



Comparative Analysis of the Efficacy of Filters from Different Brands of Cigarettes

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Learning Objective:

The objective is to learn a technically simple, efficient, inexpensive, reproducible and quantitative method for measuring the tar-retaining efficacy of cigarette filters.

Background:

- **Greater than 95% of the cigarettes sold worldwide have a filter.**
- **Filters are designed to remove micro-particles (“tar”) in cigarette smoke.**
- **There are many different types of cigarette filters.**
- **There exists a need to evaluate the efficacy of the different types of filters.**

Hypothesis:

- 1) It is theorized that a scheme can be developed whereby spectrofluorometry and/or spectrophotometry can be used to measure tar on cigarette filters.
- 2) It is postulated that the measurement of total tar, or a spectrum of smoke components, may prove to be more accurate than the methods that have been described previously.

"Tar" Collected From Single Cigarettes

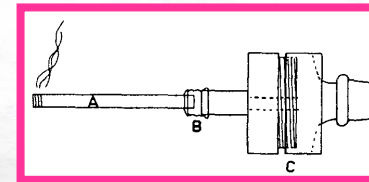
(Filter vent holes open or blocked during smoking)

Univ. of Ky., Filtered, Ultra-Low Nicotine, Reference Cigarette

Federal Trade Commission Machine-Smoking Protocol

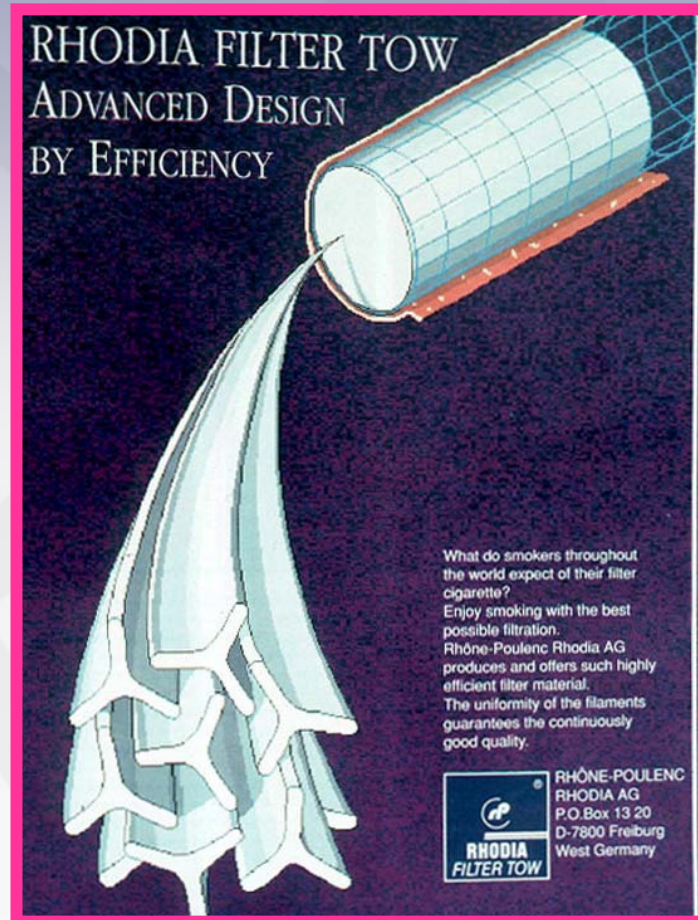
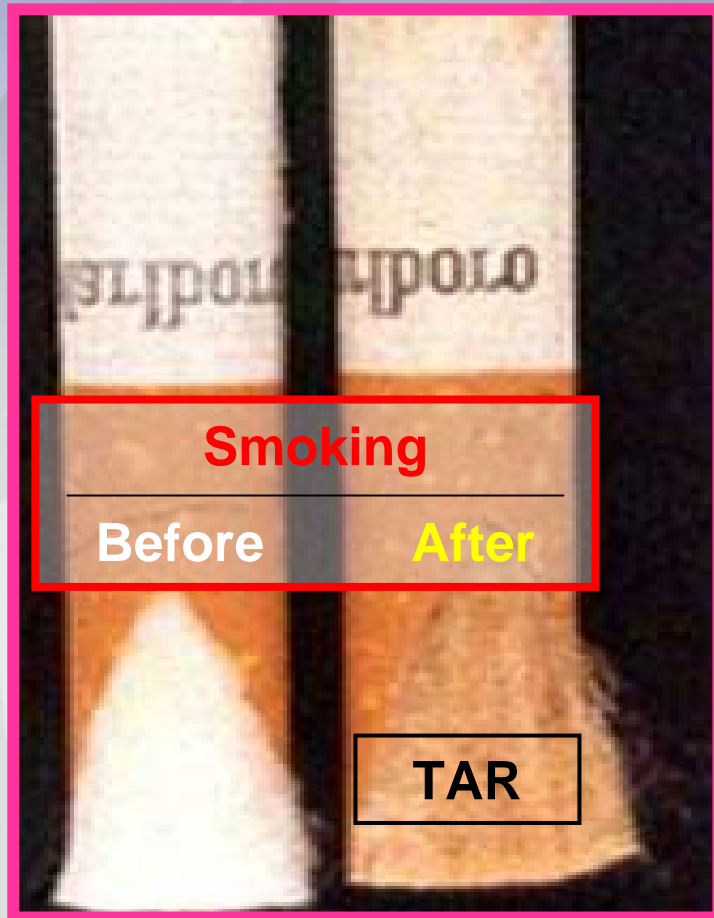
Approximate Composition of Smoke

- 1.7 mg "Tar"
- 0.2 mg Nicotine
- 0.3 mg Water
- 3.0 mg Carbon Monoxide
- 0.1 mg Nitrogen Oxides

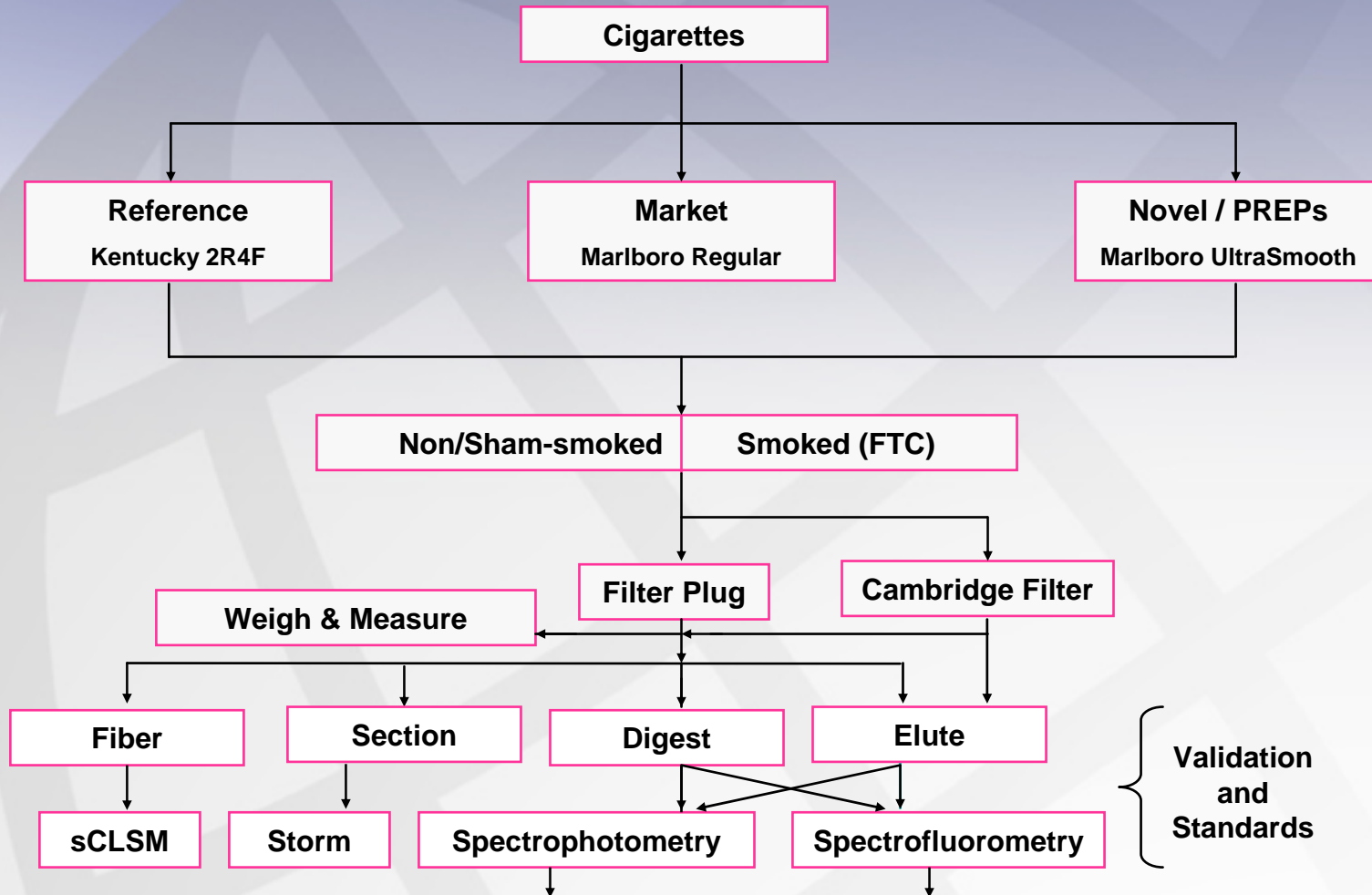


Cambridge Filter Unused	Smoke Collection Filters Filter holes: Open Blocked	

Most Cigarette Filters Consist of a Plug Having ~ 12,000 Y-shaped Fibers of Cellulose Acetate

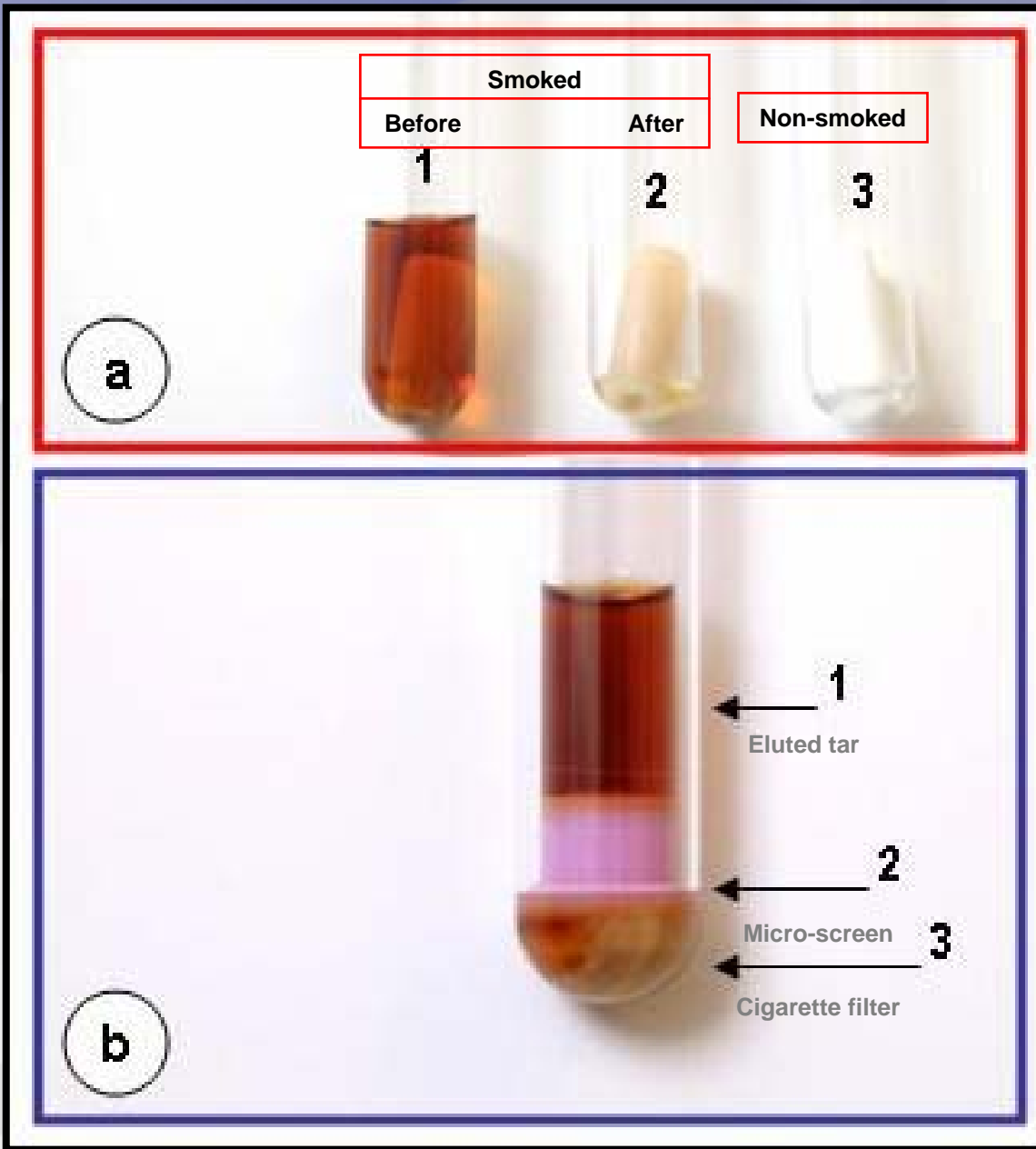


Study Scheme











Results:

(a) Cigarette brand, (b) Filter wt, (c) Filter vol, (d) mg Tar, (e) Dye fluorescence, (f) MESF - beads

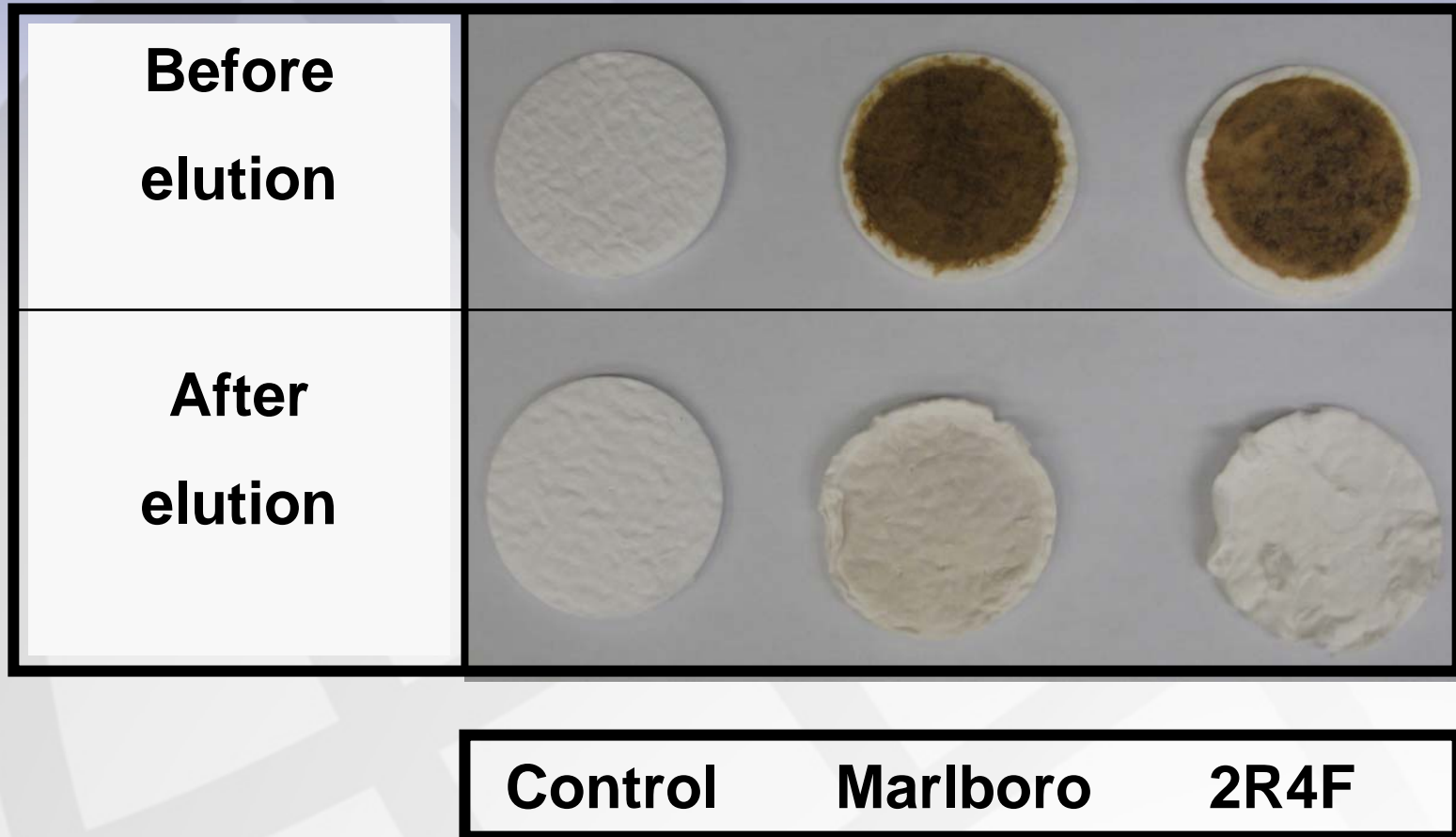


Elution of tobacco smoke “tar” from cigarette filters with a plasma-extractor micro-screen filter tube

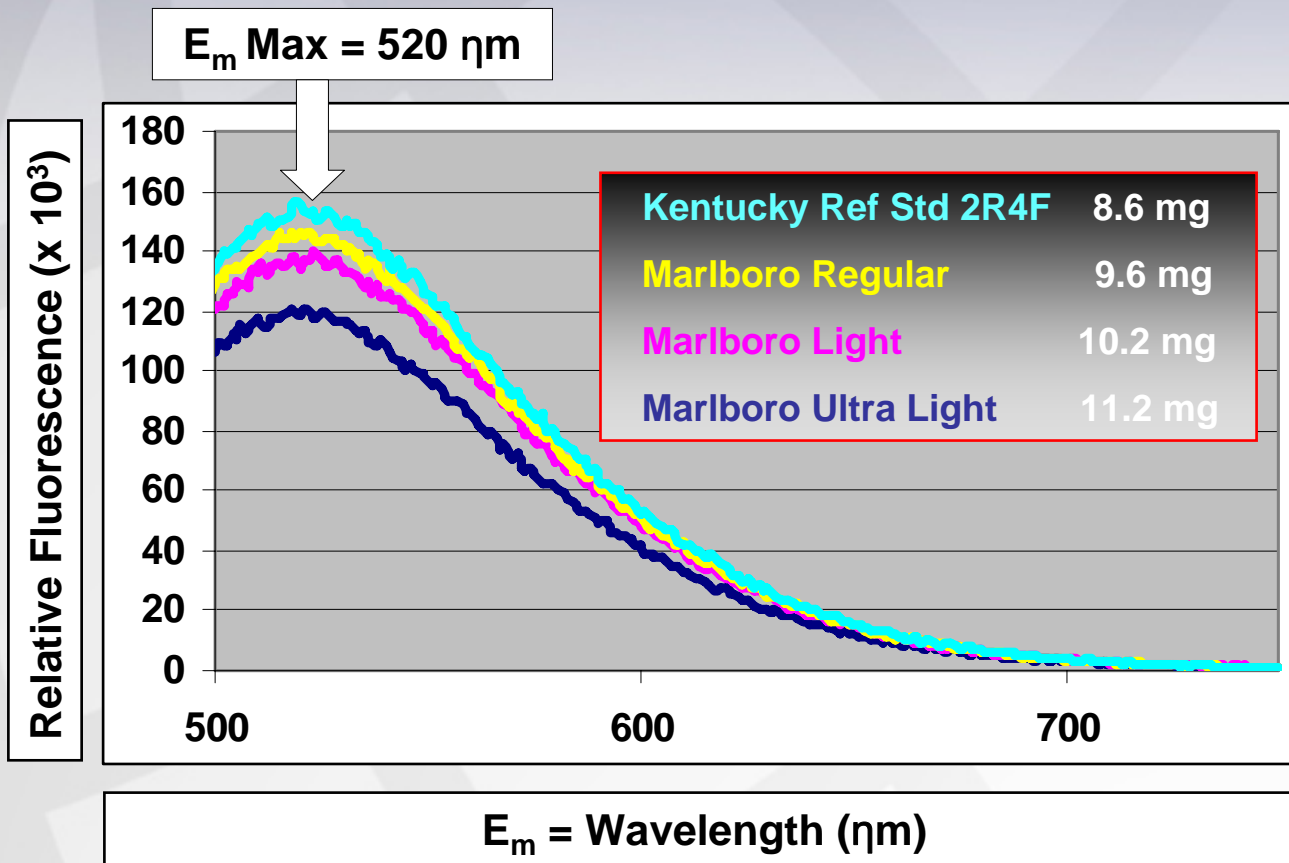
Elution of Tar from Cigarette Filters with Absolute Methanol

Cigarette	Non-smoked	Smoked
2R4F		
Marlboro Regular		
Marlboro Light		
Marlboro Ultralight		

Elution of Tar from Cambridge Glass-fiber Filter Pad with Absolute Methanol



Emission Spectra (Em) of Tar Eluted from the Filters of Different Cigarettes (Ex = 475 nm)





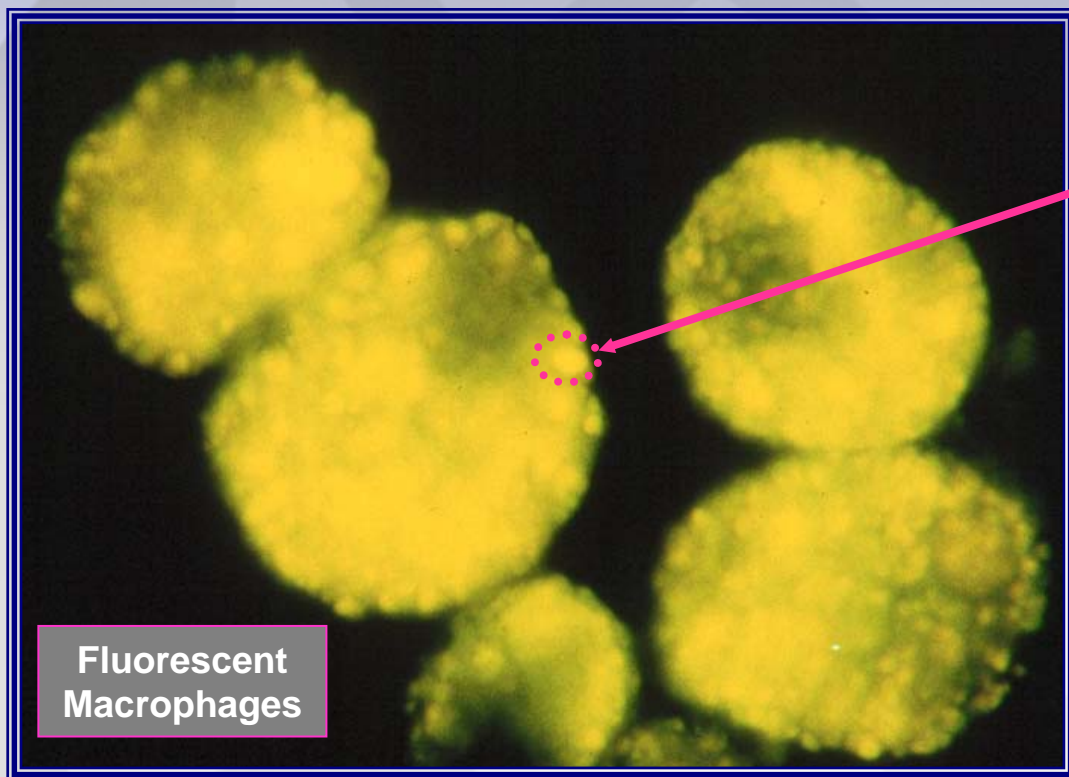
Cigarette filter fibers

2 from non-smoked cigarettes

2 from smoked cigarettes

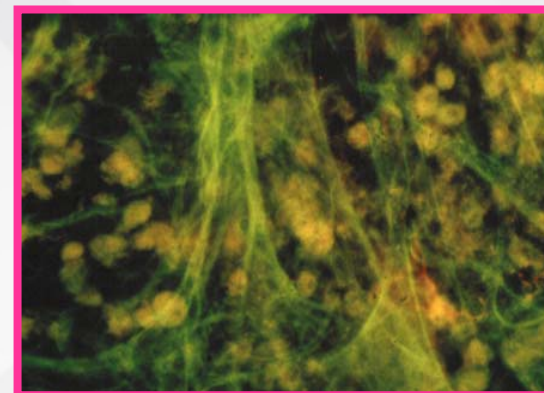
**White Light
Microscope**

Living Non-stained Lung Macrophages Isolated from Fresh Surgically Excised Lung Tissue of a Long-term Smoker (“Smoker Cells”) ^a



Fluorescent Macrophages

Tar-associated cytoplasmic inclusion body



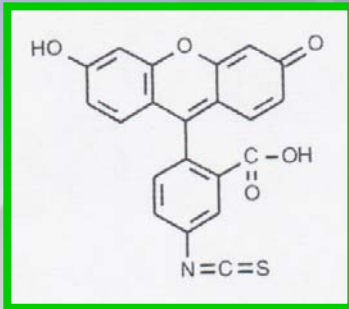
Macrophages in Fresh Human Lung Tissue

^a For a review, see:

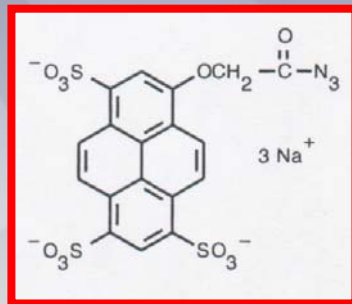
Pauly, J. L. Fluorescent human lung macrophages analyzed by spectral confocal laser scanning microscopy and multispectral cytometry. *Microsc. Res. Tech.* 67: 79-89, 2005.



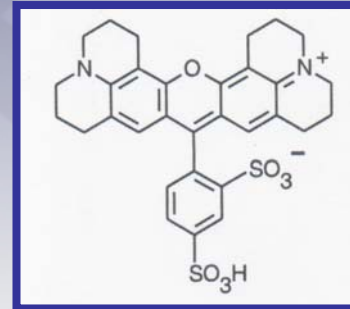
Structure of Conventional Fluorescent Probes



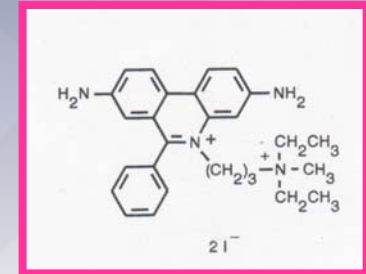
Fluorescein



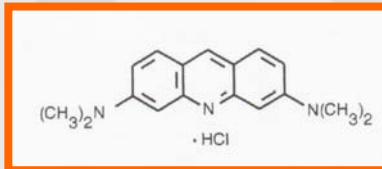
Rhodamine



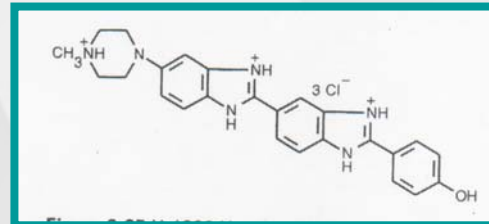
Cascade Blue



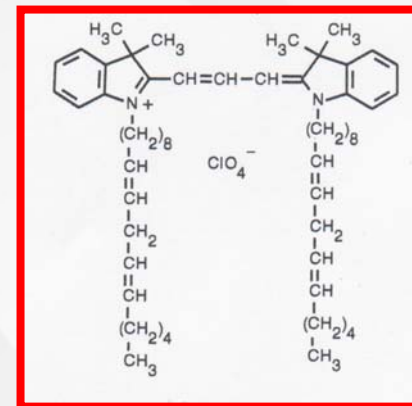
Propidium Iodide



Acridine Orange

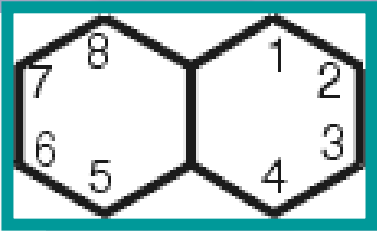
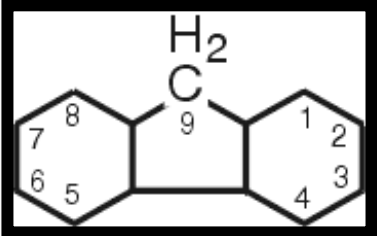
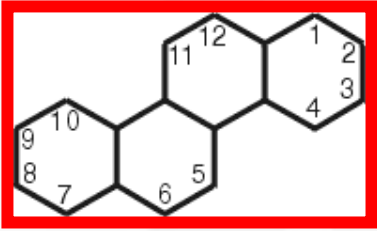
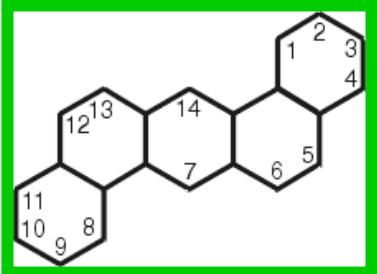


Hoechst 33258



Fast Dil

PAH on Cigarette Filters (US Pat. #6,273,095; 08-14-01)

PAH Name	Concentration (ng)	Chemical Structure	Rings
• 2-methyl-napthalene	2728		2
• acenaphtylen	67		
• acenaphthene	239		
• dibenzofuran	345		3
• fluorine	1068		
• phenanthrene	462		
• anthracene	203		4
• carbozole	102		
• pyrene	89		
• chrysene	64		5
• benzo(a)anthracene	73		

Rings

2

3

4

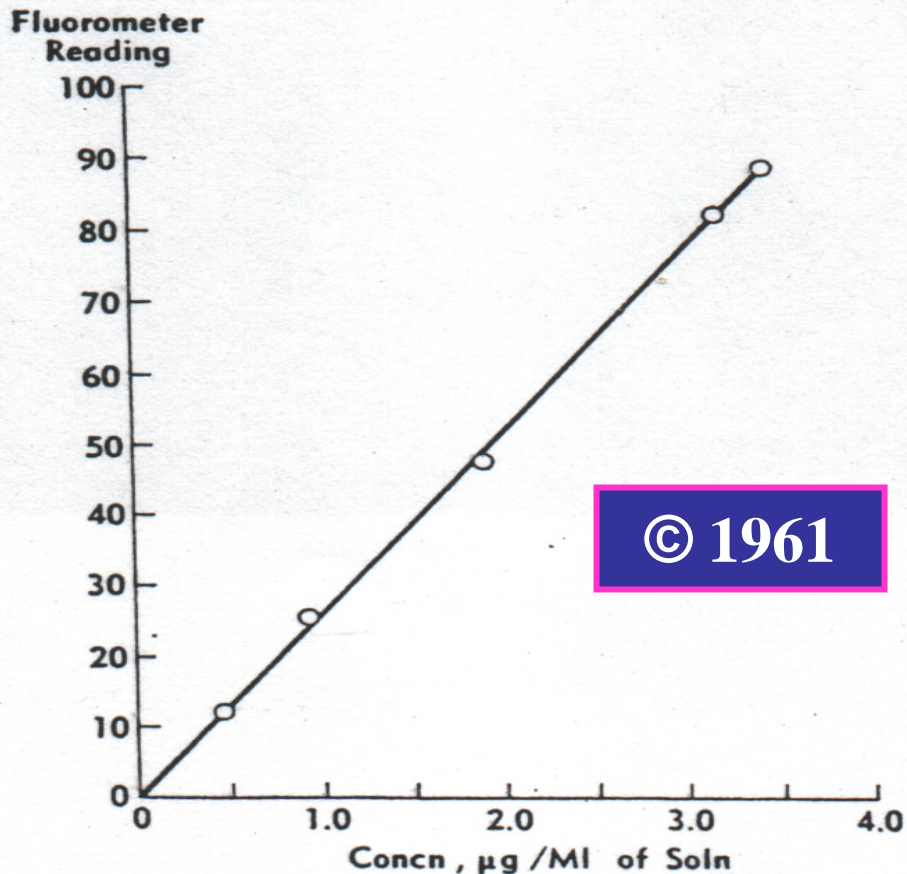
5

Harm



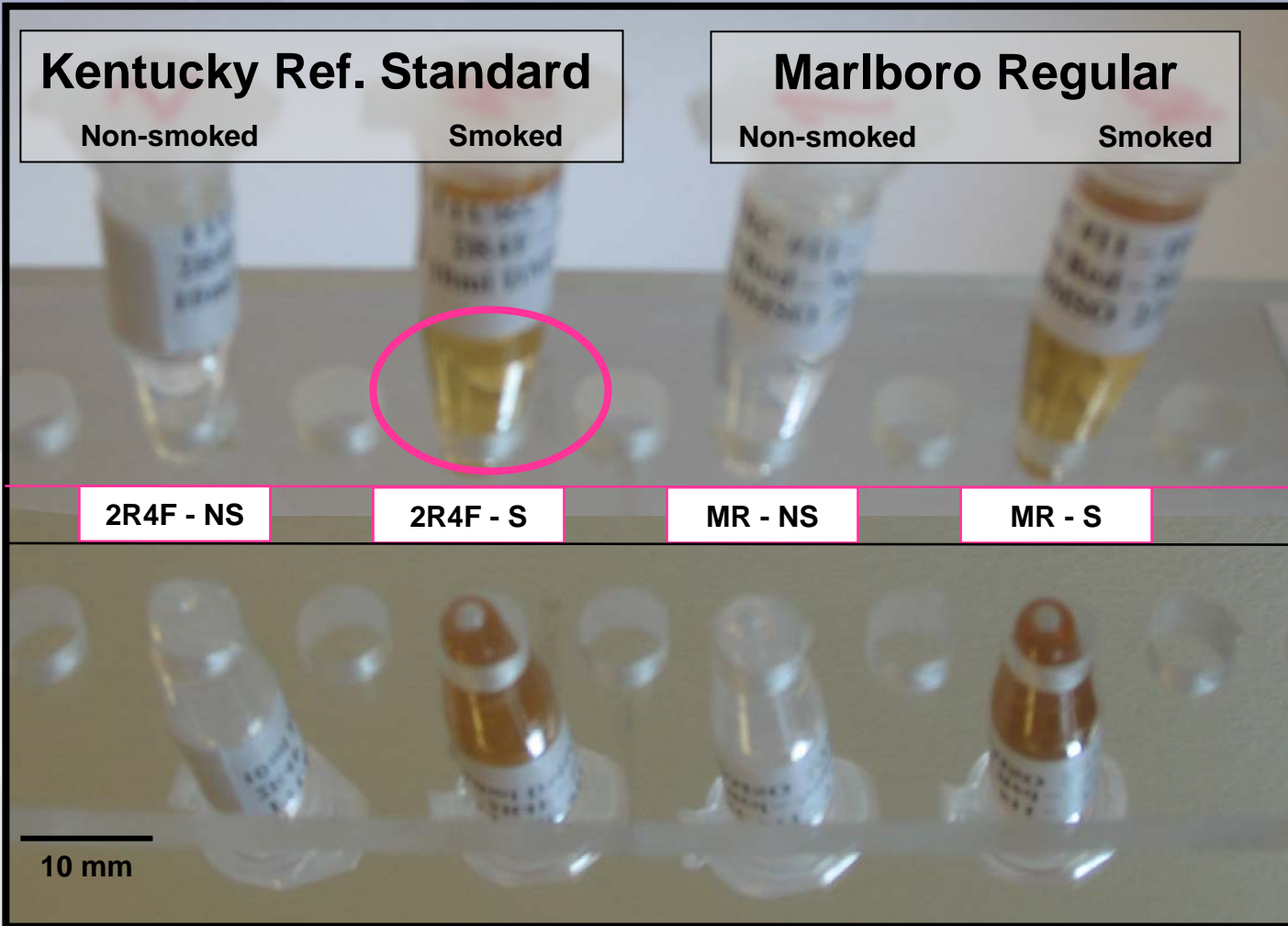
Tar versus Fluorescence

Relative fluorescence



Tobacco tar (μg)

Chemically Digested Cigarette Filters for Tar Analysis by Spectrofluorometry



Summary:

The proposed method for assaying tar-trapping efficacy of cigarette filters is:

- 1) Technically simple
- 2) Rapid
- 3) Quantitative
- 4) Cheap
- 5) Reproducible

This investigation was funded by:

