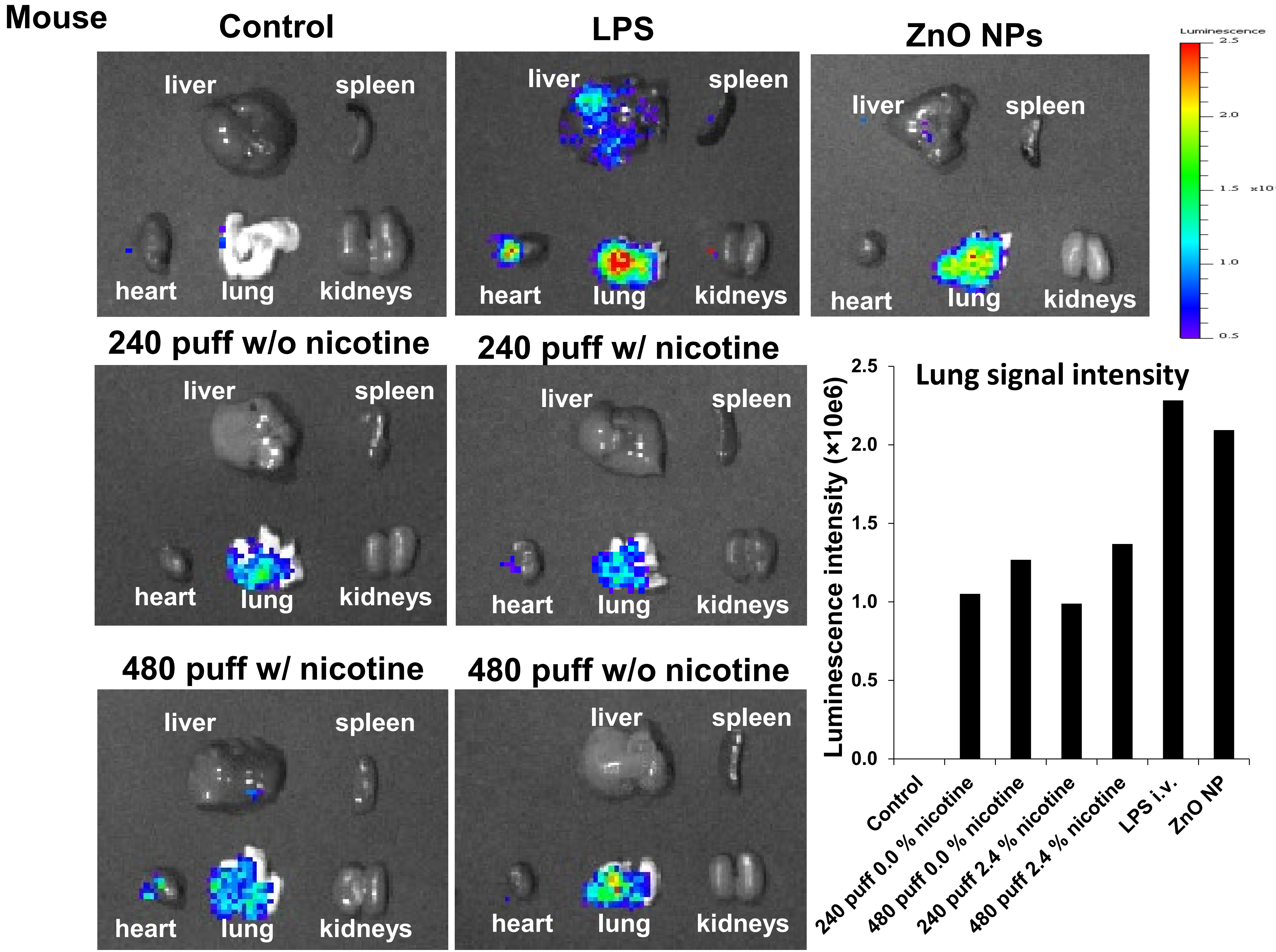
TIME

As the Number of Vaping-Related Deaths Climbs, These States Have Implemented E-Cigarette Bans

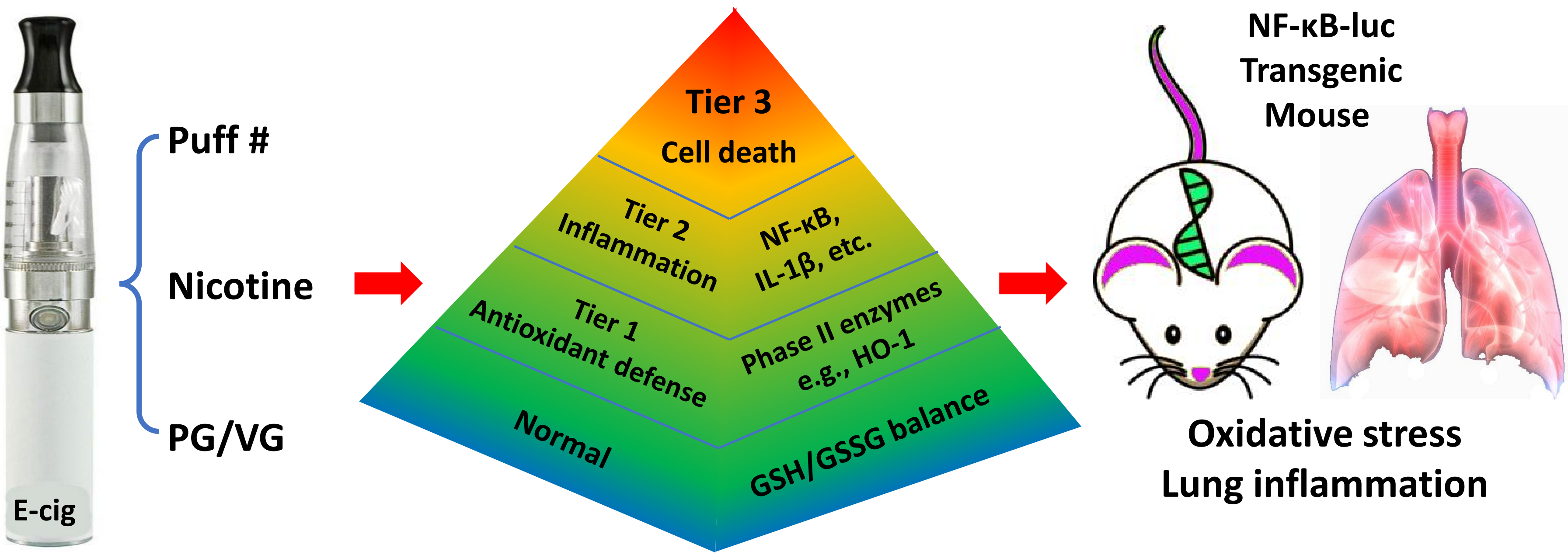
How do we collect the aerosols?




Cytotoxicity
A
MTS
20 puffs (10 min)
120 puffs (1 h)
960 puffs (8 h)
% Cell Viability (MTS)
0
20
40
60
80
100
Nicotine-0
Nicotine-1.2%
Nicotine-2.4%
B
ATP
20 puffs (10 min)
120 puffs (1 h)
960 puffs (8 h)
% Cell Viability (ATP)
0
20
40
60
80
100
Nicotine-0
Nicotine-1.2%
Nicotine-2.4%
C
GSH
20 puffs (10 min)
120 puffs (1 h)
960 puffs (8 h)
% GSH level
0
30
60
90
120
150
Nicotine-0
Nicotine-1.2%
Nicotine-2.4%
D
MTS
ATP
GSH
% of Nicotine
(0, 1.2, 2.4)
Number of puffs
(20, 120, 960)
Number of puffs
(20, 120, 960)
Number of puffs
(20, 120, 960)


Mouse
Control
LPS
ZnO NPs
Luminescence
2.5
2.0
1.5
x10^5
1.0
0.5
liver
spleen
heart
lung
kidneys
240 puff w/o nicotine
240 puff w/ nicotine
480 puff w/ nicotine
480 puff w/o nicotine
Lung signal intensity
Luminescence intensity (×10e6)
0.0
0.5
1.0
1.5
2.0
2.5
Control
240 puff 0.0 % nicotine
480 puff 0.0 % nicotine
240 puff 2.4 % nicotine
480 puff 2.4 % nicotine
LPS i.v.
ZnO NP

Summary



E-cig
Puff #
Nicotine
PG/VG
Tier 3
Cell death
Tier 2
Inflammation
NF-κB,
IL-1β, etc.
Tier 1
Antioxidant defense
Phase II enzymes
e.g., HO-1
Normal
GSH/GSSG balance
NF-κB-luc
Transgenic
Mouse
Oxidative stress
Lung inflammation

Summary

Fire chamber