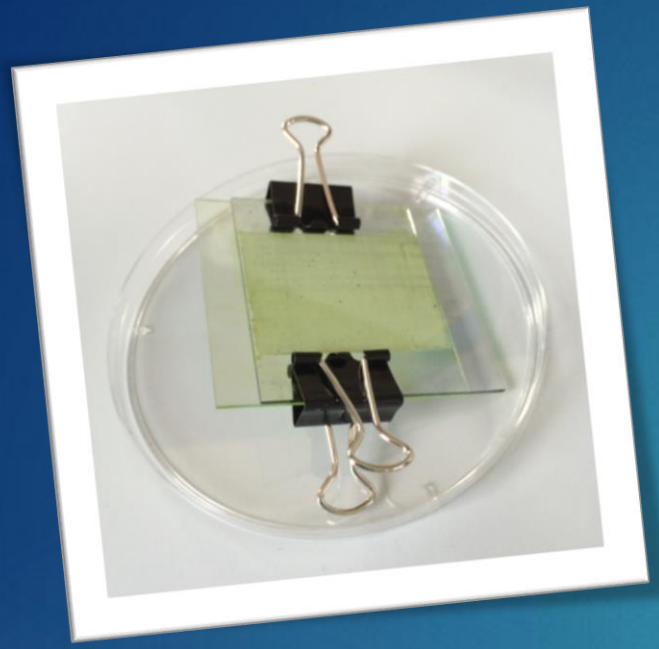


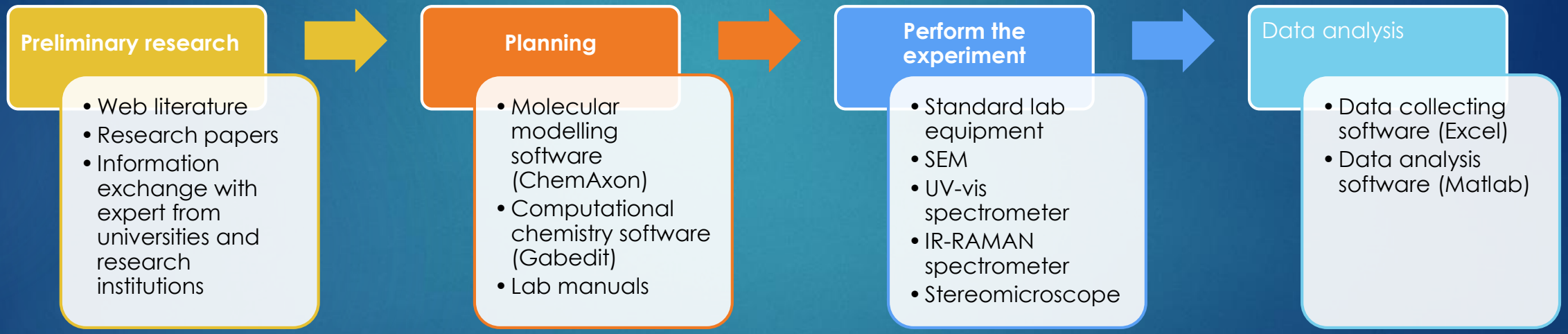
DSSC

An interdisciplinar approach to the artificial photosynthesis

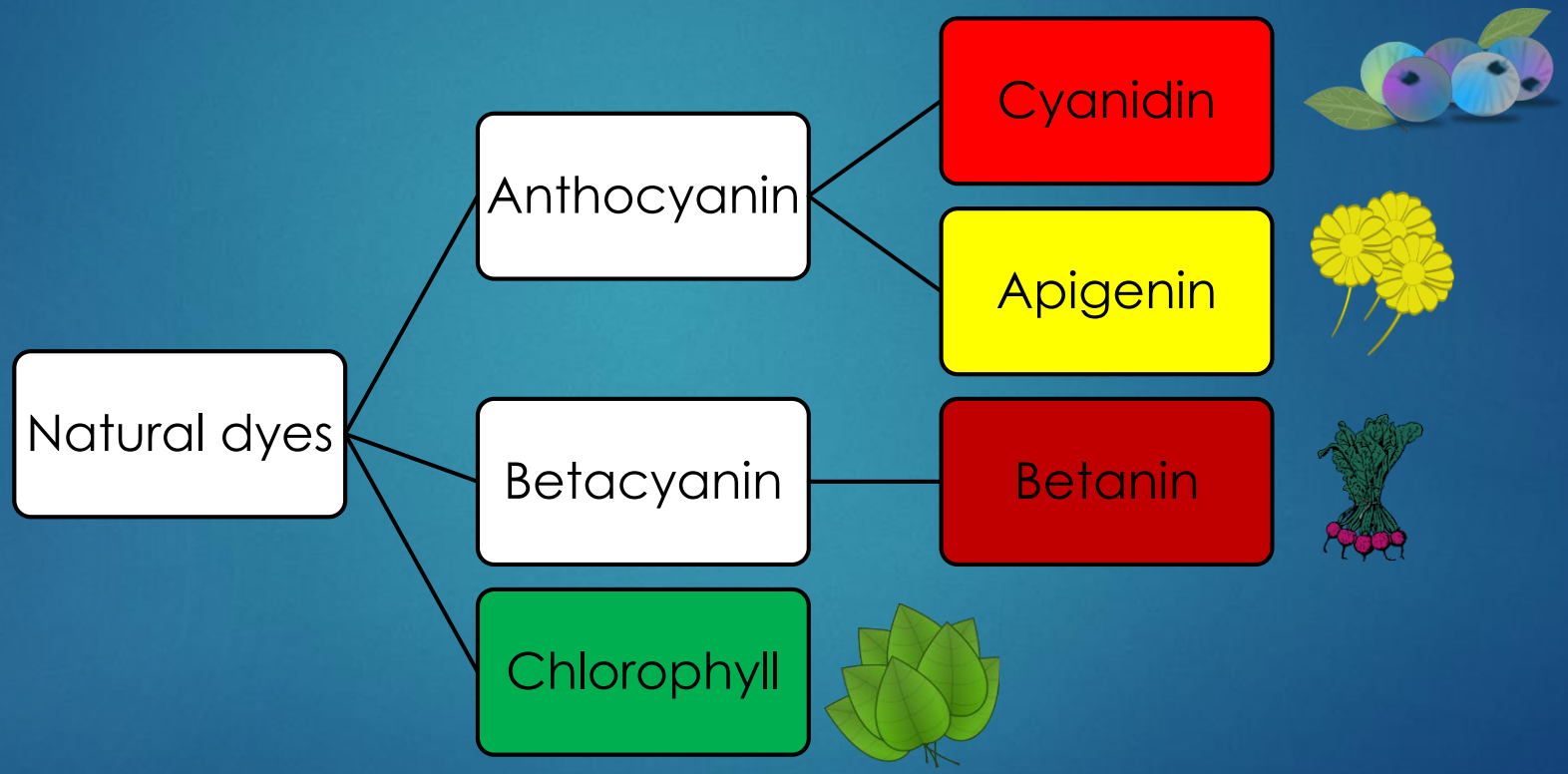
Matteo Giardino

INVESTIGATED ASPECTS

RESEARCH METHODS

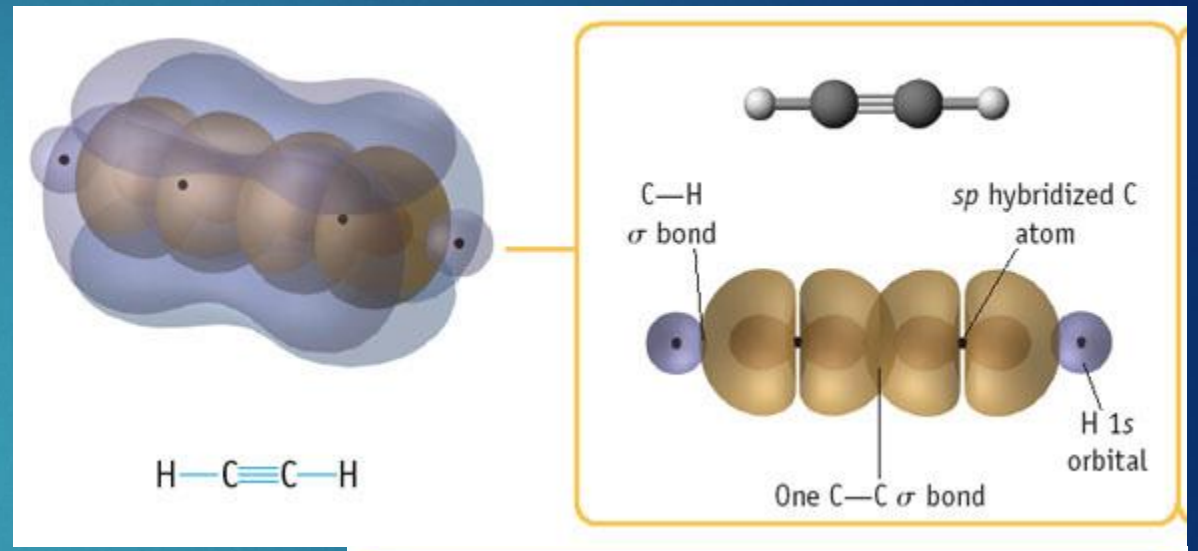


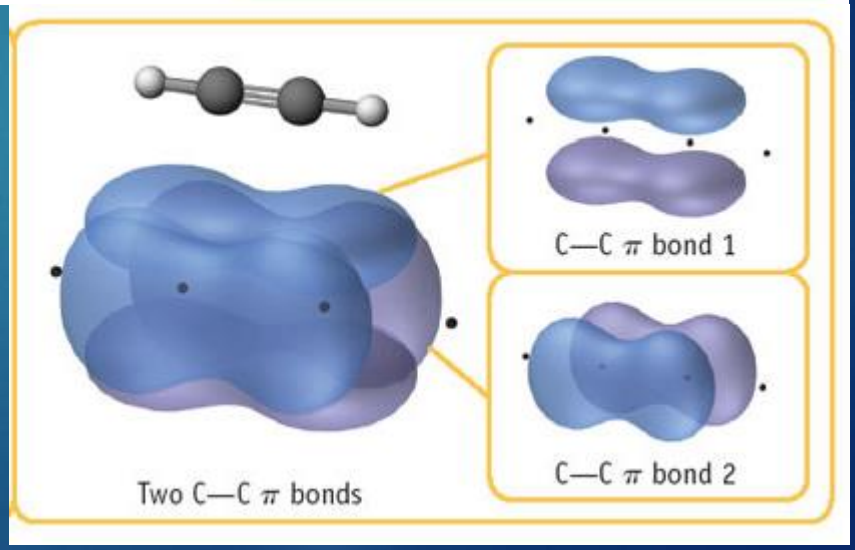
DIFFERENT DYES



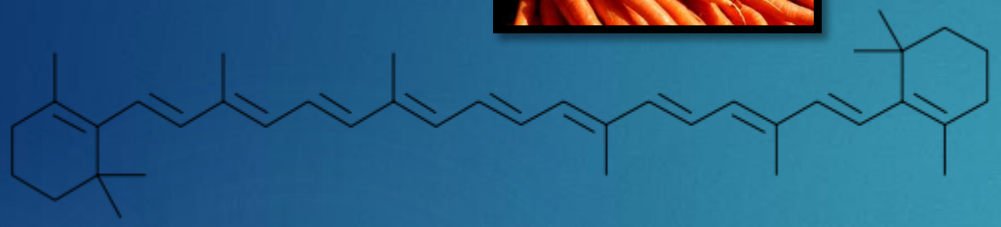
CHROMOPHORE GROUPS

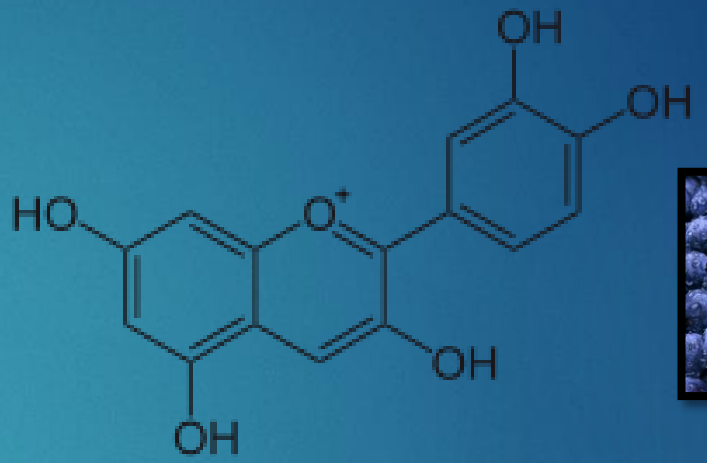
- Electron transition responsible for chromophoric properties:
  - $\pi \rightarrow \pi^*$
  - $n \rightarrow \sigma^*$
  - $n \rightarrow \pi^*$
- In organic chemistry the most common chromophore groups are: $C \equiv C, C = C,\ N \equiv N, C = N, N = O$.

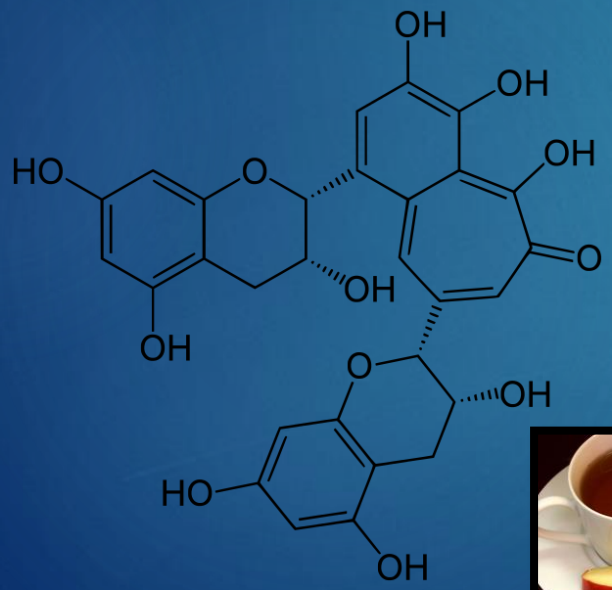


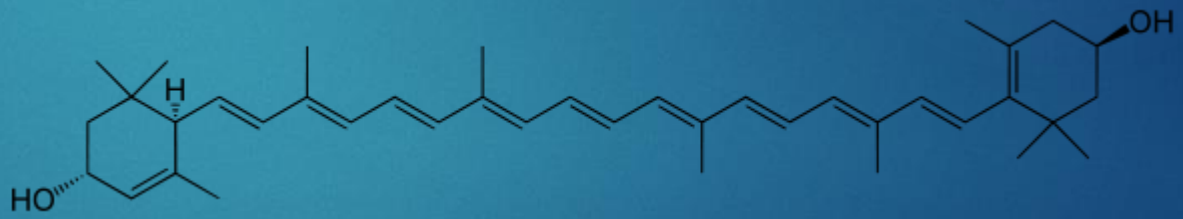


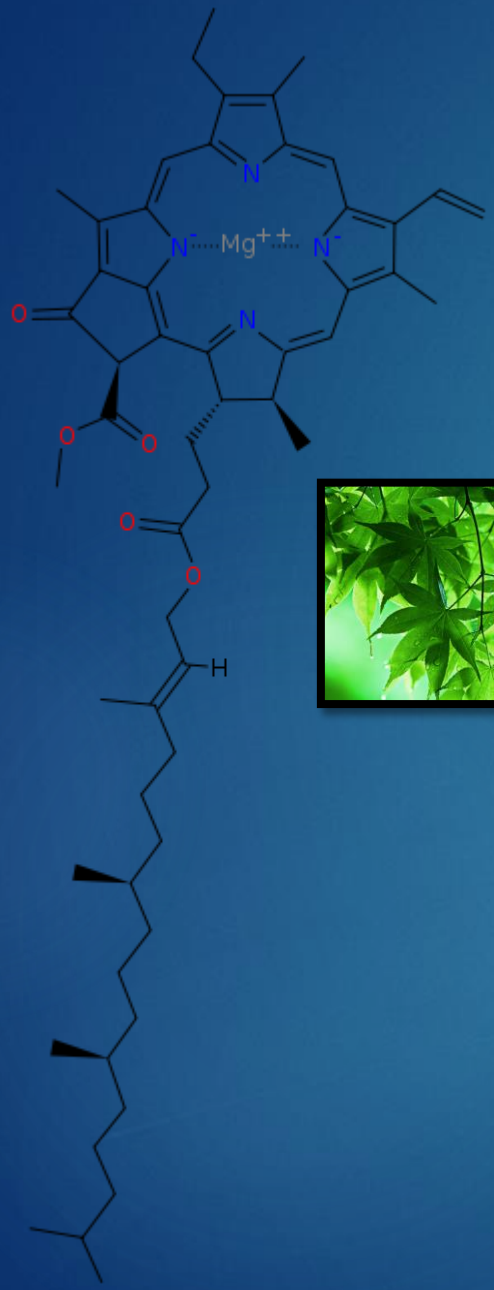
CHROMOPHORE IN NATURE

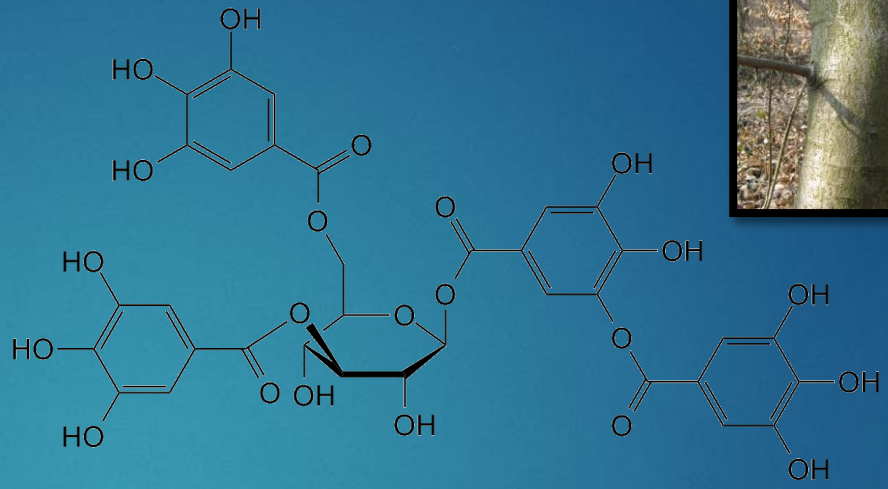








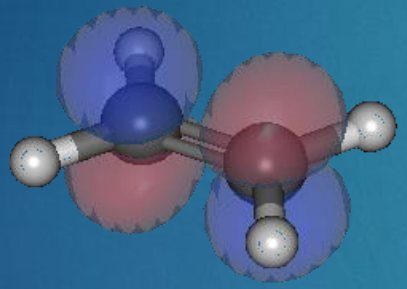

N
N
Mg
N
O
O
O
O
O
O
H


OH
HO
HO
O
HO
HO
HO
O
O
O
OH
OH
OH
O
O
OH
OH
OH

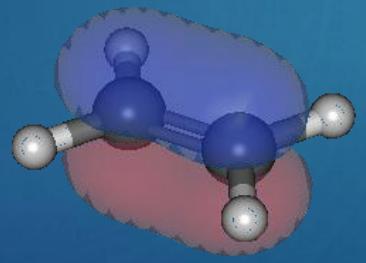
ORGANIC CHEMISTRY AND SEMICONDUCTORS

- **HOMO** and **LUMO** are acronyms respectively for **highest occupied molecular orbital** and **lowest unoccupied molecular orbital.**
- Roughly, the **HOMO** level is to organic semiconductors what the valence band maximum is to inorganic semiconductors.
- The energy difference between the HOMO and LUMO is termed the **HOMO–LUMO gap**.
- The same analogy exists between the **LUMO** level and the conduction band minimum.

E



π^* $LUMO$



π $HOMO$

E

C.B. (Full)

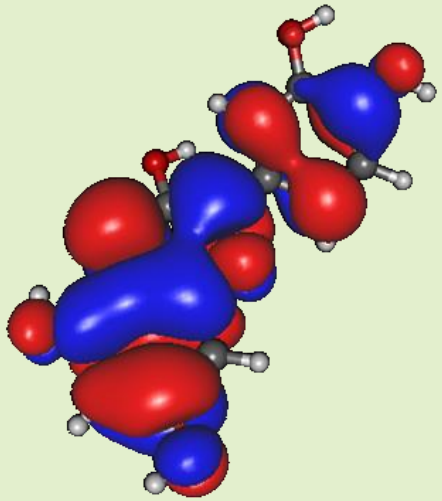
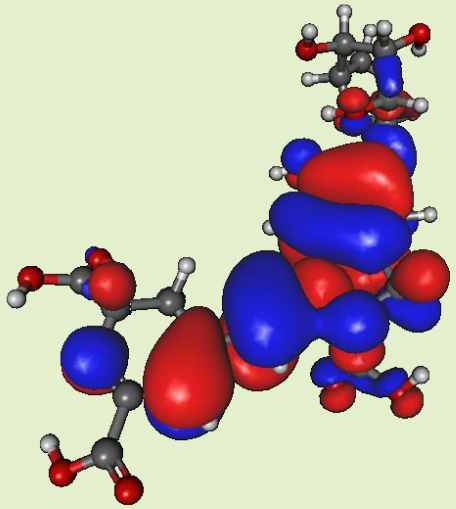
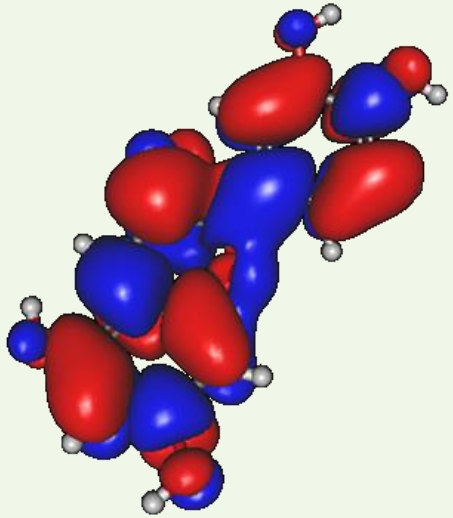
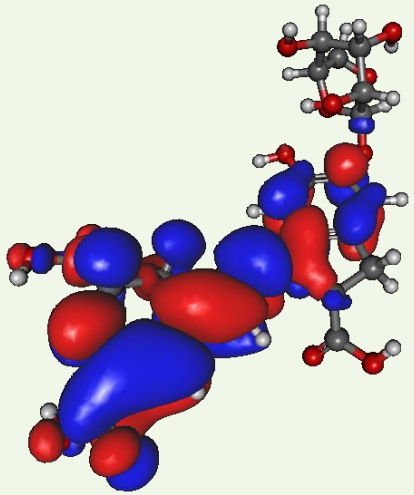
GAP

V.B. (Empty)

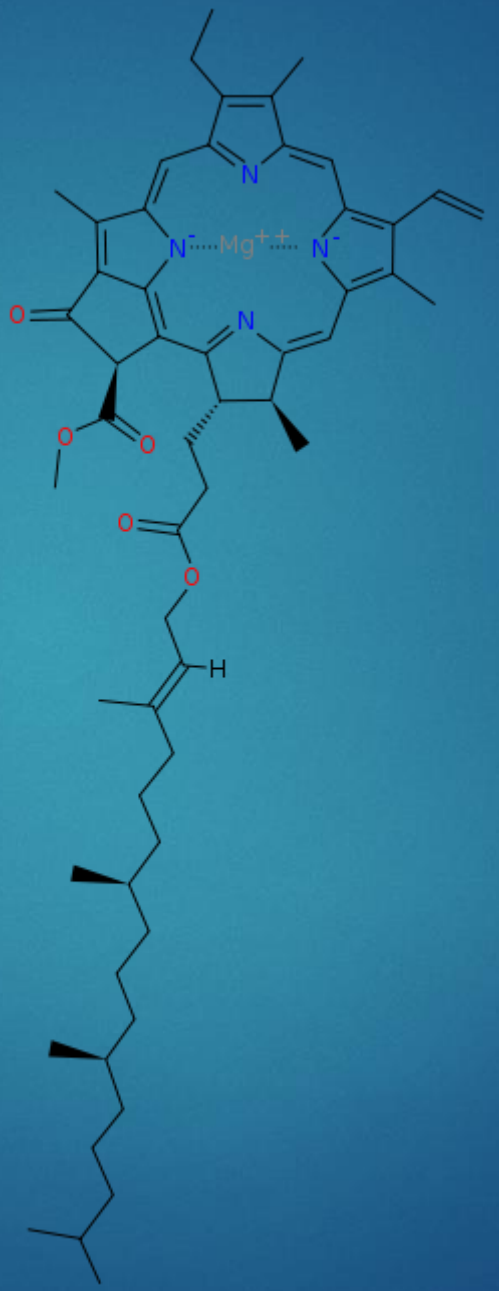
C.B. (Empty)

GAP

V.B. (Full)

	Cyanidin	Betanin
HOMO		
LUMO		

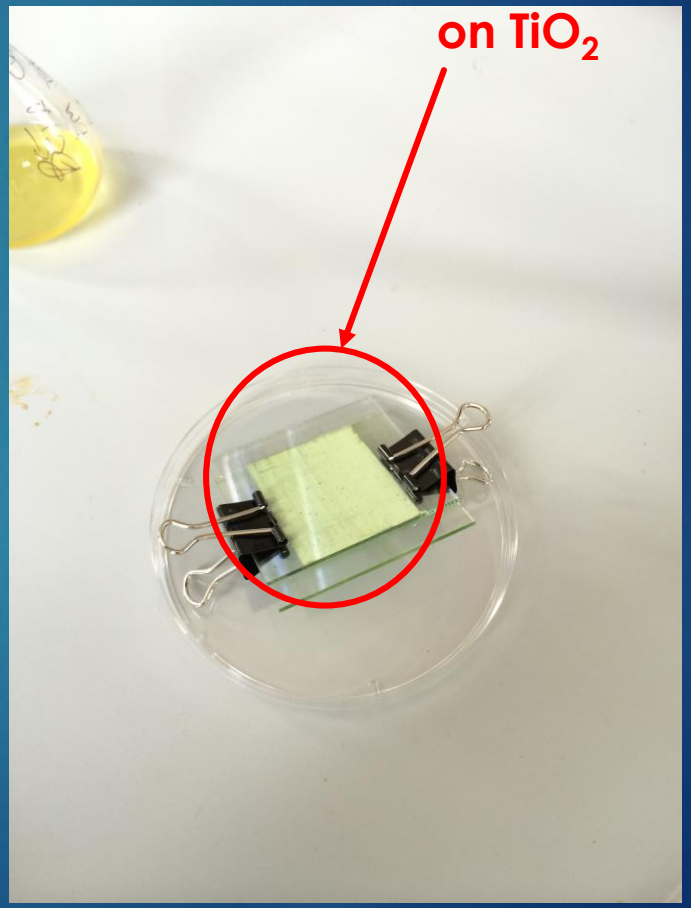
CHLOROPHYLL



Porphyrin ring
(chelating Mg^{++} ion)

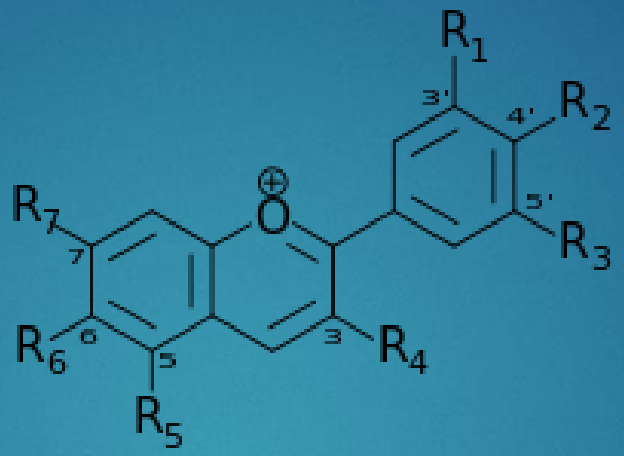
Phytyl chain

CHLOROPHYLL

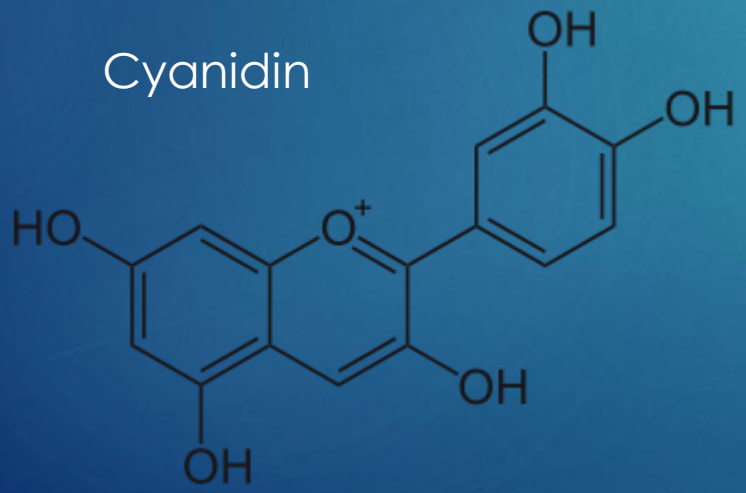


Chlorophyll is weakly absorbed on TiO_2

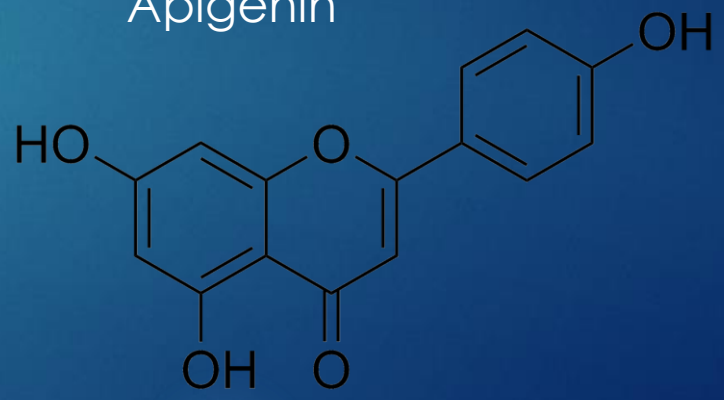
ANTHOCIANYNS



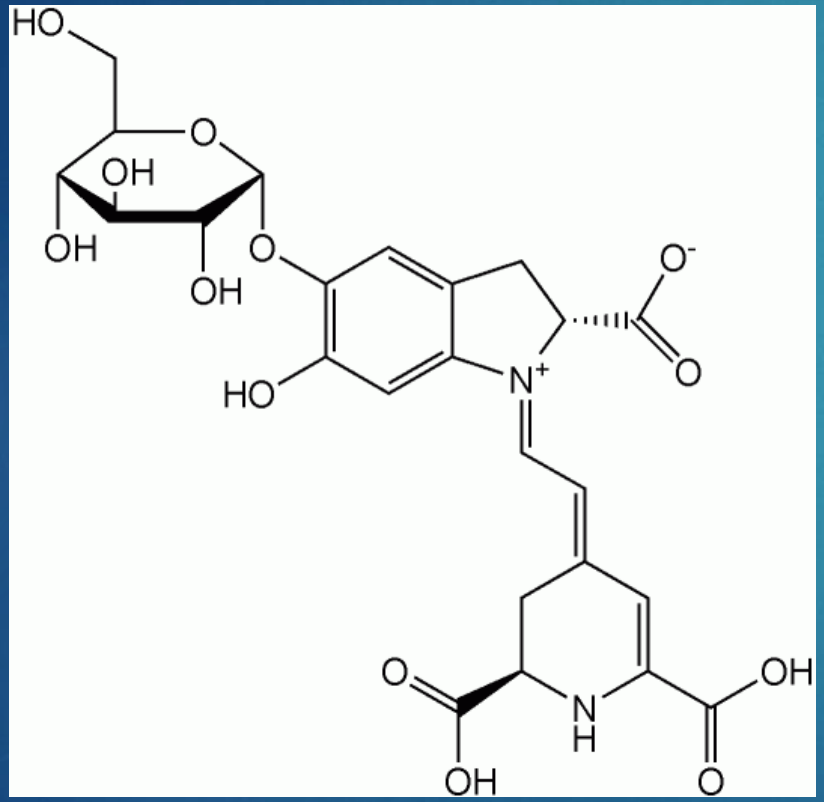
Cyanidin



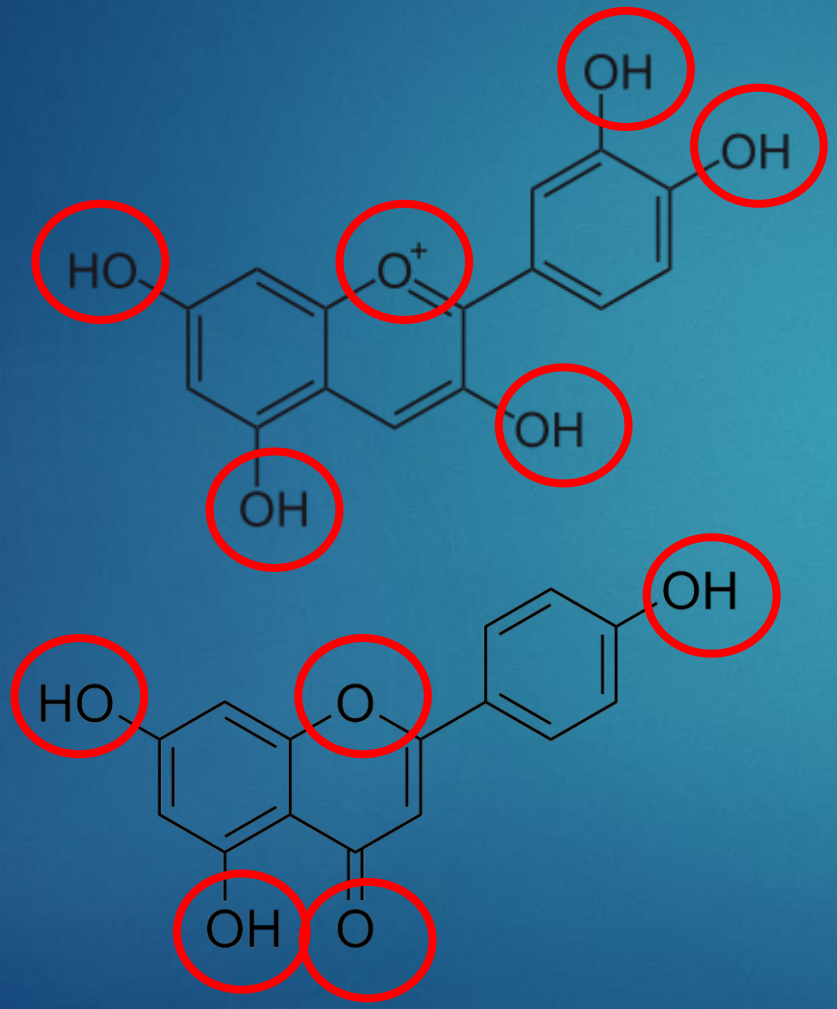
Apigenin

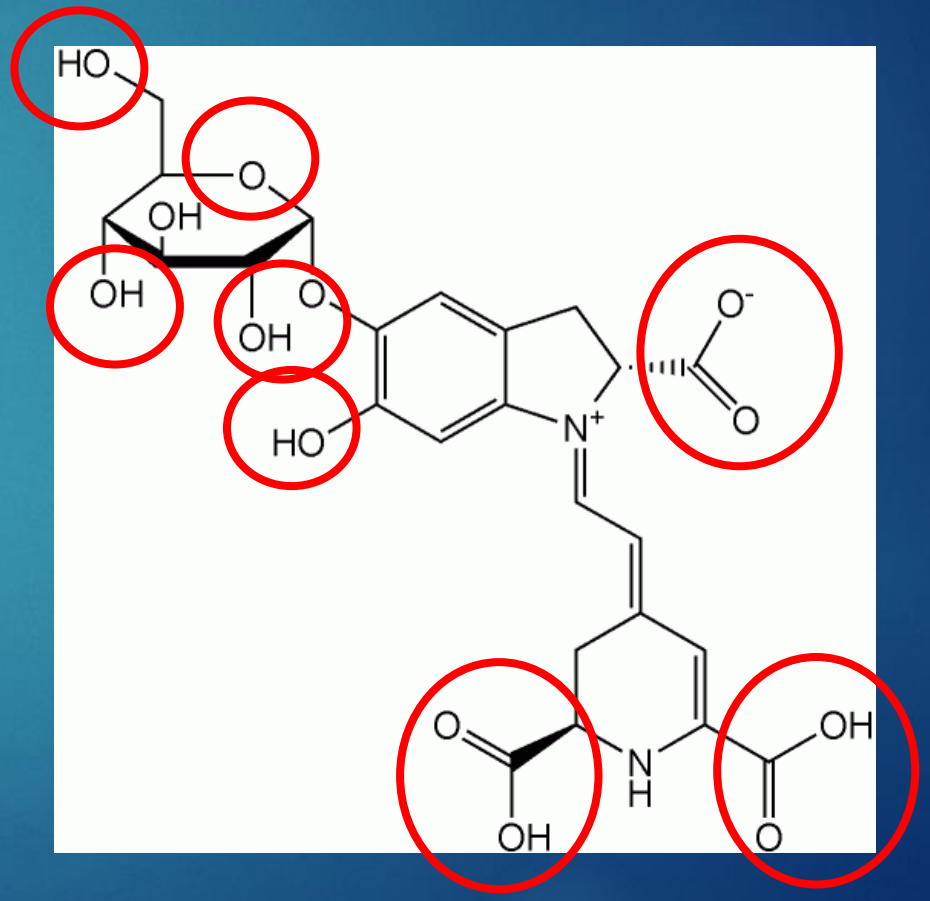


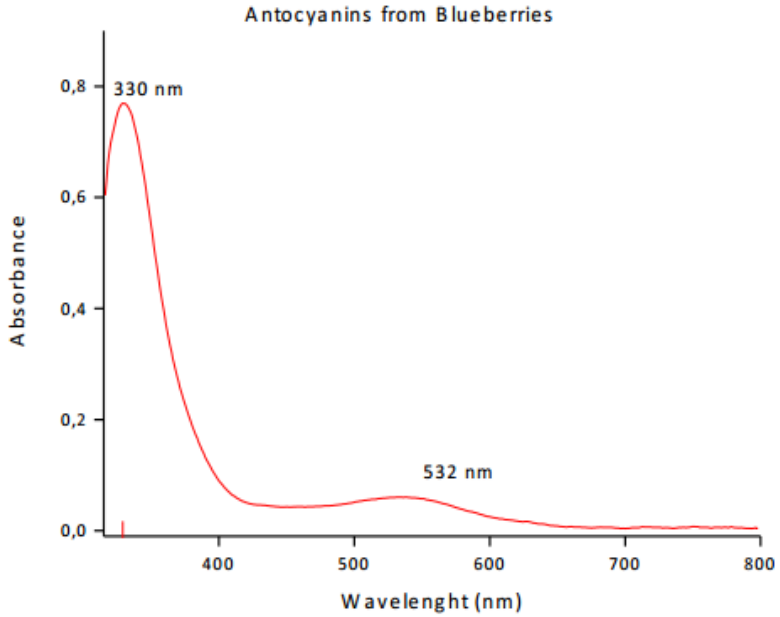
BETANIN

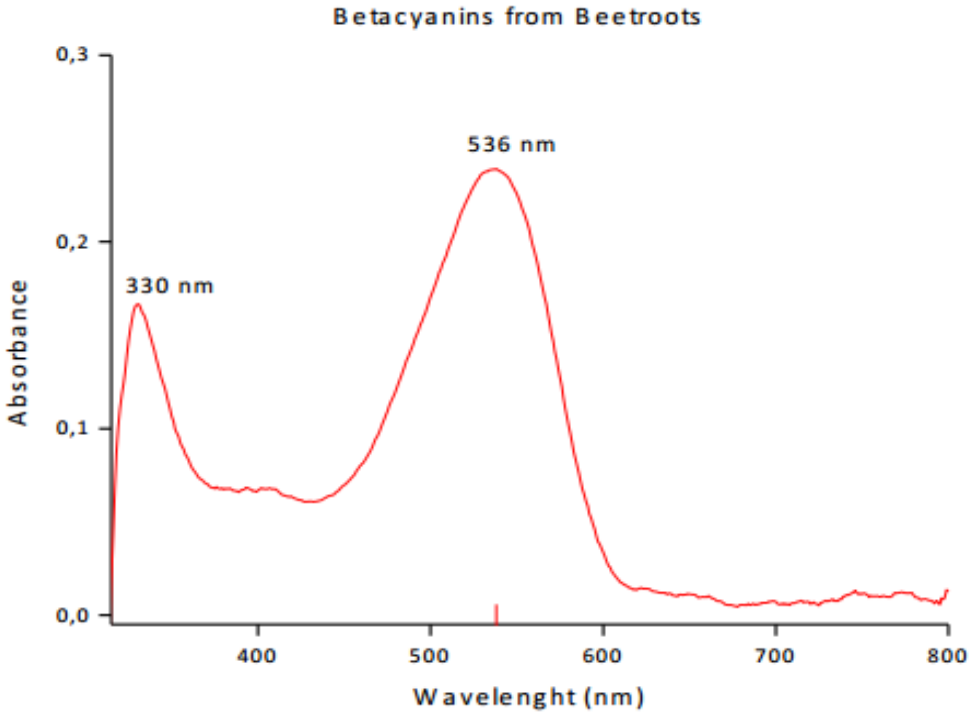


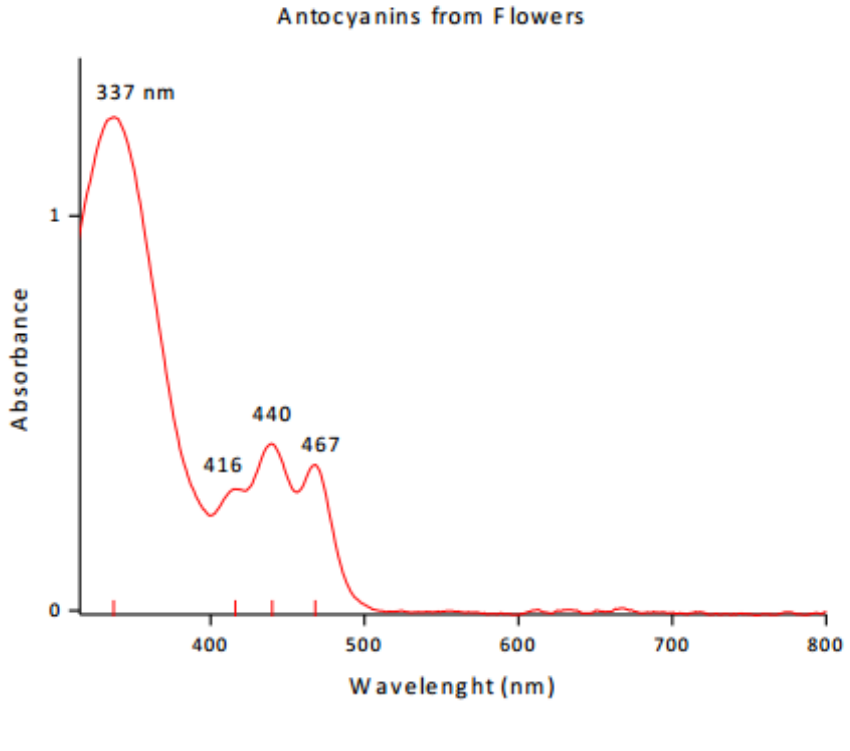
WHY DO WE USE THESE DYES?



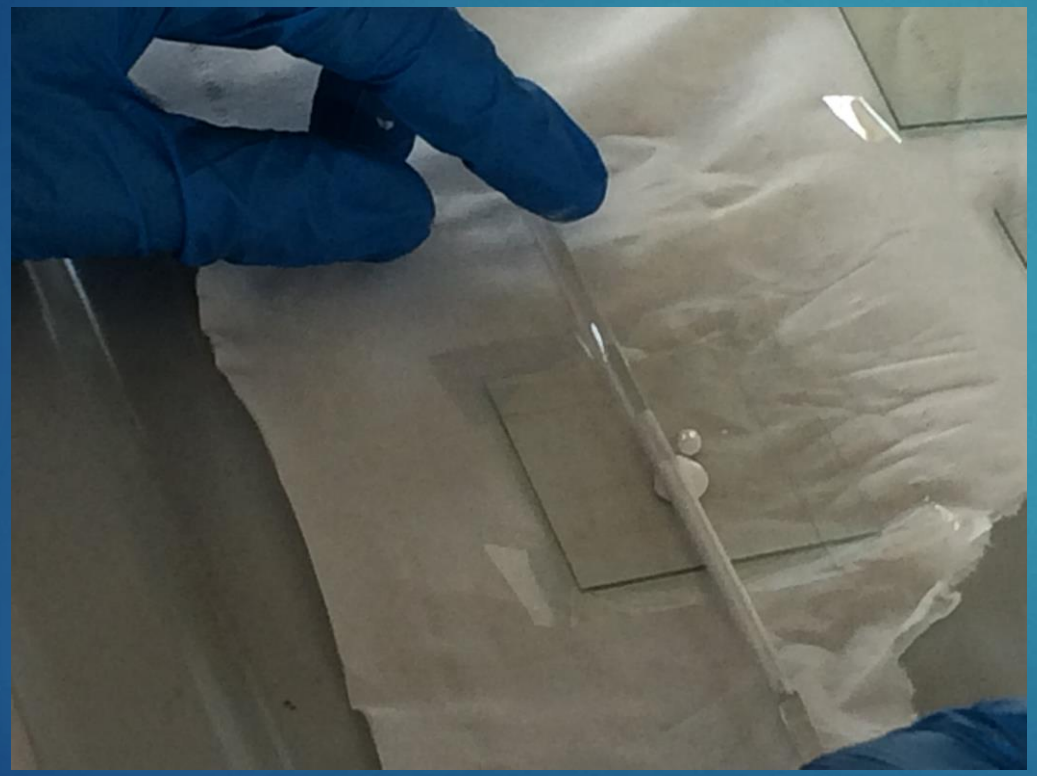



Antocyanins from Blueberries
Absorbance
0,8
0,6
0,4
0,2
0,0
330 nm
532 nm
400
500
600
700
800
Wavelenght (nm)


Betacyanins from Beetroots
Absorbance
0,3
0,2
0,1
0,0
330 nm
536 nm
400
500
600
700
800
Wavelenght (nm)


Antocyanins from Flowers
Absorbance
1
0
337 nm
440
467
416
400
500
600
700
800
Wavelenght (nm)

TiO_2 LAYER PREPARATION



SYNTERING

- 250°C for 60 minutes.
- Slow cooling with closed owen.

TiO_2 LAYER SURFACE ANALYSIS

Microscopy

SEM

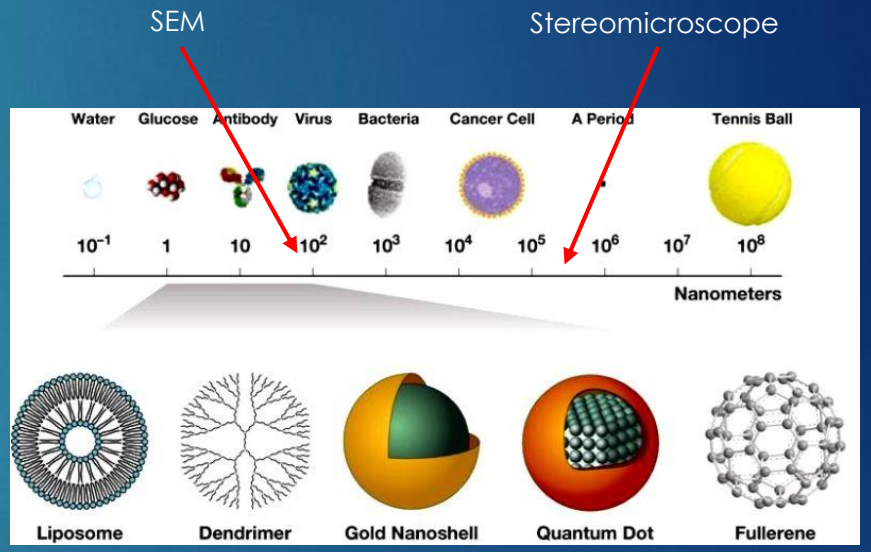
Stereomicroscope

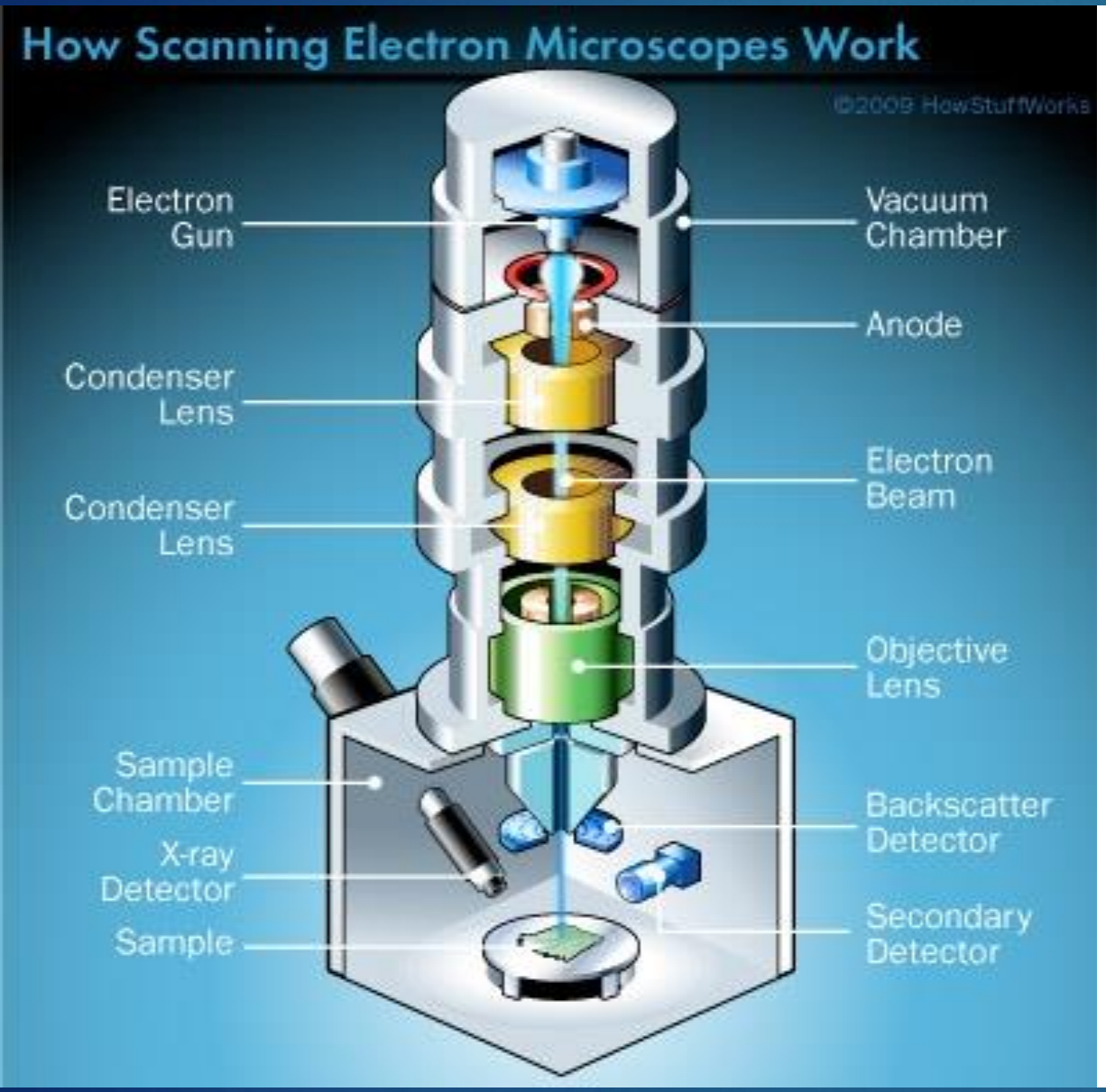
until 10^5 x

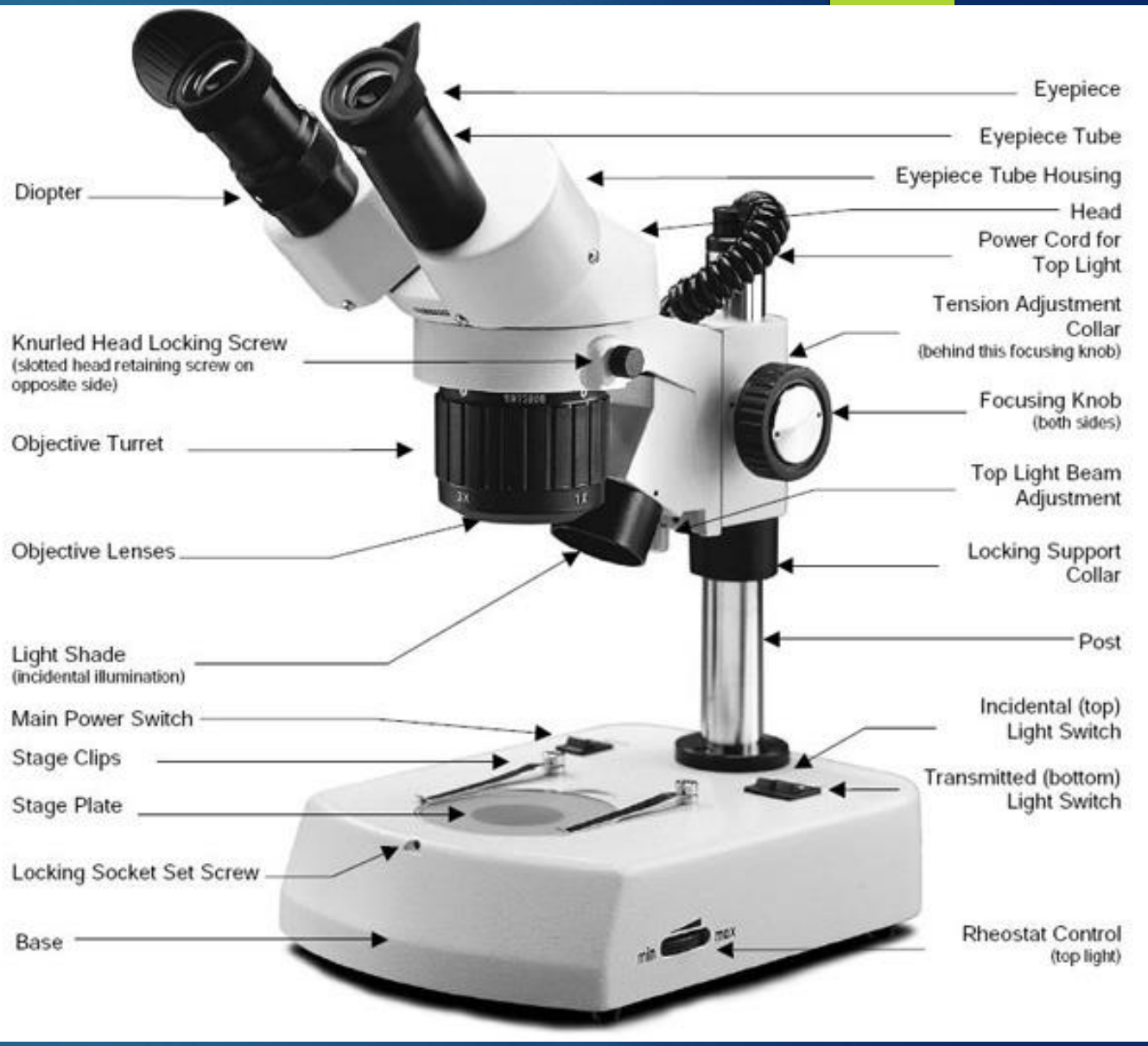
Checking the particles sinterization

about 20/40x

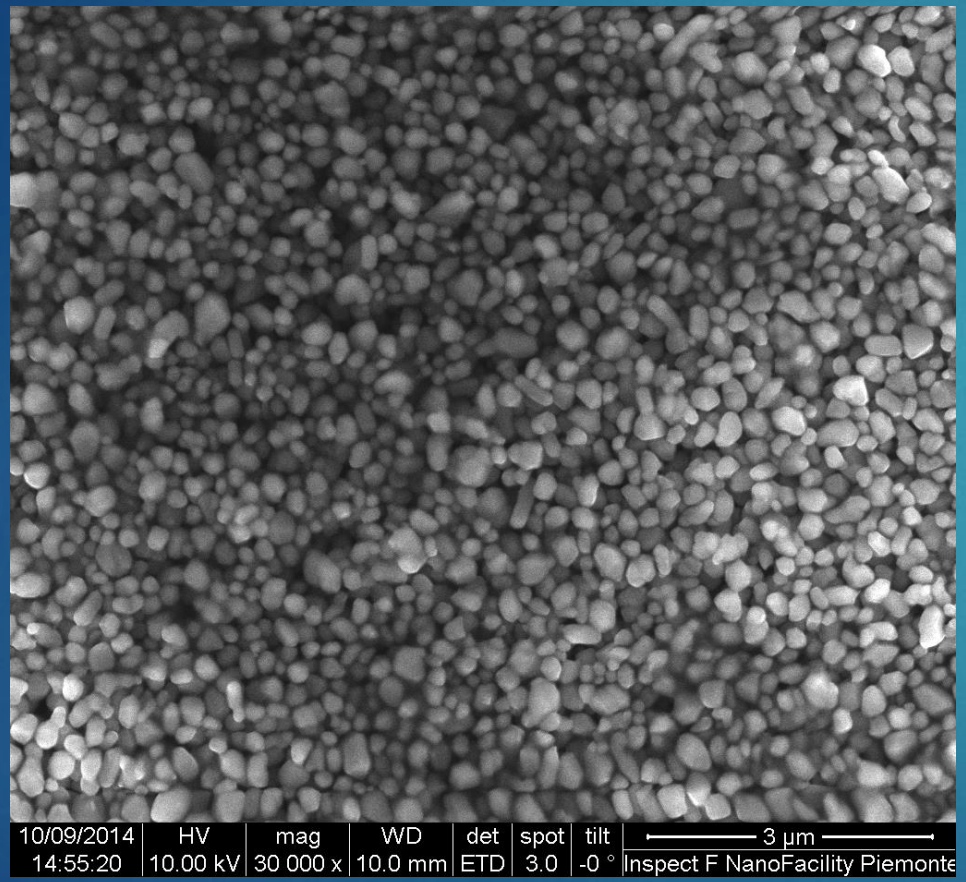
Checking the surface regularity



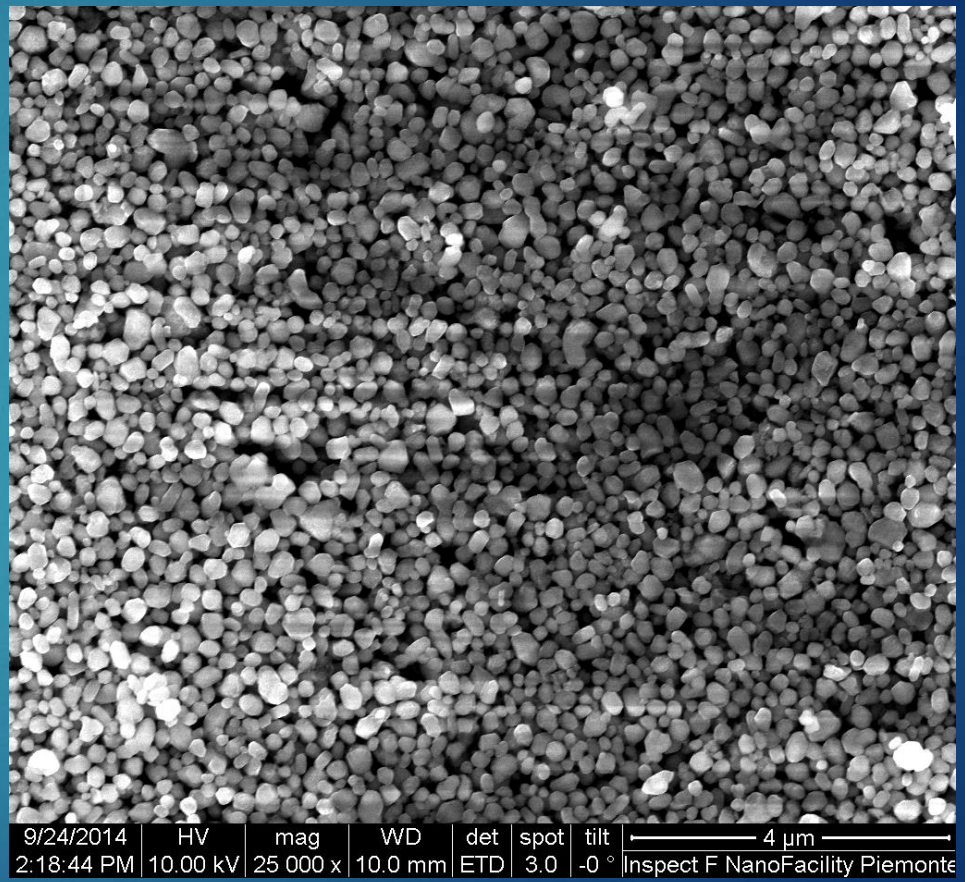

How Scanning Electron Microscopes Work
©2009 HowStuffWorks
Electron Gun
Vacuum Chamber
Anode
Condenser Lens
Electron Beam
Condenser Lens
Objective Lens
Sample Chamber
Backscatter Detector
X-ray Detector
Secondary Detector
Sample


Eyepiece
Eyepiece Tube
Eyepiece Tube Housing
Diopter
Head
Power Cord for Top Light
Tension Adjustment Collar (behind this focusing knob)
Knurled Head Locking Screw (slotted head retaining screw on opposite side)
Focusing Knob (both sides)
Objective Turret
Top Light Beam Adjustment
Objective Lenses
Locking Support Collar
Post
Light Shade (incidental illumination)
Main Power Switch
Incidental (top) Light Switch
Stage Clips
Transmitted (bottom) Light Switch
Stage Plate
Locking Socket Set Screw
Base
min
max
Rheostat Control (top light)

SINTERING (SEM Pictures)



Sintering process (1)

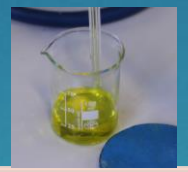


Sintering process (2)

EXTRACTION PROCEDURES

Apigenin

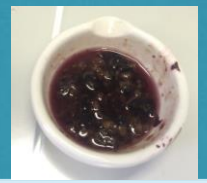
Hot extraction with absolute ethanol



Filtration

Cyanidin/ Betalain

Washing fruits with diluted acetic acid.



Solvent extraction with acetone and filtration

Phase separation with petroleum ether

Centrifugation

Chlorophyll

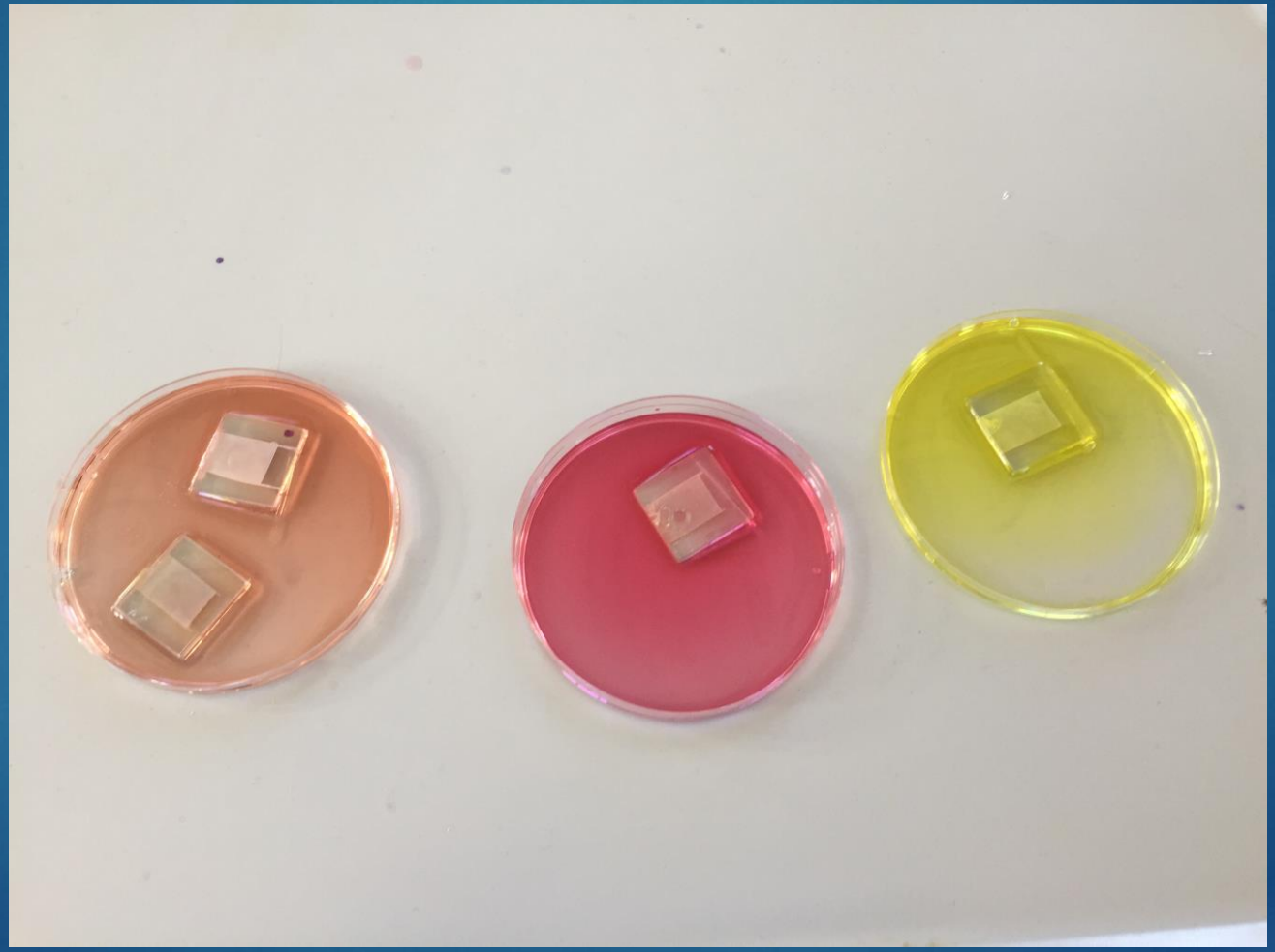
Fragmenting leaves with a small amount of $NaHCO_3$.

Solvent extraction with absolute ethanol

Filtration

Centrifugation

DYES ABSORPTION



COMPLETED DEVICES