



Les étapes du traitement de l'analyse d'image

La capture → image brute

Prétraitement → niveaux de gris

Segmentation → image binaire

Post-traitement → régions d'intérêts

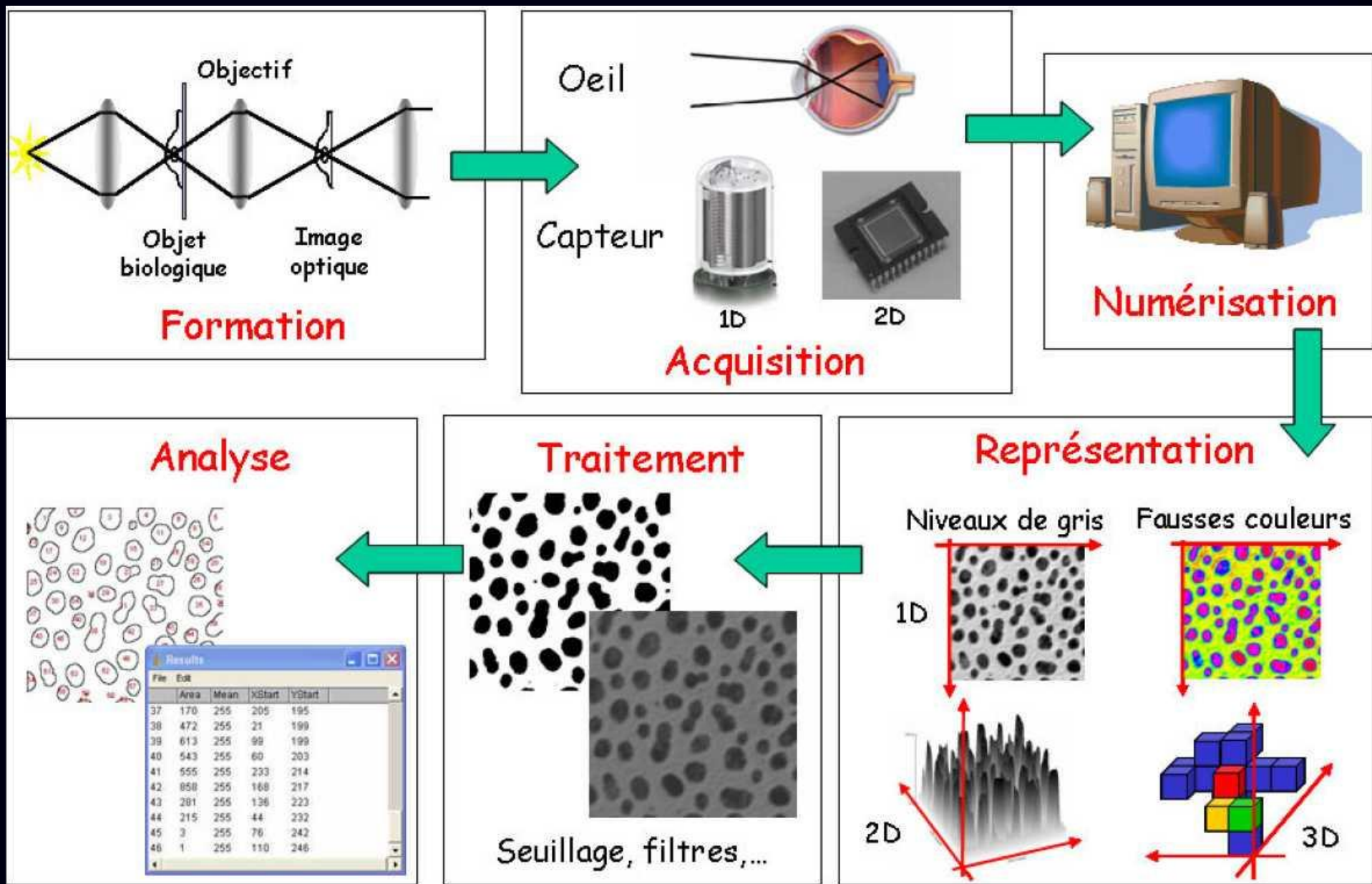
Quantification → données

Amélioration

Publication



Le traitement et l'analyse d'images





ImageJ est un logiciel libre de traitement et d'analyse d'images



Traduction en Java du logiciel NIH Image
du National Institutes of Health (USA)
développé par Wayne Rasband

Il fonctionne sur de multiples plates-formes (Windows, Mac, Linux, Unix, ...).

<http://rsbweb.nih.gov/ij/>



Installation

Download - Mozilla Firefox

Download

rsbweb.nih.gov/ij/download.html

home | news | docs | download | plugins | resources | list | links

Download

Platform Independent

To install ImageJ 1.44 on a computer with Java pre-installed, or to upgrade to full distribution (including macros, plugins and LUTs), download [ij144.zip](#) (3 MB) and extract the ImageJ directory. Use the *Help>Update ImageJ* command to upgrade to the latest pre-release version.

Mac OS X

Download [ImageJ 1.44](#) (5.4MB) as a double-clickable Mac OS X application, [ImageJ64](#), which uses Java 1.6 in 64-bit mode on Intel Macs running OS X 10.4 or later. ([Instructions](#))

Linux

Download ImageJ 1.44 [bundled with 32-bit Java](#) (46MB) or with [64-bit Java](#) (40MB). Both versions include Java 1.6.0_20 from Sun and the ImageJ source code. ([Instructions](#))

Windows

Download ImageJ 1.44 [bundled with 32-bit Java 1.6.0_20](#) (28MB), [with 64-bit Java 1.6.0_20](#) (24MB; requires 64-bit Windows) or [without Java](#) (3MB). ([Instructions](#))

Ouverture de ij146-jdk6-setup.exe

Vous avez choisi d'ouvrir :

- ij146-jdk6-setup.exe**
qui est un fichier de type : Binary File (27.2 Mo)
à partir de : http://rsbweb.nih.gov

Voulez-vous enregistrer ce fichier ?

Enregistrer le fichier Annuler



Installation

Welcome to the ImageJ Setup Wizard

This will install ImageJ 1.44p on your computer.

It is recommended that you close all other applications before continuing.

Click Next to continue, or Cancel to exit Setup.

Next > Cancel

Select Destination Location
Where should ImageJ be installed?

Setup will install ImageJ into the following folder.

To continue, click Next. If you would like to select a different folder, click Browse.

F:\ImageJ Browse...

At least 106,8 MB of free disk space is required.

< Back Next > Cancel

Select Start Menu Folder
Where should Setup place the program's shortcuts?

Setup will create the program's shortcuts in the following Start Menu folder.

To continue, click Next. If you would like to select a different folder, click Browse.

ImageJ Browse...

Don't create a Start Menu folder

< Back Next > Cancel

Select Additional Tasks
Which additional tasks should be performed?

Select the additional tasks you would like Setup to perform while installing ImageJ, then click Next.

Additional icons:

- Create a desktop icon
- Create a Quick Launch icon

< Back Next > Cancel

Ready to Install
Setup is now ready to begin installing ImageJ on your computer.

Click Install to continue with the installation, or click Back if you want to review or change any settings.

Destination location:
F:\ImageJ

< Back Install Cancel

Installing
Please wait while Setup installs ImageJ on your computer.

Extracting files...
F:\ImageJ\jre\lib\charsets.jar

Progress bar (100% complete)

< Back Next > Cancel

Completing the ImageJ Setup Wizard

Setup has finished installing ImageJ on your computer.

Click Finish to exit Setup.

Launch ImageJ

Finish



Configuration

Welcome to ImageJ



The program will now be auto-configured. You may be prompted to input the locations of various files that can not be auto-detected. Please consult the installation instructions for further assistance.

OK

ImageJ Configuration



A configuration file was successfully created as:

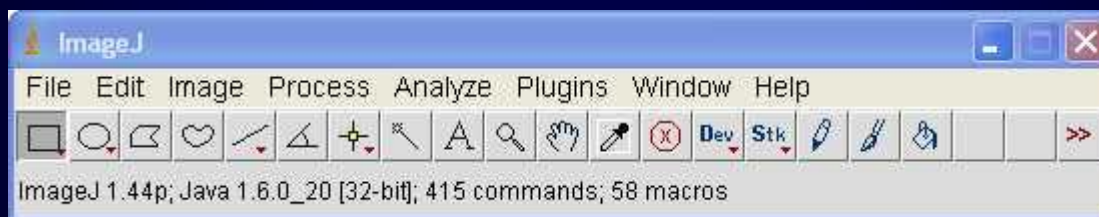
F:\ImageJ\ImageJ.cfg

with the following parameters:

Line 1- .
Line 2- jre\bin\javaw.exe
Line 3- -Xmx640m -cp ij.jar ij.ImageJ

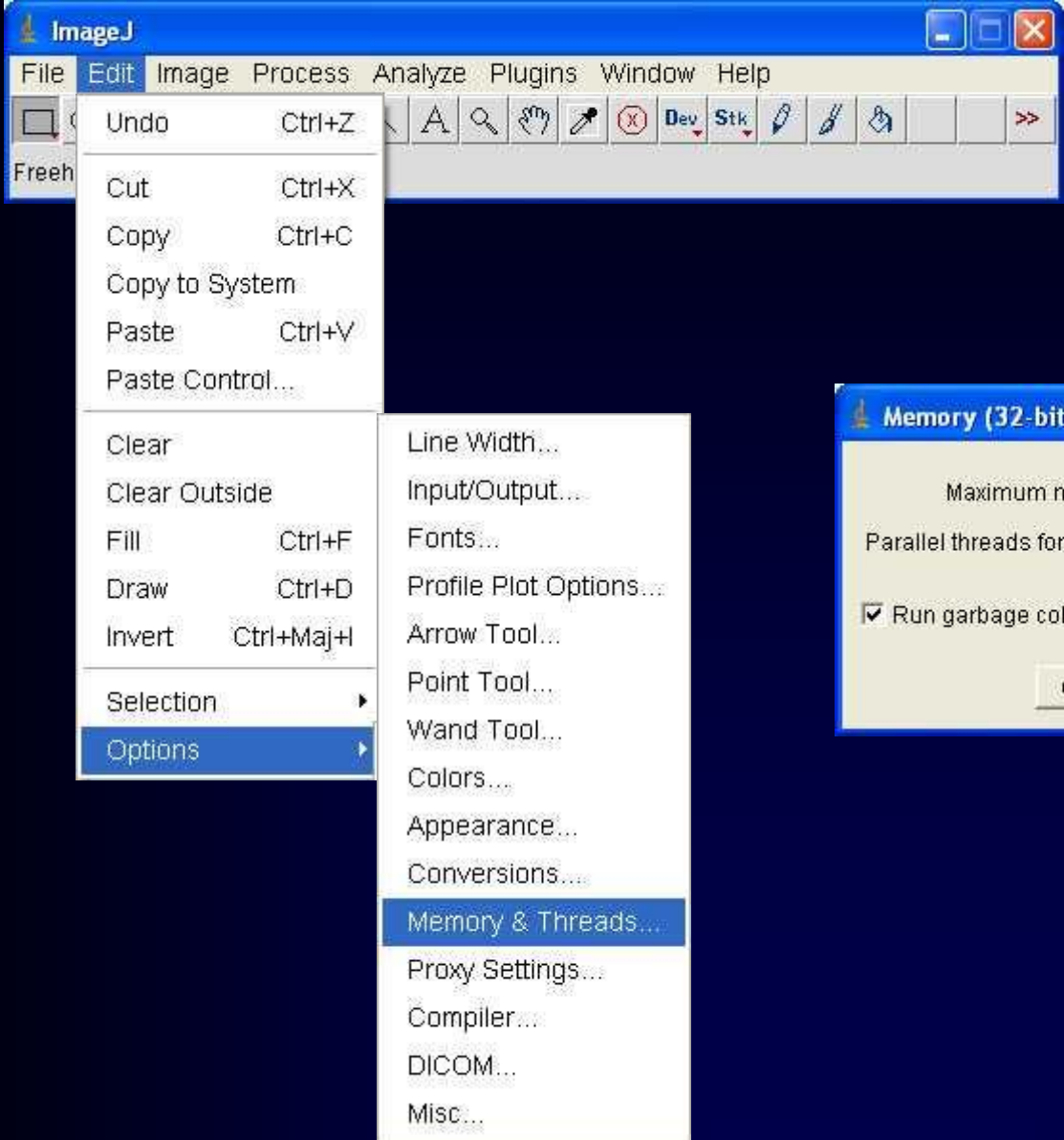
Please consult the installation instructions for further details.

OK



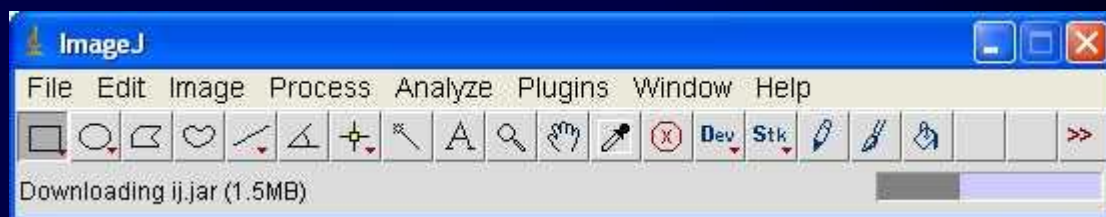
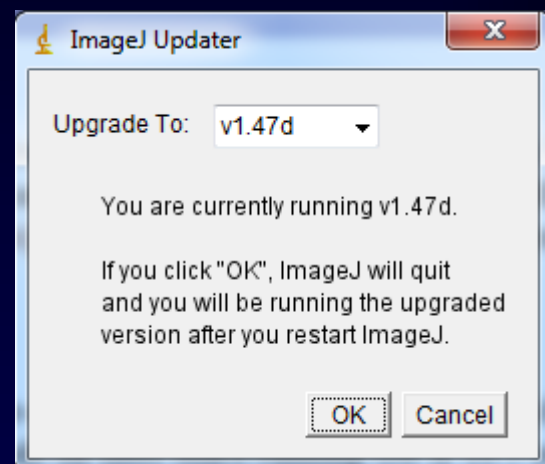
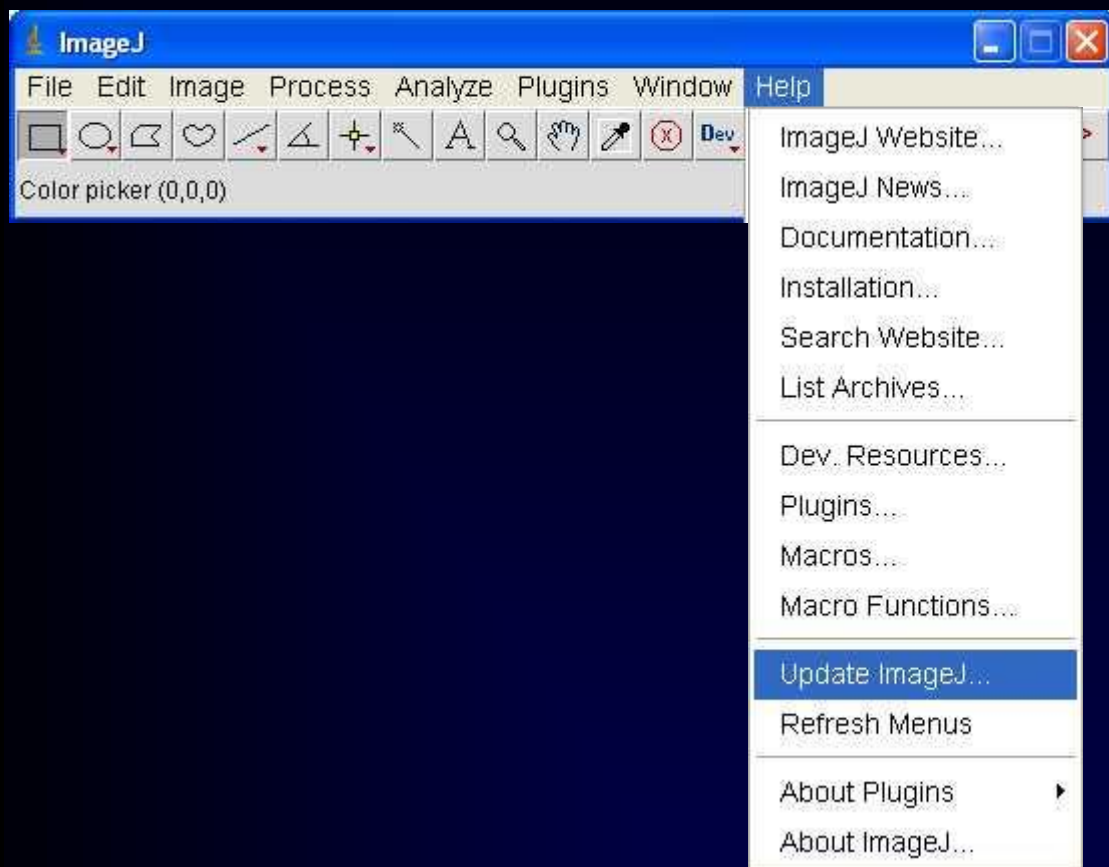


Configuration



Edit → Option → Memory & Treads...

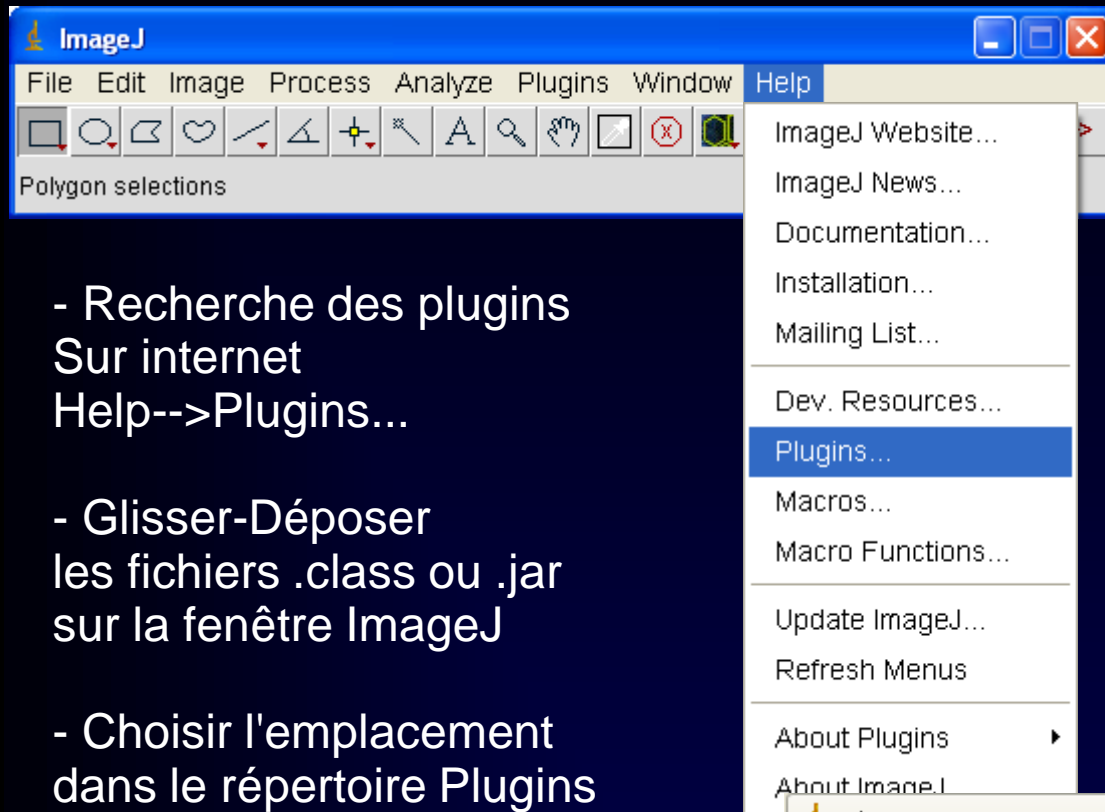
Mise à jour



Help → Update ImageJ...



Installation de Plugins



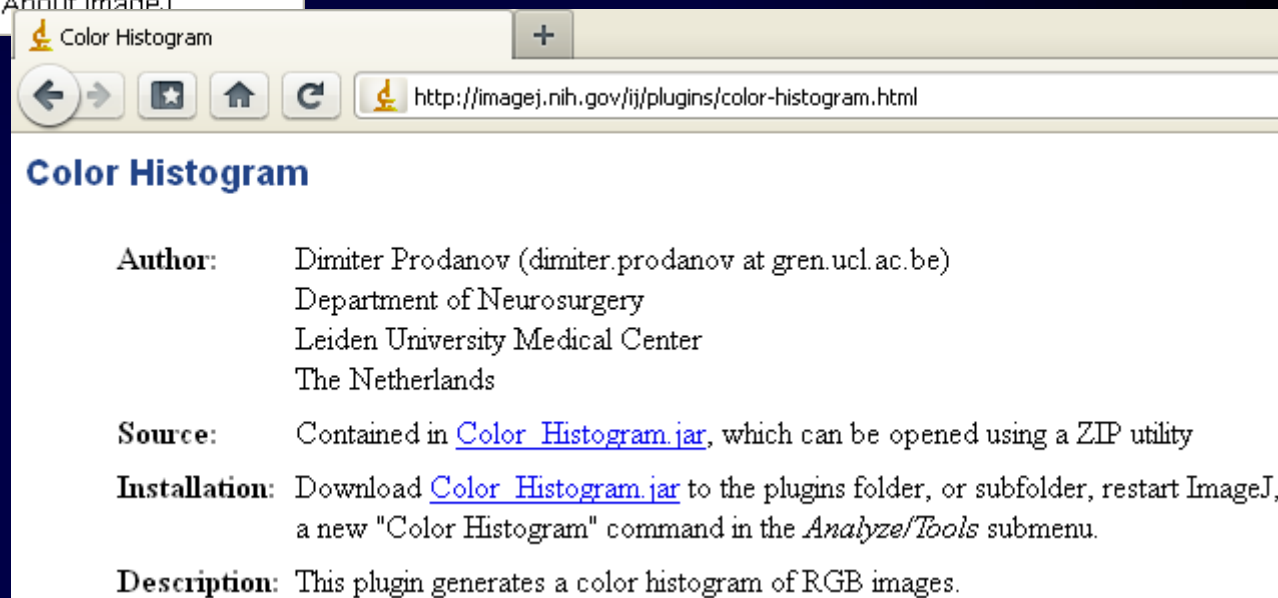
- Recherche des plugins
Sur internet
Help-->Plugins...

- Glisser-Déposer
les fichiers .class ou .jar
sur la fenêtre ImageJ

- Choisir l'emplacement
dans le répertoire Plugins

- Mettre à jour les menus
Help--> Refresh Menus

- Apparition de la
nouvelle commande
dans le menu Plugins

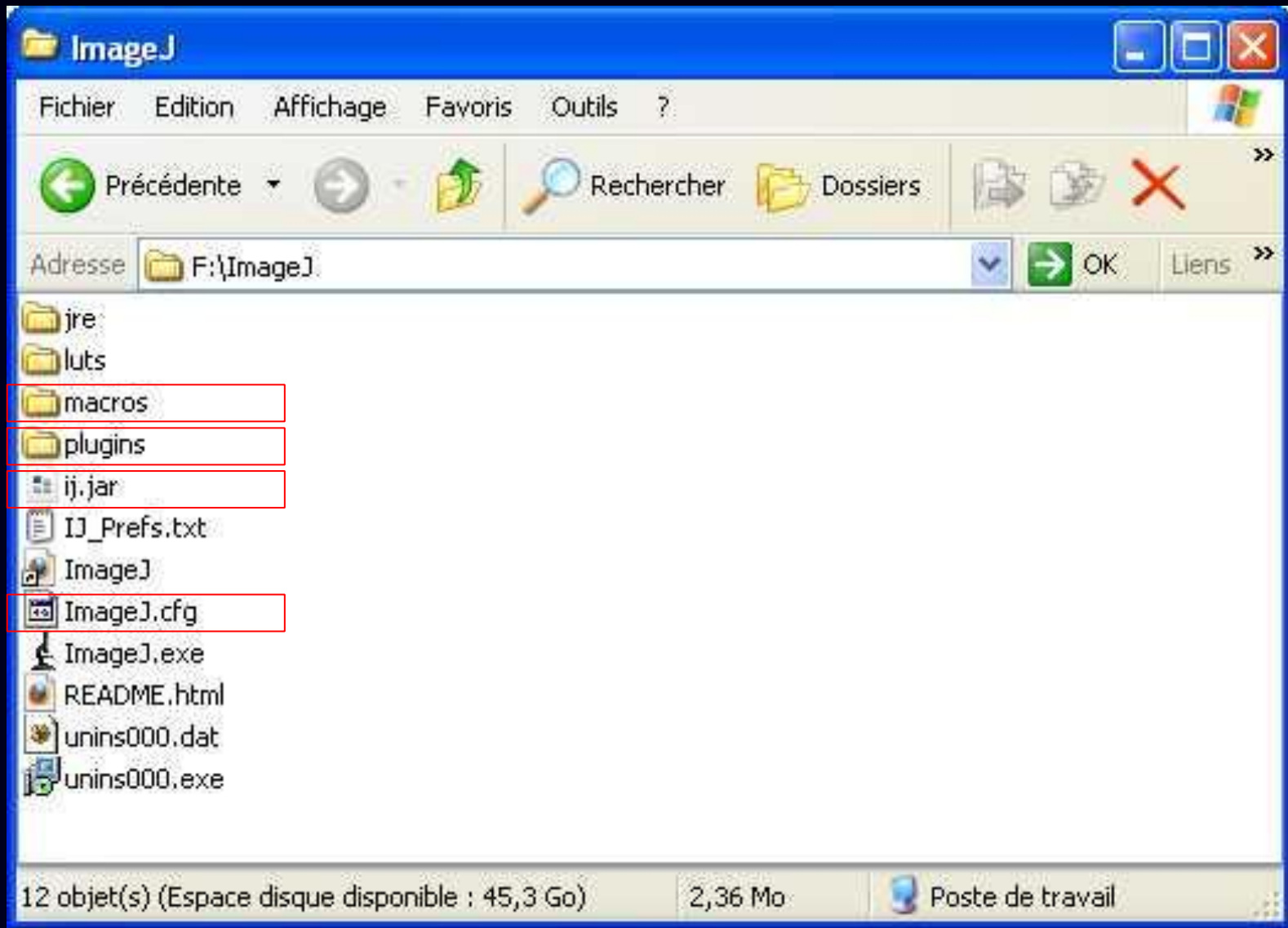


Help→ Plugins...

Help→ Refresh Menus



Dossiers ImageJ





Topic 01 - Installation, configuration, help and updates



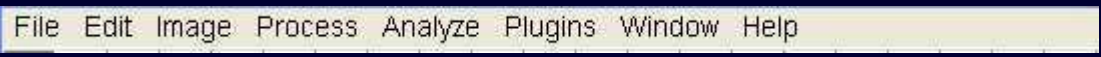
Les bases pour l'utilisation d'ImageJ



Interface



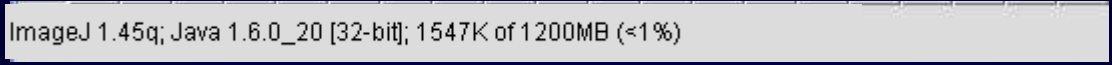
Barre de menu



Barre d'outils



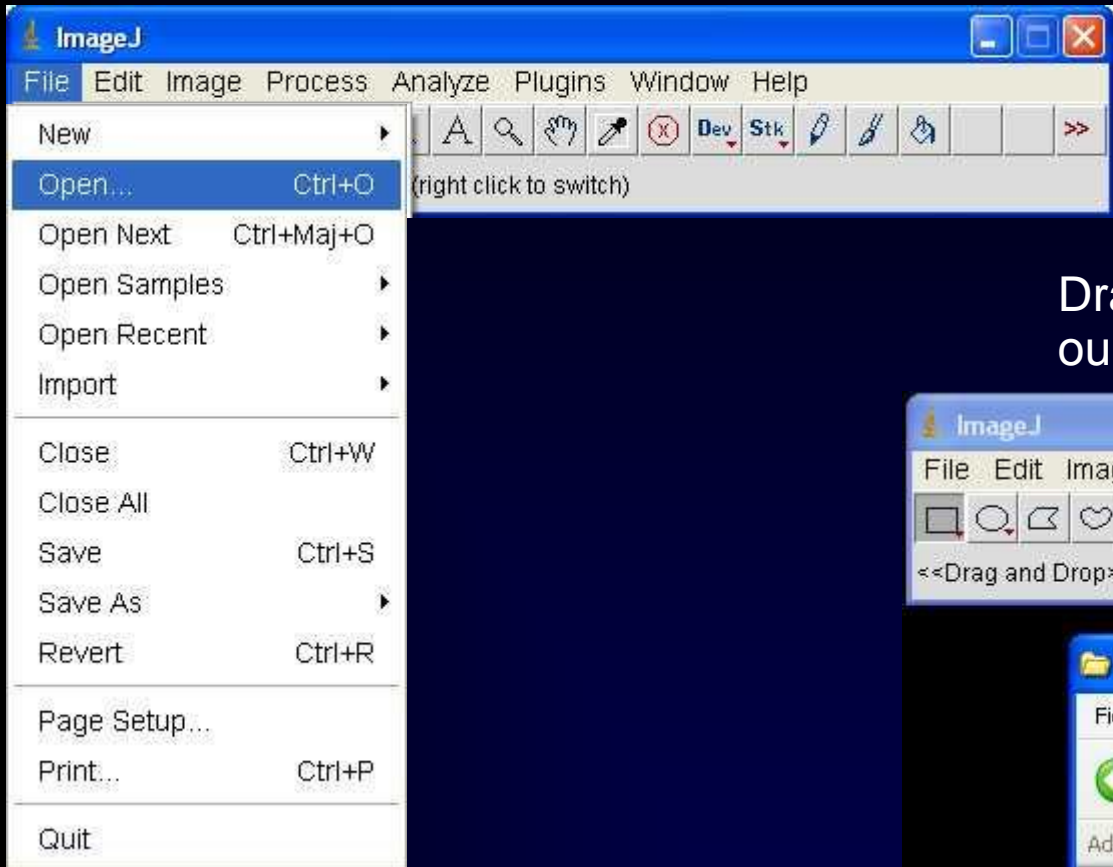
Barre d'état



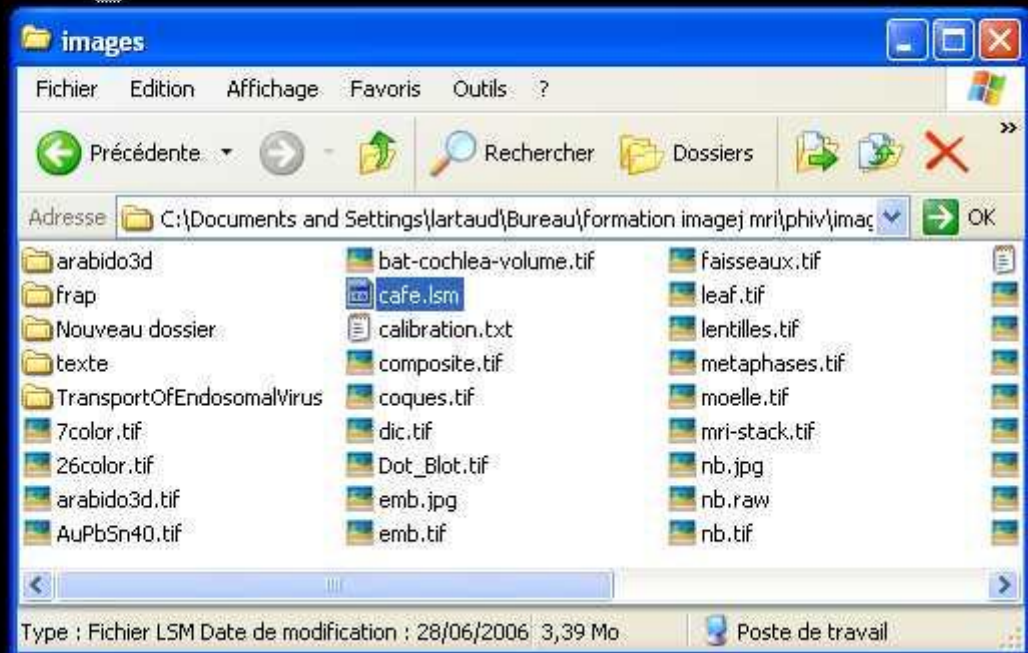


Ouvrir une image

File → Open...



Drag and Drop sur la fenêtre ou l'icône

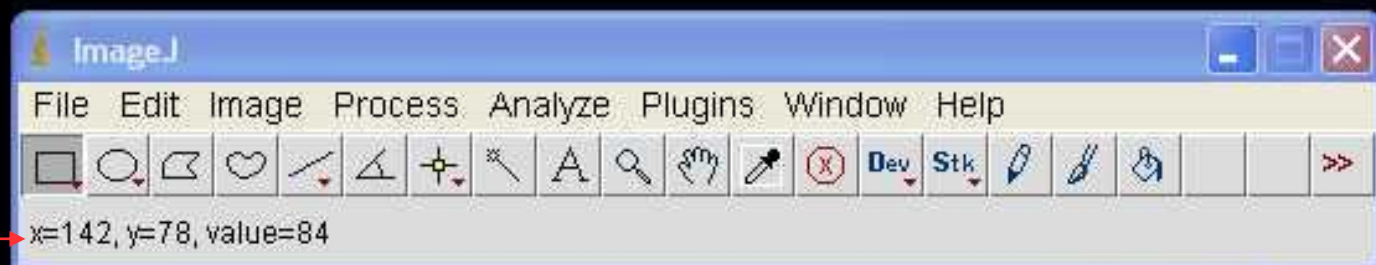


File → Open ...

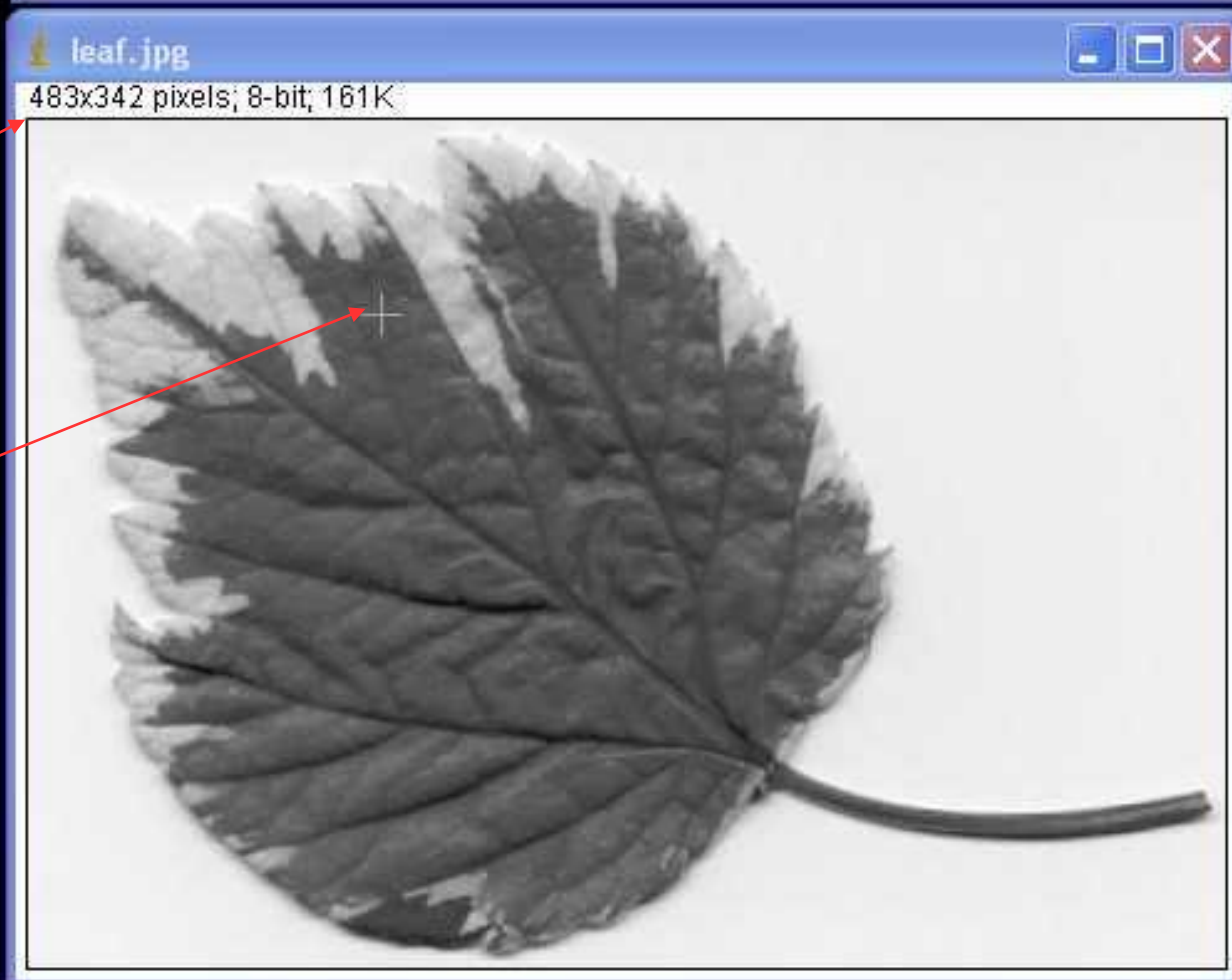


Informations pixel

Informations sur le pixel
sous le curseur de la souris
position en x,y
et valeur en niveau de gris



Informations image



Curseur de souris



Zoom

Touche « - »



Touche « + »

Zone affichée

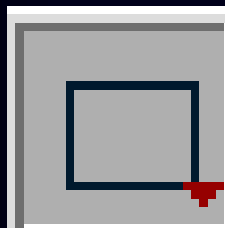
Rapport affichage/image



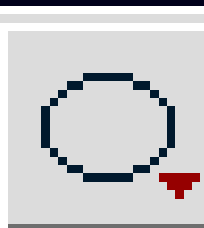
Déplacement de l'image dans la fenêtre
Avec la souris et la barre d'espace appuyée

Outils de sélection (ROI)

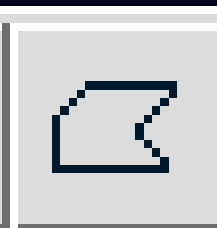
Rectangl
e



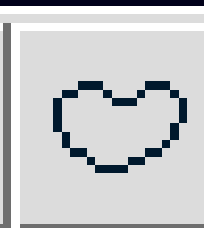
Ovale



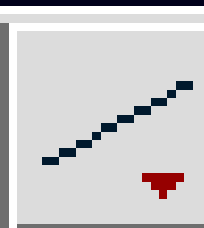
Polygone



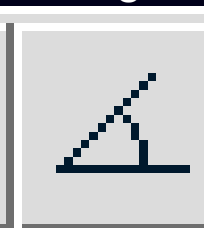
À main levée



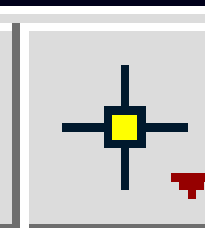
Ligne



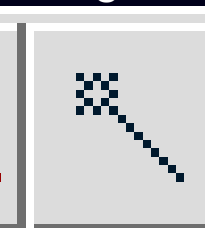
Angle



Point



Baguette



Choix d'outils différents : Clic droit sur triangle rouge

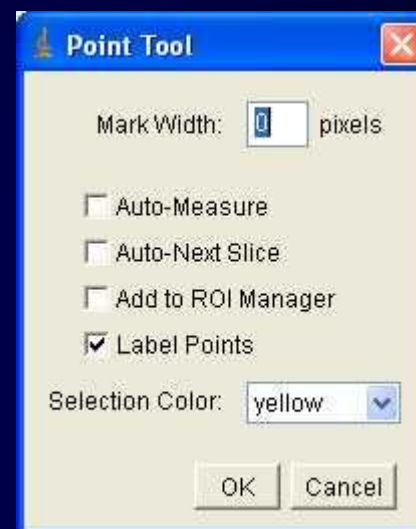
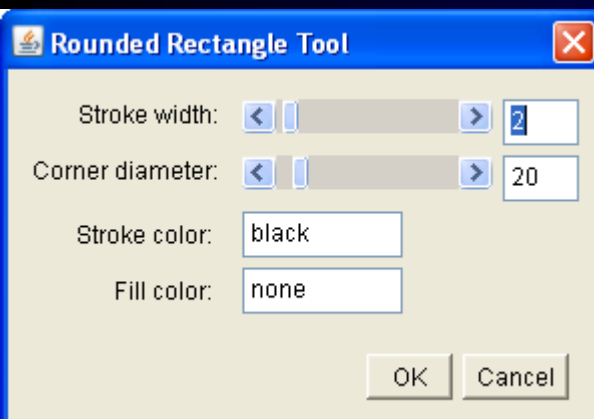
- ✓ Rectangle Tool
- Rounded Rectangle Tool

- ✓ Oval selections
- Elliptical selections
- Selection Brush Tool

- ✓ Straight Line
- Segmented Line
- Freehand Line
- Arrow tool

- ✓ Point Tool
- Multi-point Tool

Options : Double clic sur l'icône de l'outil



Ajouter à la sélection : Maj-clic

Supprimer de la sélection : Alt-clic

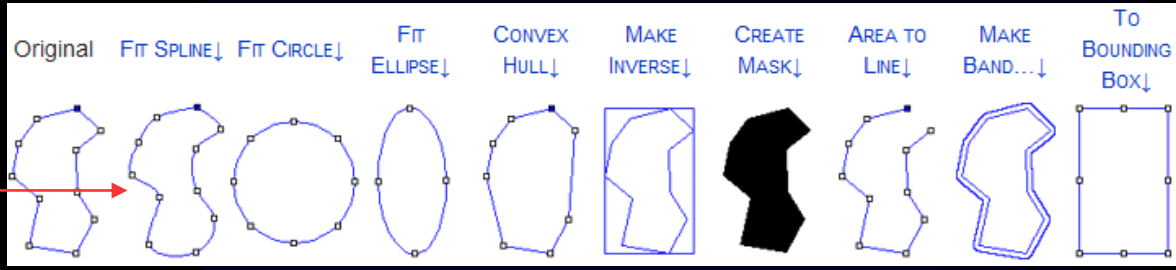
Retrouver la sélection : Edit → Selection → Restore Selection



Menus de sélection

- Select All Ctrl+A
- Select None Ctrl+Maj+A
- Restore Selection Ctrl+Maj+E
- Fit Spline
- Fit Circle
- Fit Ellipse
- Convex Hull
- Make Inverse
- Create Selection
- Create Mask

- Properties... Ctrl+Y
- Rotate...
- Enlarge...
- Make Band...
- Specify... Ctrl+Y
- Straighten...
- To Bounding Box
- Line to Area
- Area to Line
- Image to Selection...
- Add to Manager Ctrl+T



- ImageJ
- File
- Edit**
- Image
- Process

- Undo Ctrl+Z
- Cut Ctrl+X
- Copy Ctrl+C
- Copy to System
- Paste Ctrl+V
- Paste Control...

- Clear
- Clear Outside
- Fill Ctrl+F
- Draw Ctrl+D
- Invert Ctrl+Maj+I
- Selection**
- Options

Specify

Width:

Height:

X Coordinate:

Y Coordinate:

Oval

Centered

OK Cancel

Edit → Selection



ROI Manager

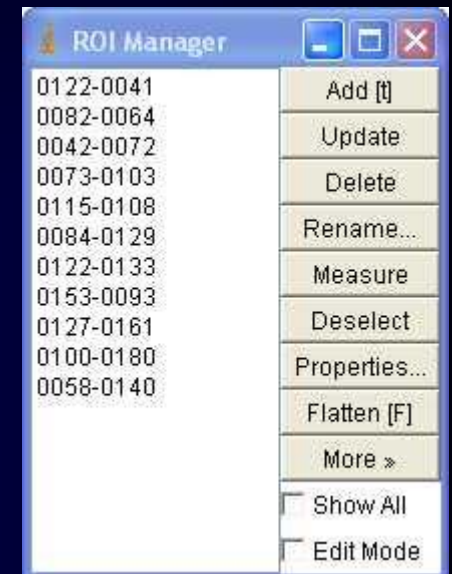
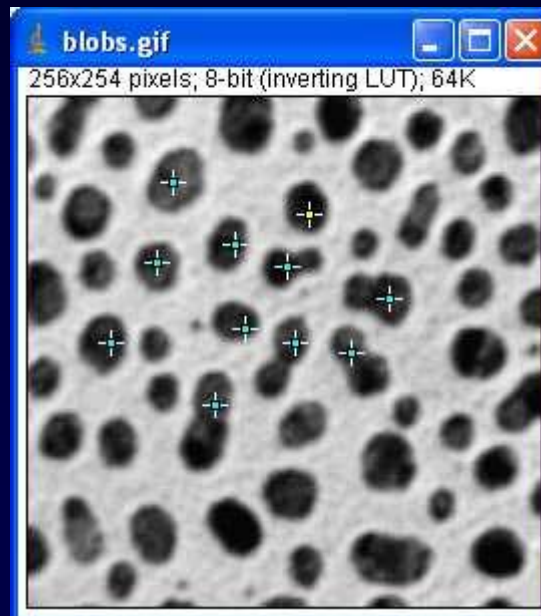
The screenshot shows the ImageJ interface with the following components:

- ImageJ Window:** Displays the menu bar (File, Edit, Image, Process, Analyze, Plugins, Window, Help) and a toolbar. The **Analyze** menu is open, showing options like Measure, Analyze Particles..., Summarize, Distribution..., Label, Clear Results, Set Measurements..., Set Scale..., Calibrate..., Histogram, Plot Profile, Surface Plot..., Gels, and Tools. The **ROI Manager...** option is highlighted.
- emb.tif Window:** Shows a grayscale image of a cell with a cyan outline for the cell and a yellow outline for the nucleus. The status bar indicates 333x377 pixels; 8-bit; 123K.
- ROI Manager Window:** Lists the regions: Cellule, Noyau, and Nucléole. The **Fill** button is highlighted in the context menu.
- Context Menu:** A secondary menu is open over the ROI Manager window, listing actions such as Open..., Save..., Fill, Draw, AND, OR (Combine), XOR, Split, Add Particles, Multi Measure, Multi Plot, Sort, Specify..., Remove Slice Info, Labels..., List, Help, and Options...

Analyse → Tools → ROI Manager...



Outil Point pour le comptage





Dessin



ImageJ

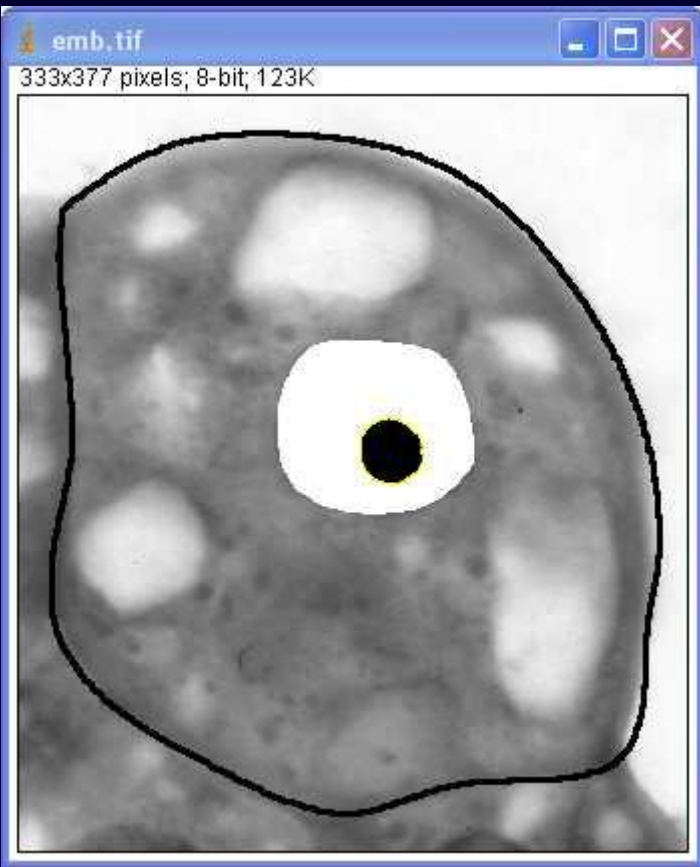
File Edit Image Process Analyze Plugins Window Help

- Undo Ctrl+Z
- Cut Ctrl+X
- Copy Ctrl+C
- Copy to System
- Paste Ctrl+V
- Paste Control...
- Clear**
- Clear Outside
- Fill Ctrl+F
- Draw Ctrl+D
- Invert Ctrl+Maj+I
- Selection
- Options

Clear → Noyau

Fill → Nucléole

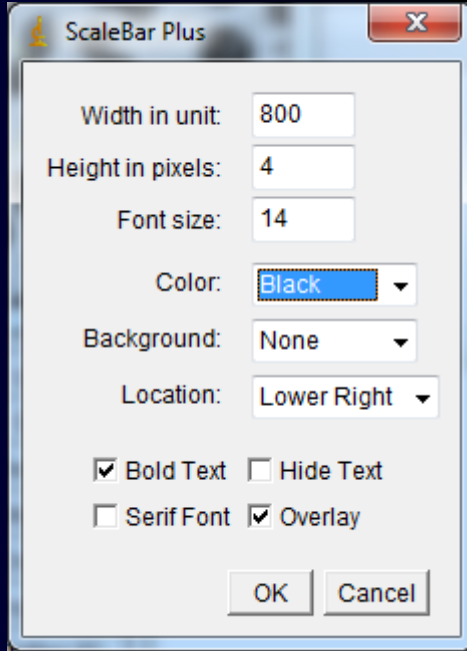
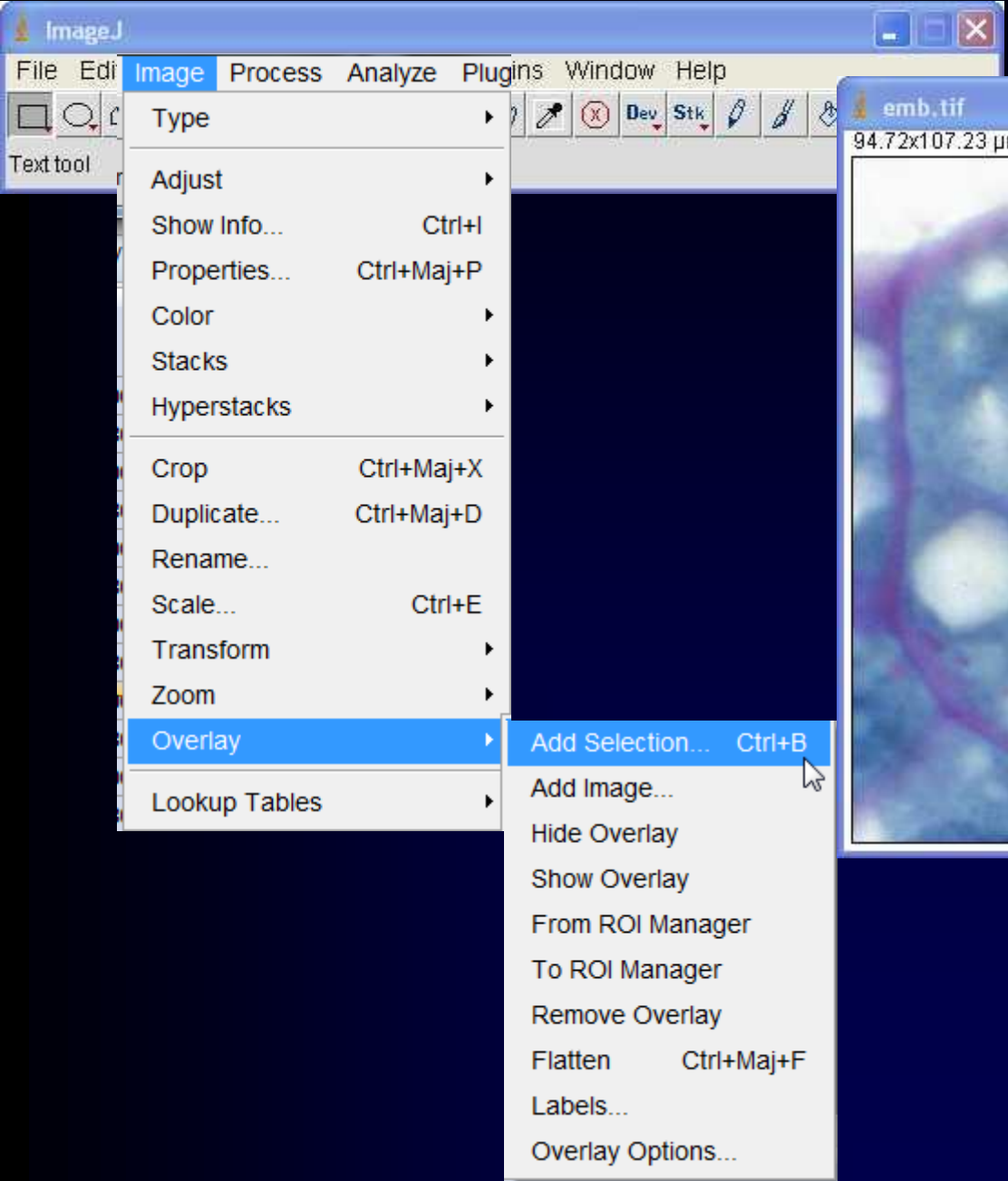
Draw → Cellule



Edit → Clear...



Annotations



Image→Overlay→Add Selection...

Analyse→Tools→Scale Bar...



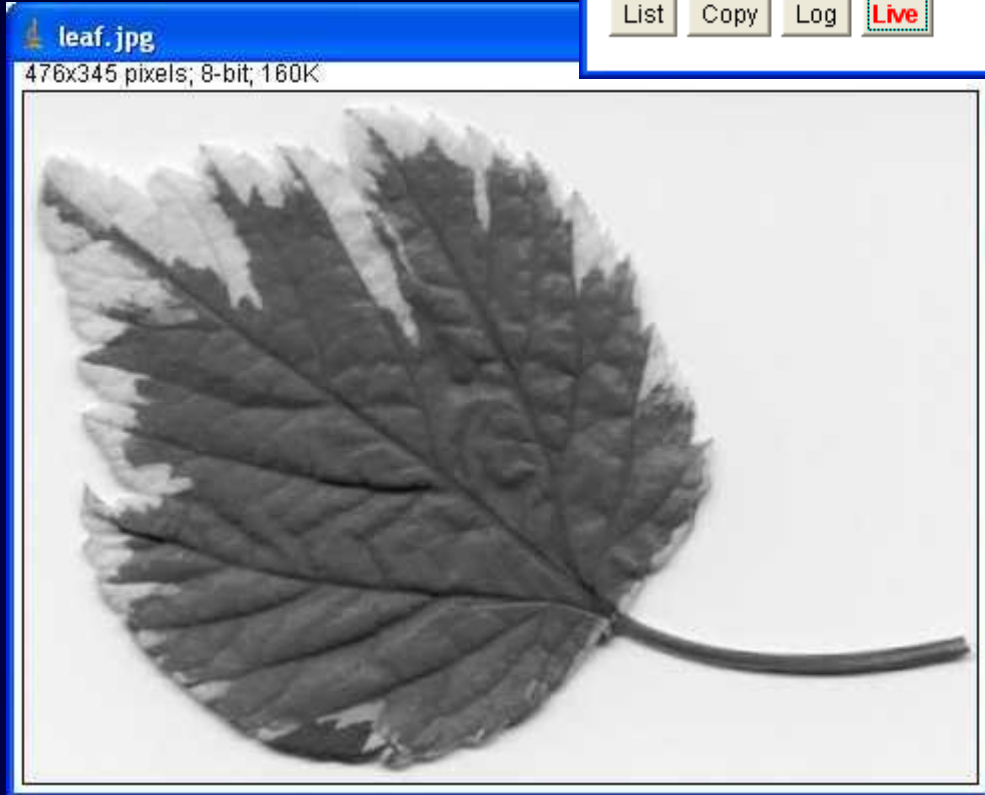
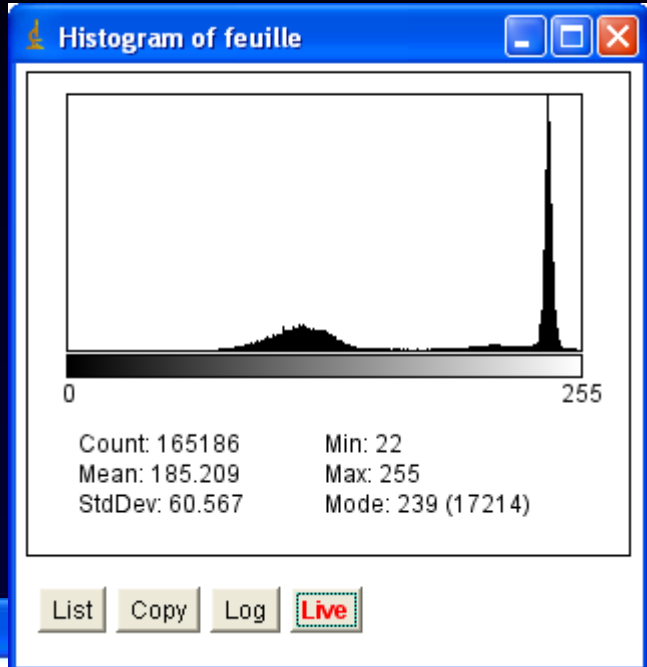
Histogramme

ImageJ

File Edit Image Process Analyze Plugins Window Help

Magnifying glass (or use "+" and "-")

- Measure Ctrl+M
- Analyze Particles...
- Summarize
- Distribution...
- Label
- Clear Results
- Set Measurements...
- Set Scale...
- Calibrate...
- Histogram Ctrl+H**
- Plot Profile Ctrl+K
- Surface Plot...
- Gels ▶
- Tools ▶



Analyse → Histogram



Seuillage

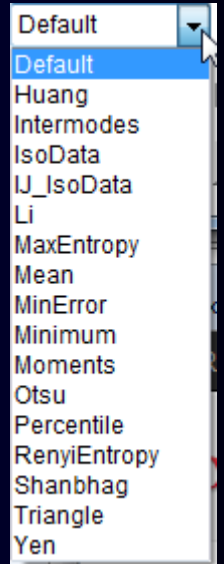
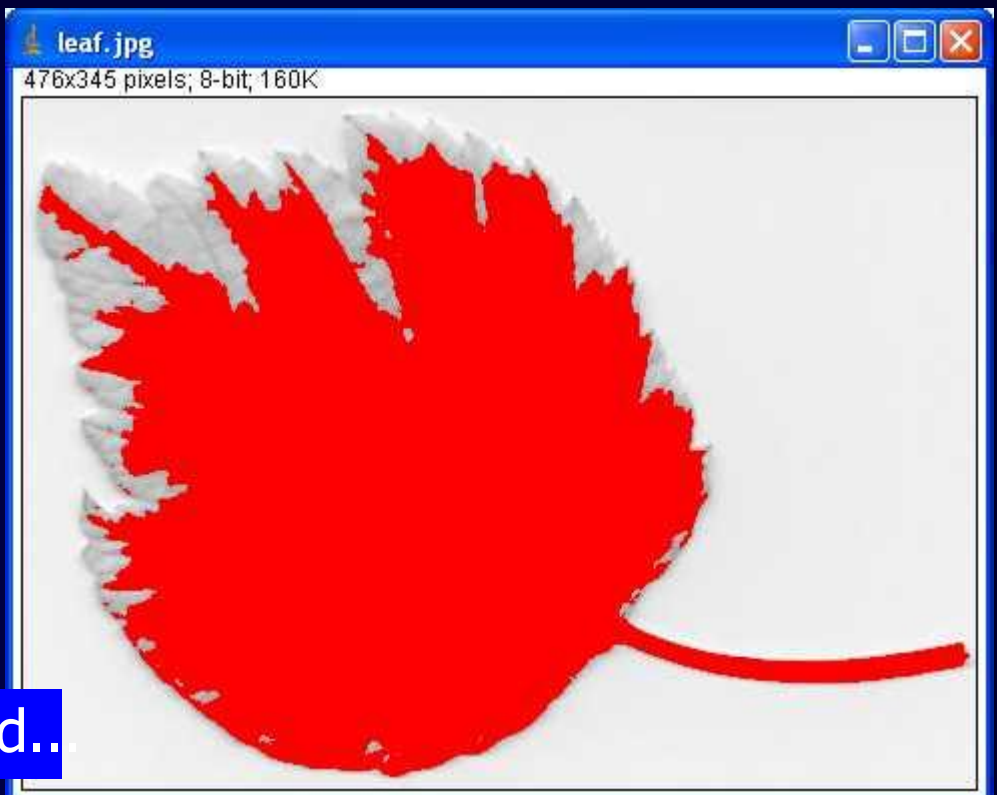
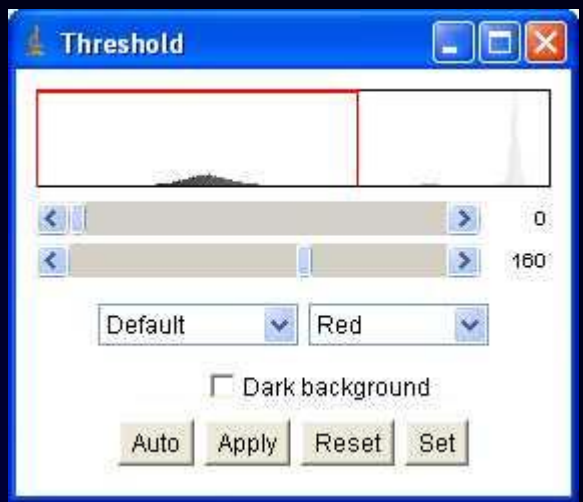
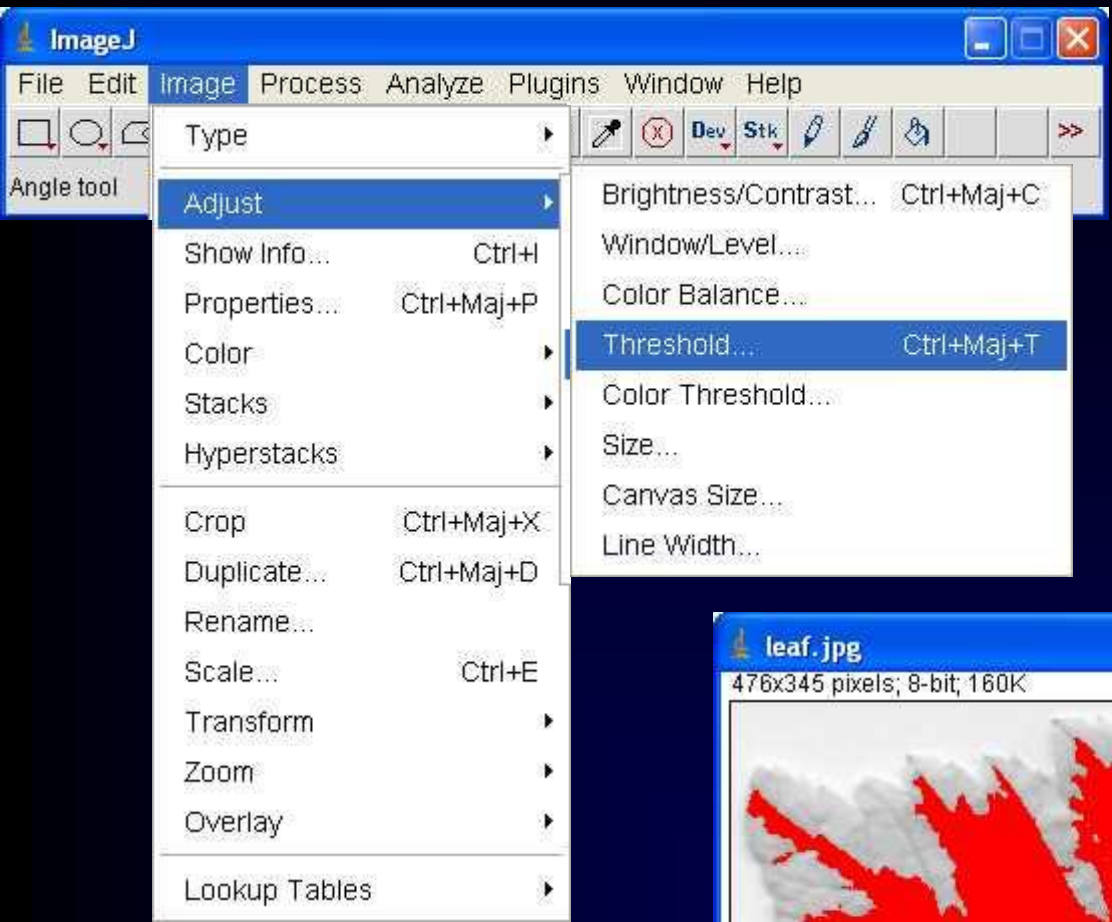
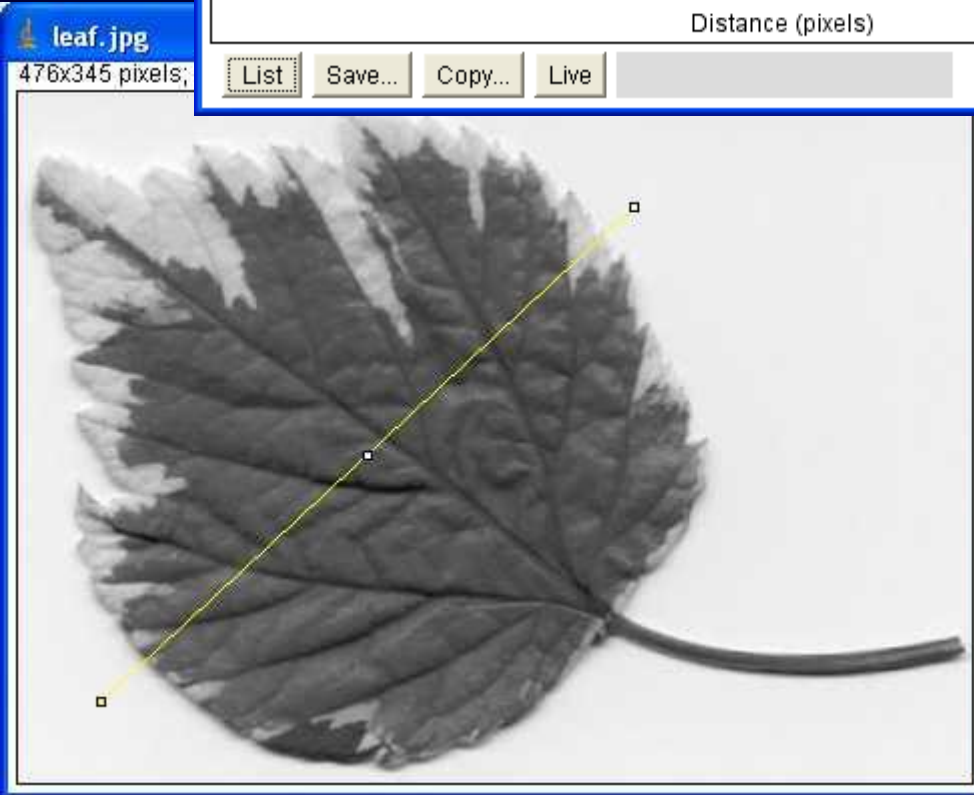
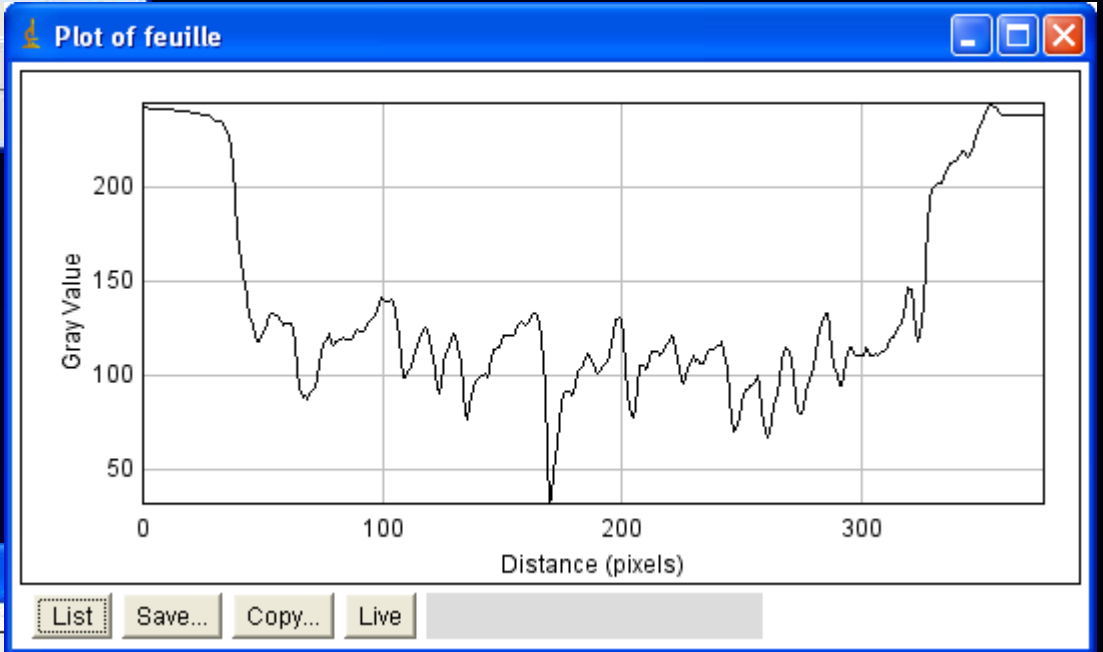
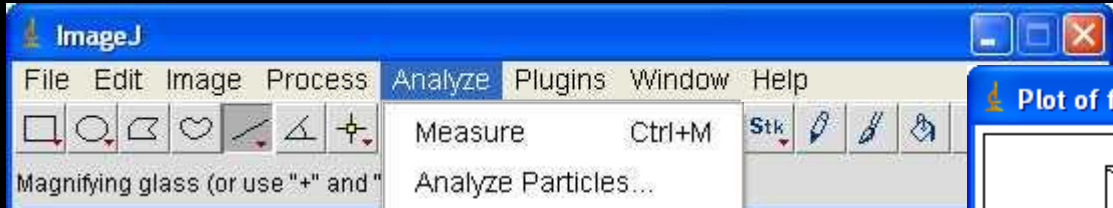


Image → Adjust → Threshold..



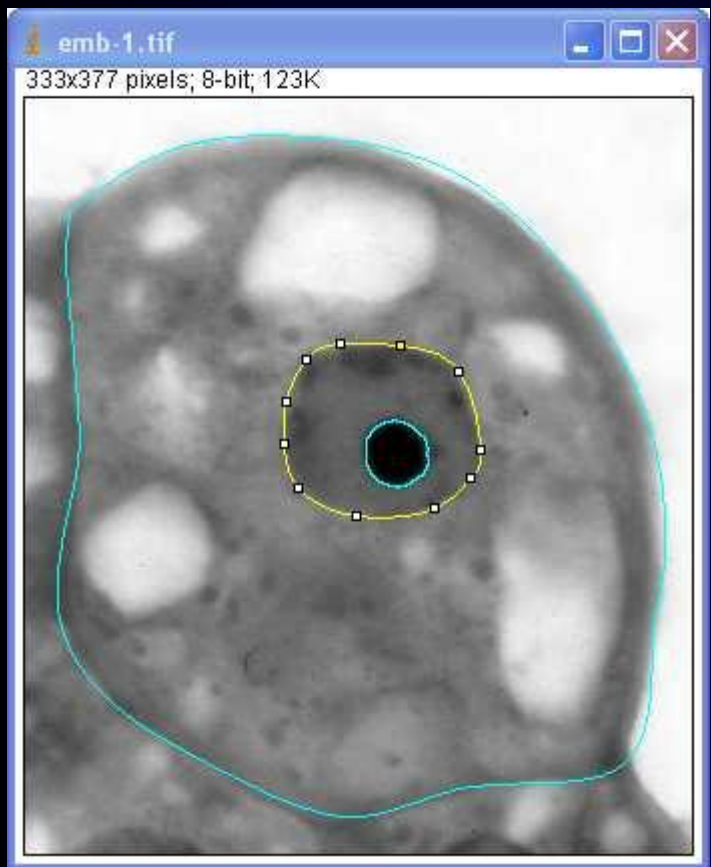
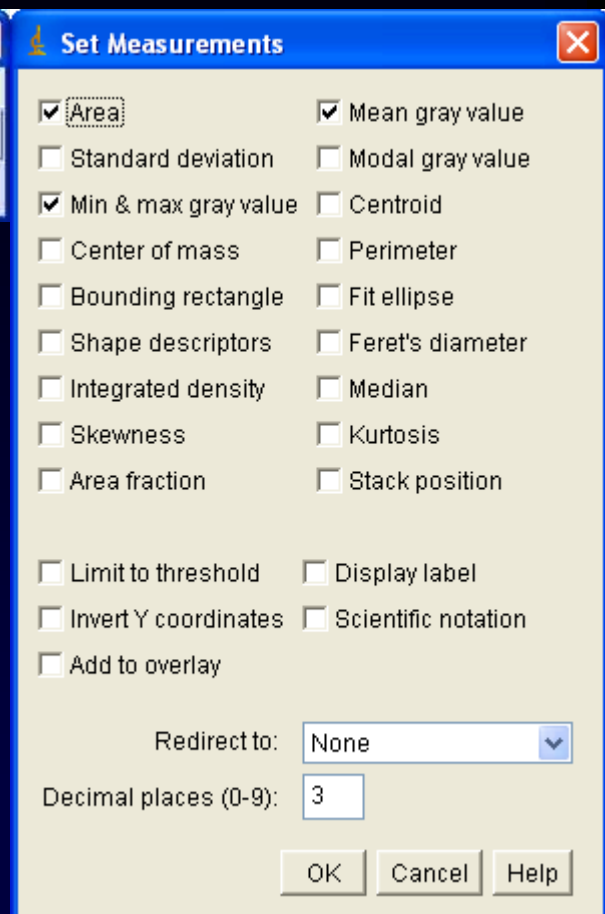
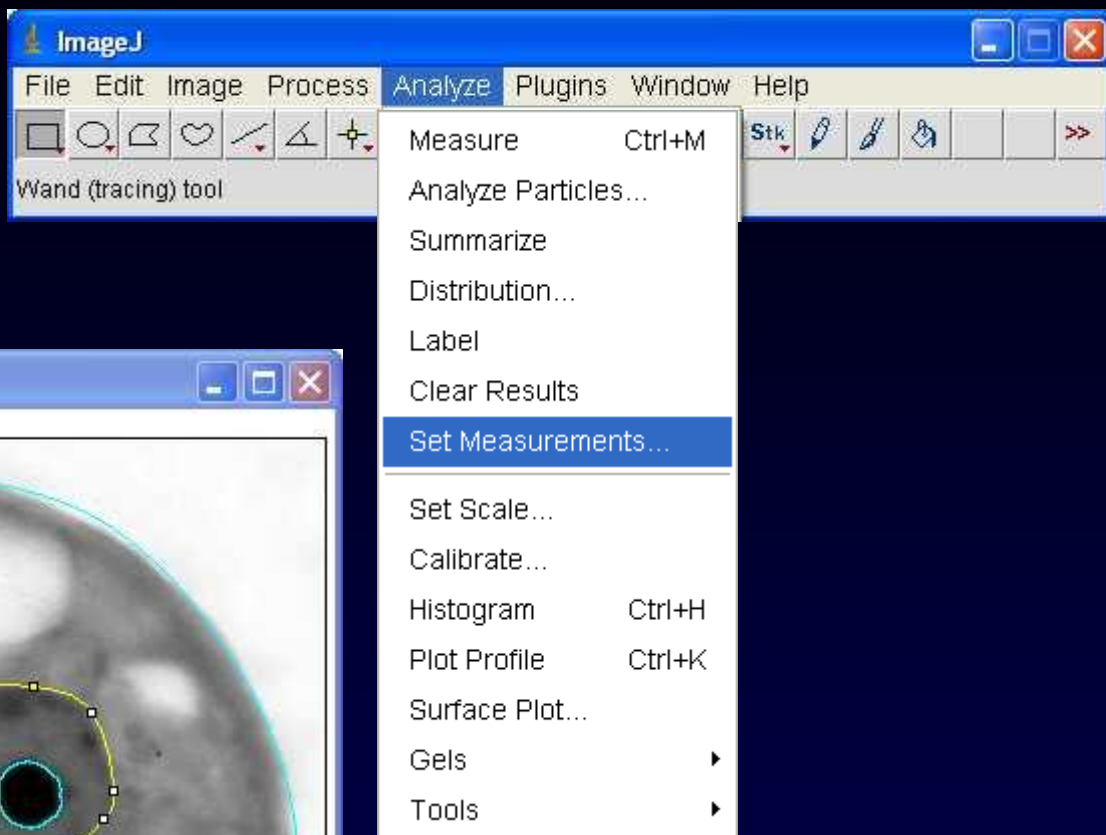
Plot Profile



Analyse → Plot Profile



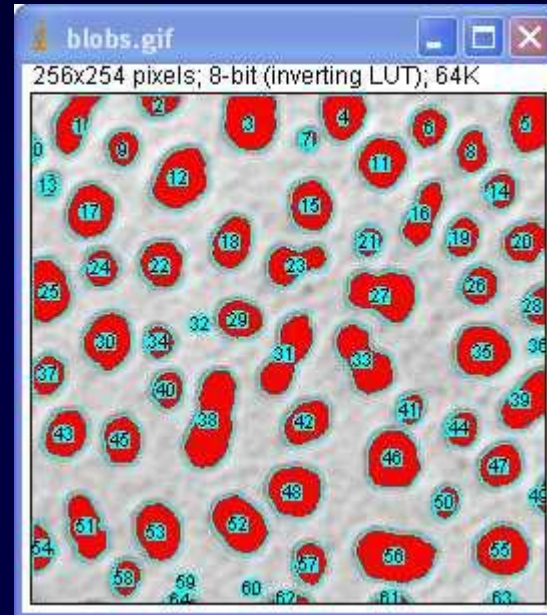
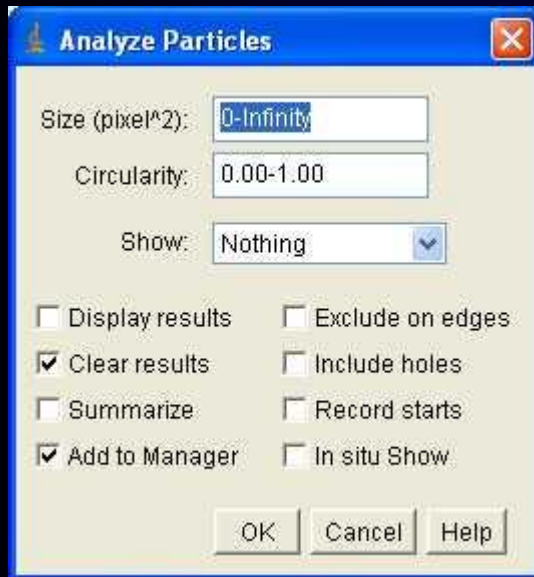
Mesures de sélection



File	Area	Mean	Min	Max
1	7154	81.665	0	141

Analyse → Measure

Mesures d'objets

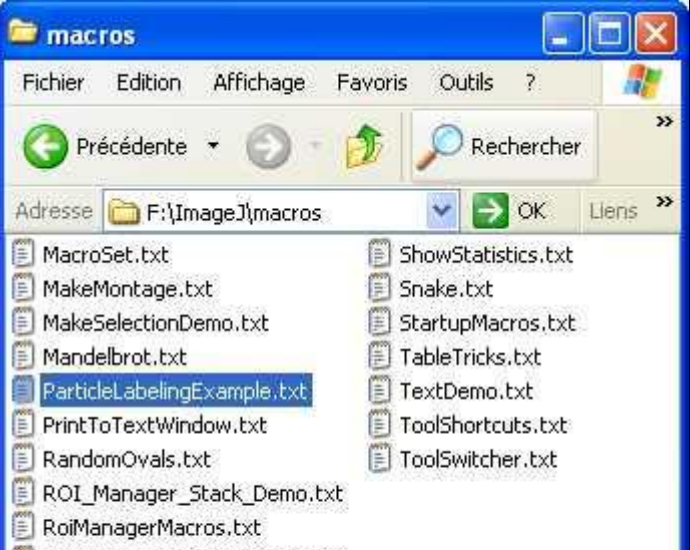
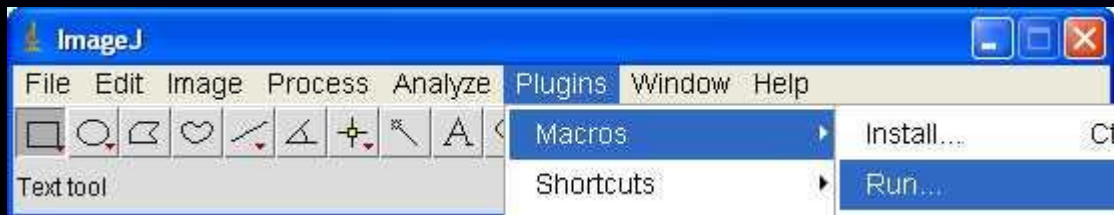


	Area	Mean	Min	Max
1	433	190.855	128	232
2	185	179.286	128	224
3	658	205.617	128	248
4	434	217.327	128	248
5	477	212.143	128	248
6	285	204.295	128	248
7	81	161.481	128	200
8	272	174.848	128	224

Analyse → Analyze Particles...



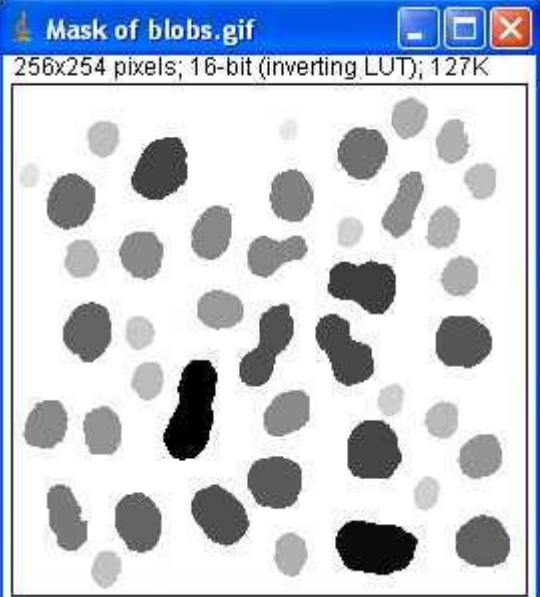
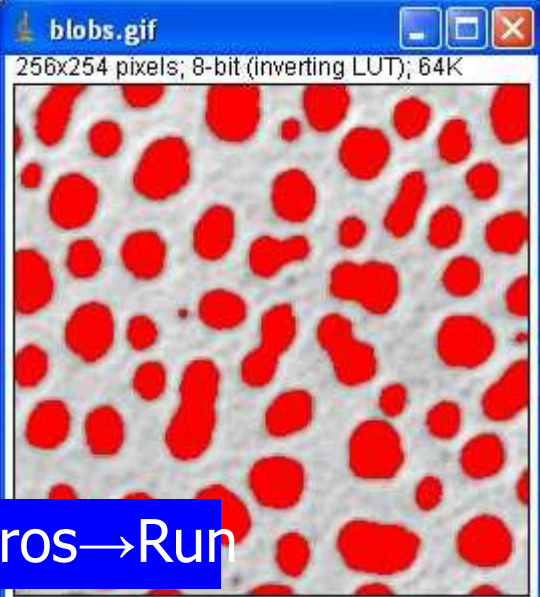
Macro



```

ParticleLabelingExample.txt
File Edit Font Macros Debug
// This macro labels the blobs from the 'Blobs' test image
// according to their area.

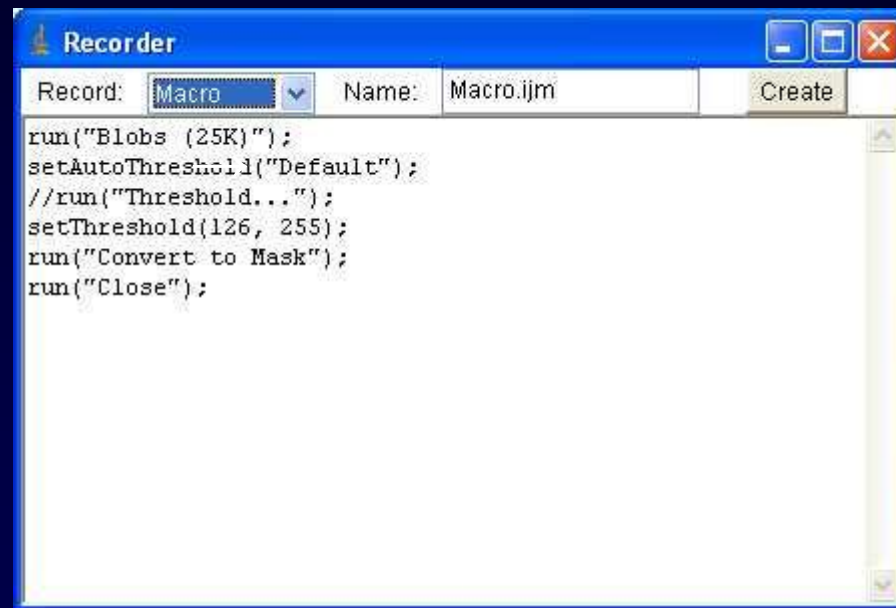
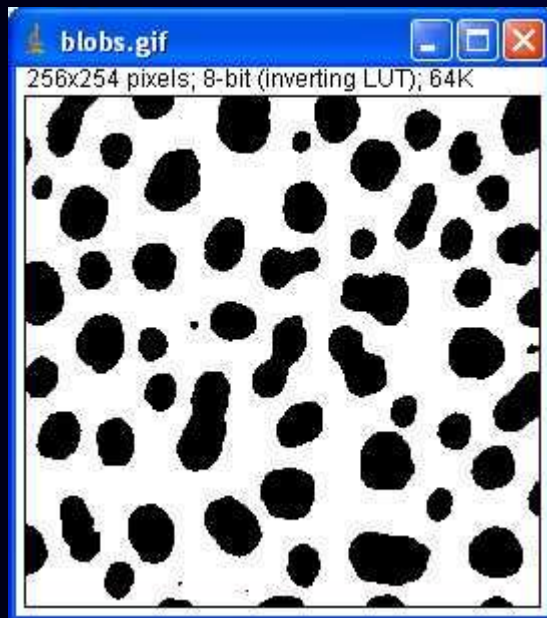
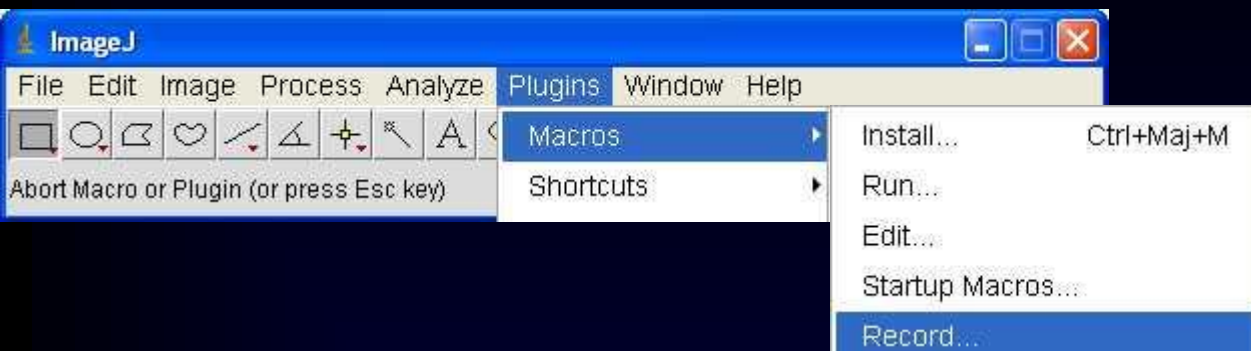
run("Set Measurements...", "area center redirect=None decimal=3");
run("Blobs (25K)");
setThreshold(125, 248);
run("Analyze Particles...",
    "minimum=1 maximum=999999 bins=20 show=Masks display exclude");
selectWindow("Mask of blobs.gif");
run("16-bit");
for (i=0; i<nResults; i++) {
    doWand(getResult("XStart", i), getResult("YStart", i));
    setColor(getResult("Area", i));
    fill();
}
    
```



	Area	XM	YM	XStart	YStart
37	170	206.414	203.488	205	195
38	472	26.319	215.160	21	199
39	613	103.332	214.269	99	199
40	543	62.664	217.835	60	203
41	555	234.522	227.816	233	214
42	858	180.452	230.218	168	217
43	281	138.466	233.655	136	223
44	215	46.542	240.989	44	232
45	3	76.827	242.827	76	242
46	1	110.500	246.500	110	246

Plugins → Macros → Run

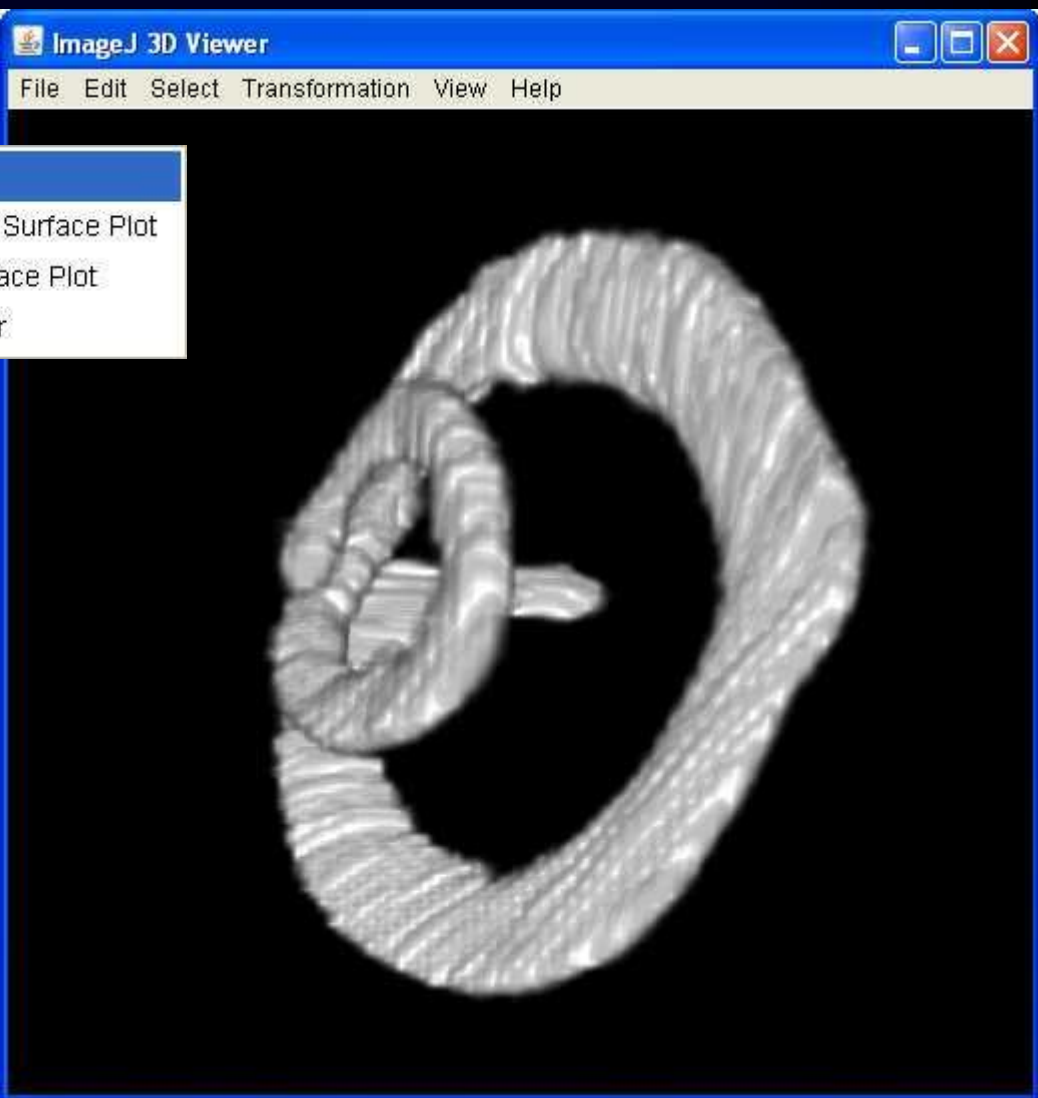
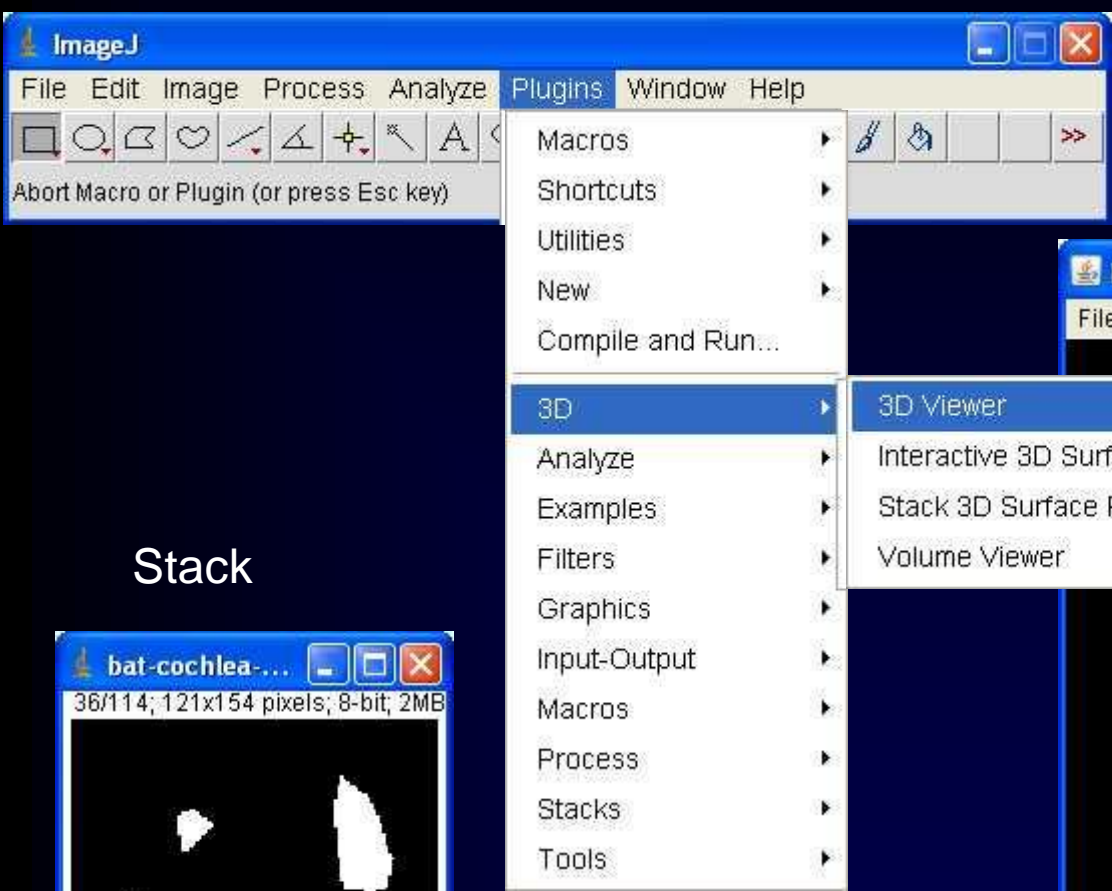
Enregistrement de macro



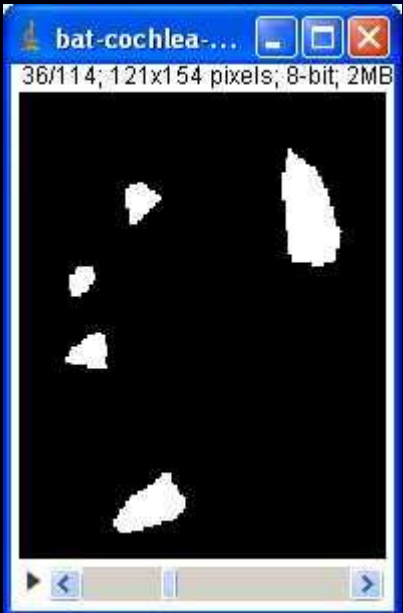
Plugins → Macros → Record...



Plugins



Stack



Plugins → 3D → 3D Viewer



Barres d'outils

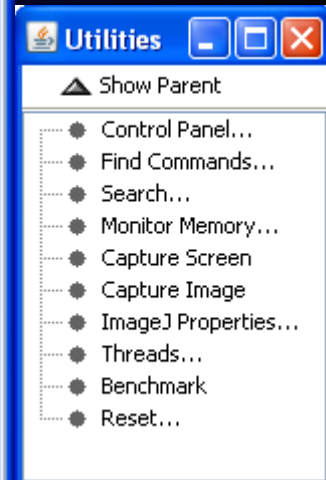
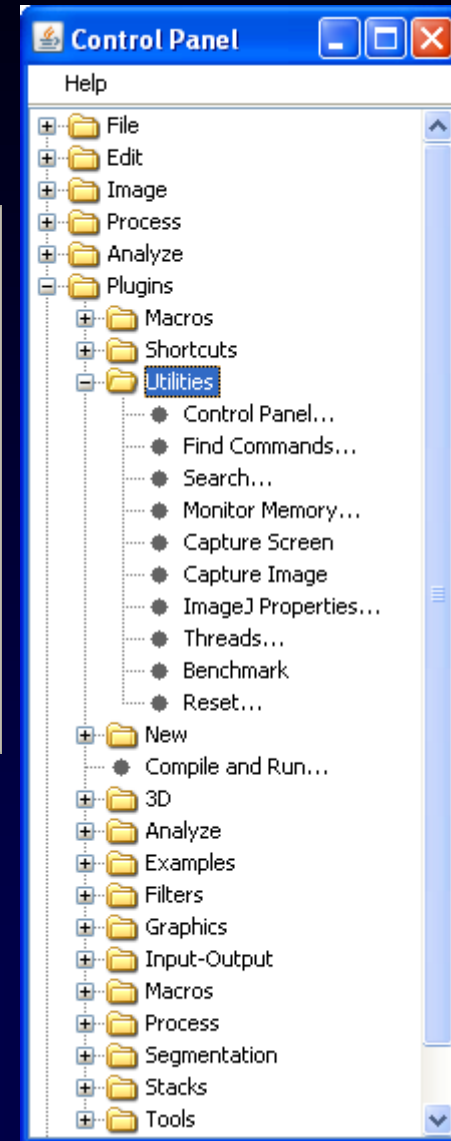
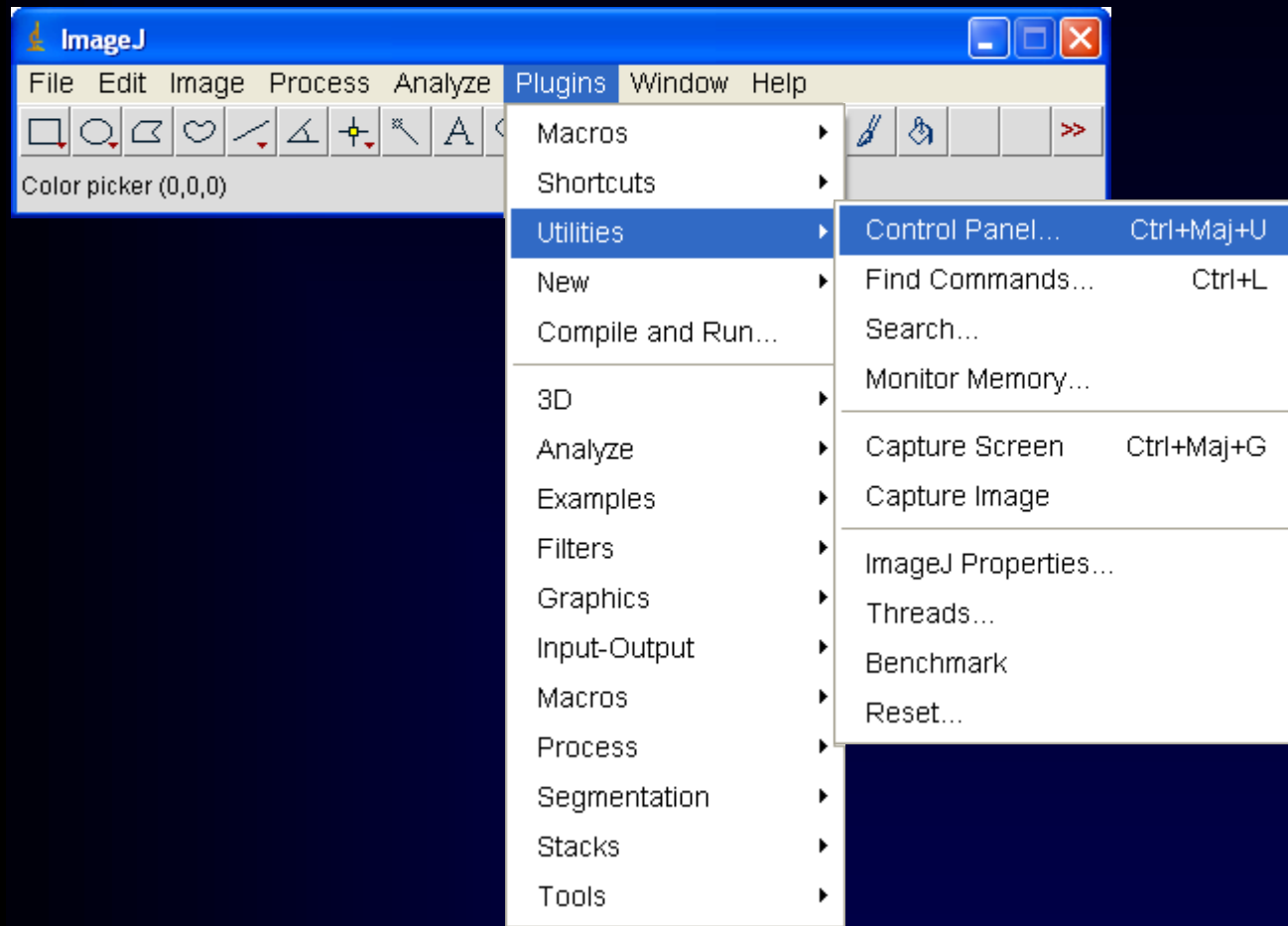


- ✓ Startup Macros
- Arrow Labelling Tools
- Drawing Tools
- Example Icons
- Lookup Tables
- Luts Macros and Tools Updater
- Magic Montage
- Plugins
- Scale Bar Tools for Microscopes
- Stack Tools
- Toolset Creator
- Help...





Panneaux de commandes



Plugins → Utilities → Control Panel



Topic 02 – Basic tools 1

Topic 03 – Basic tools 2



L'image numérique

Les Prétraitements

La Segmentation

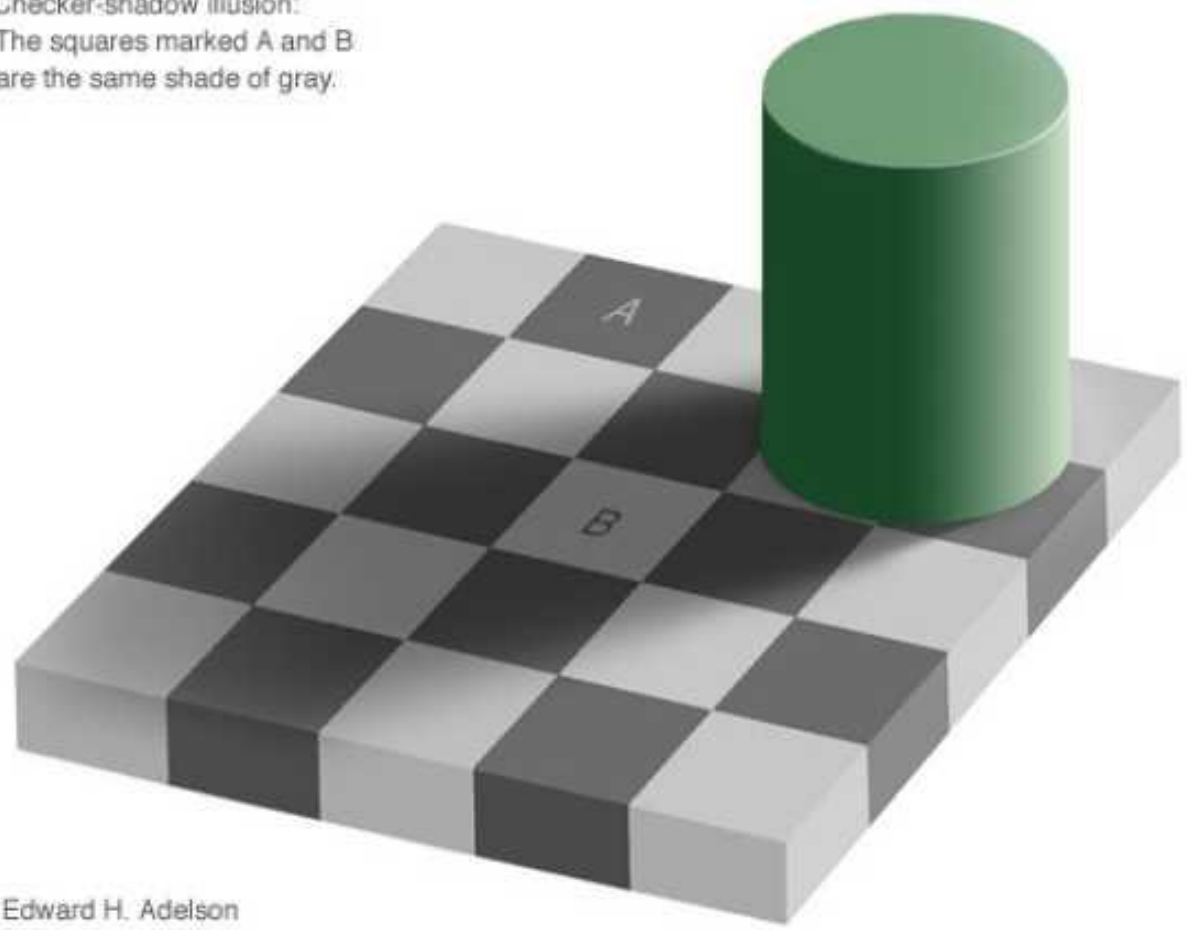
Les Post-traitements

La Quantification



Image et perception

Checker-shadow illusion:
The squares marked A and B
are the same shade of gray.



Edward H. Adelson

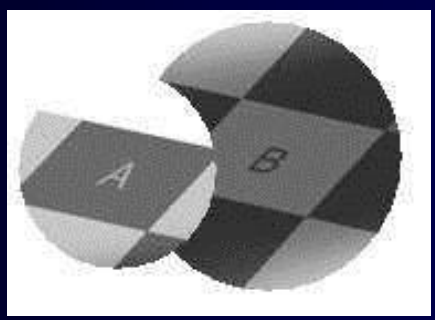
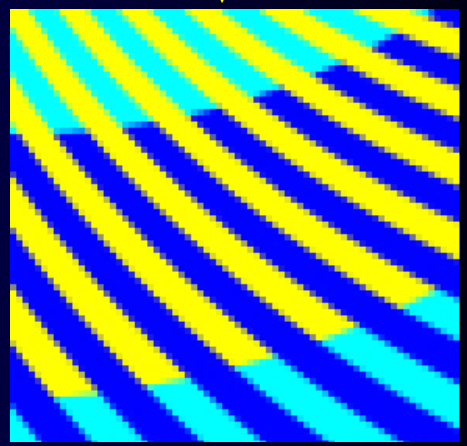
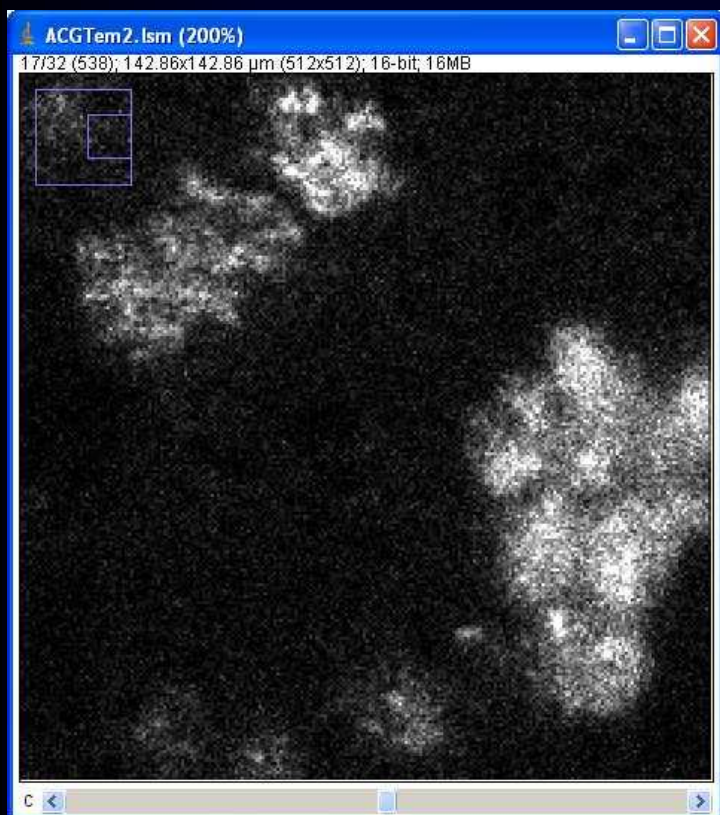


Image et déformations

Bruit



PSF

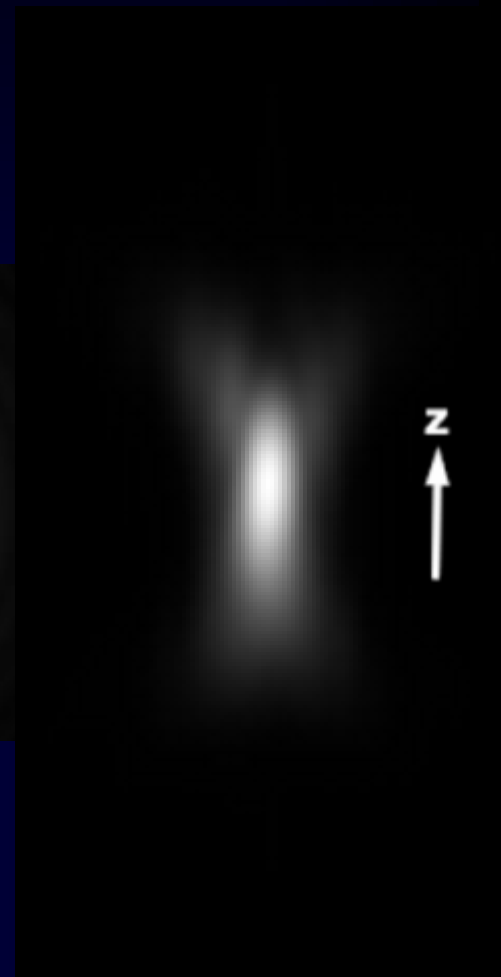
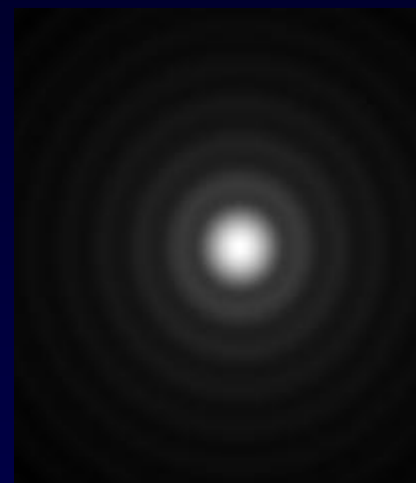
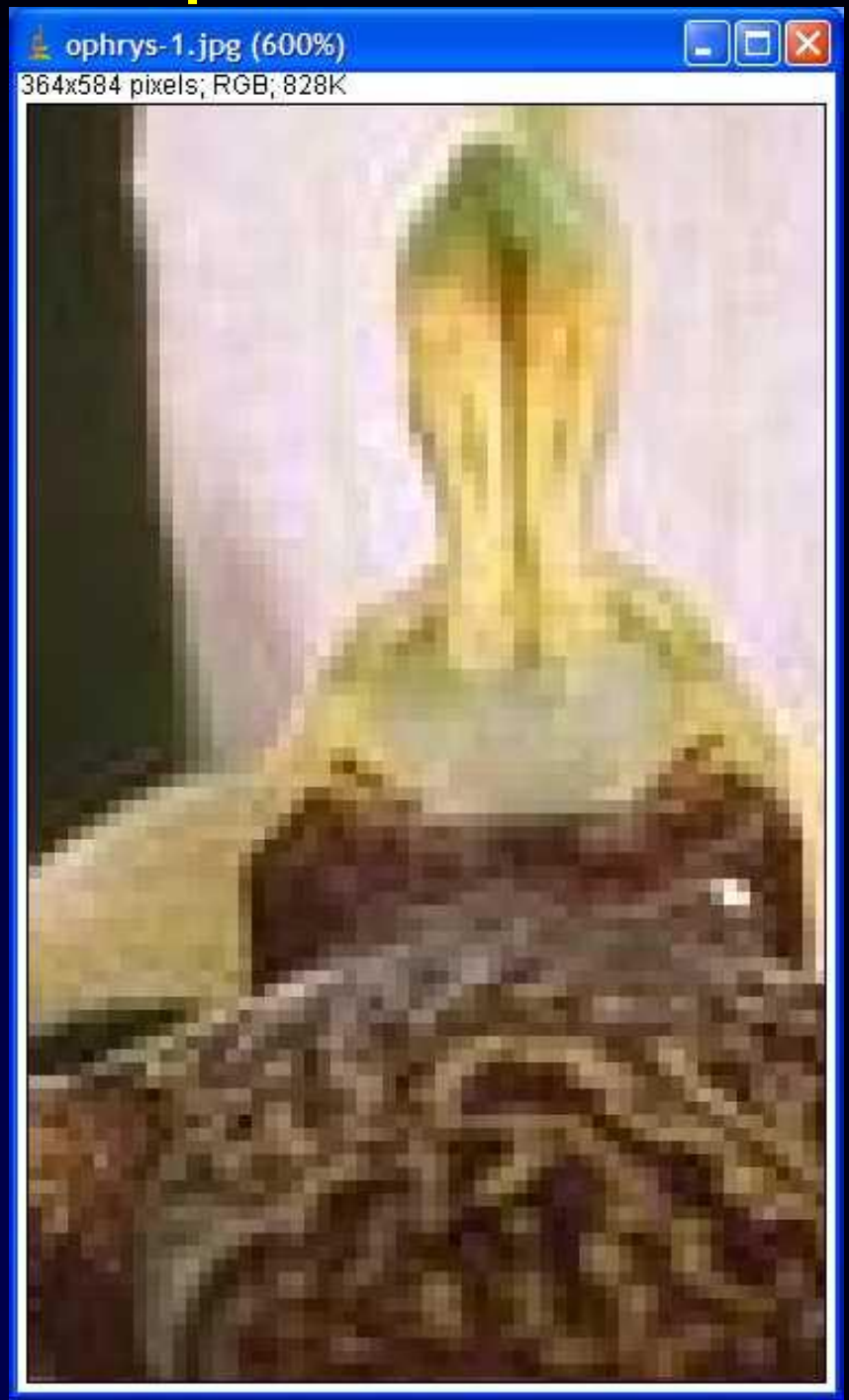




Image numérique = tableau de pixels



Détail = Affichage * 6



Résolution

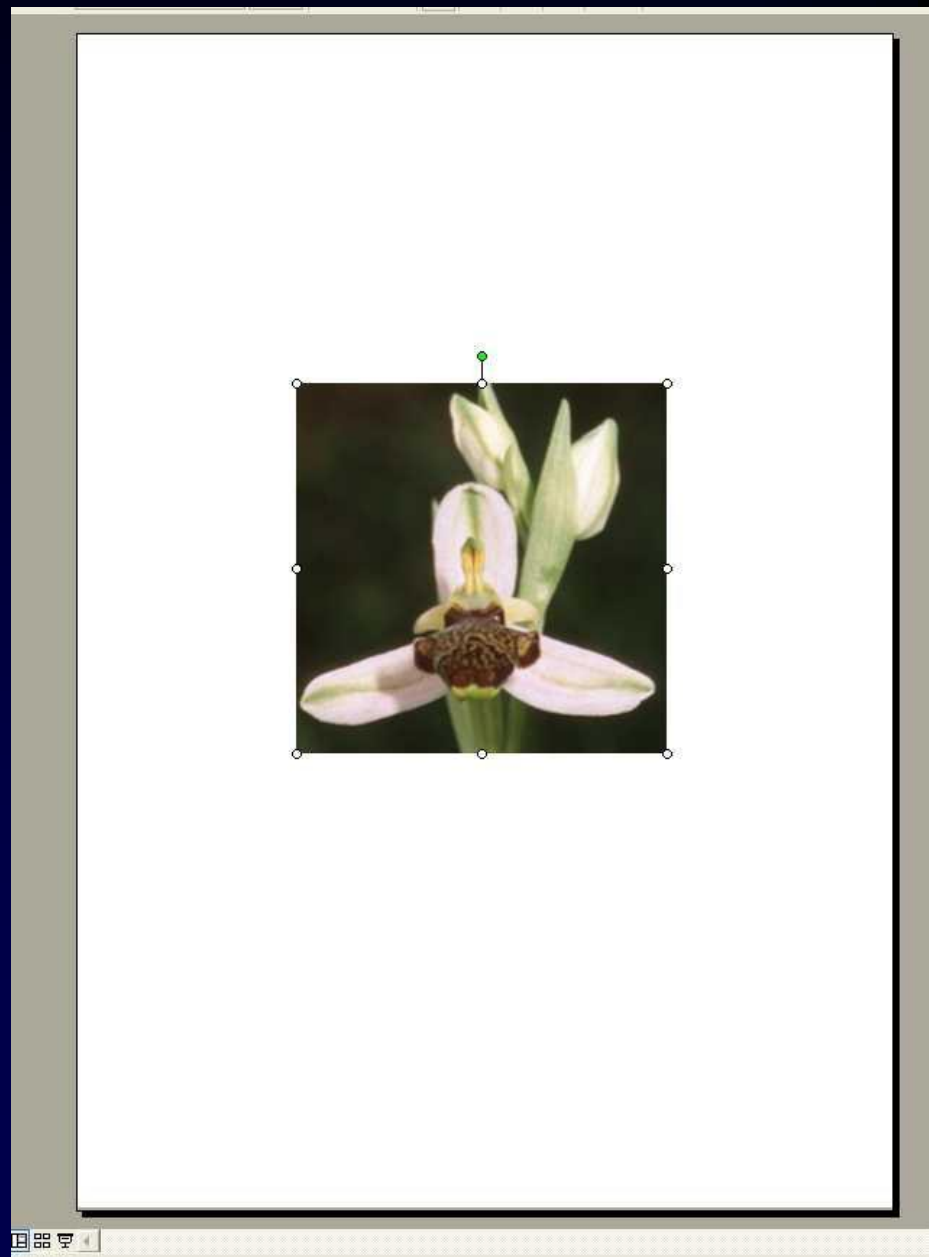
1024*1024
1 Mega pixels



Ecran 72 dpi → 35cm

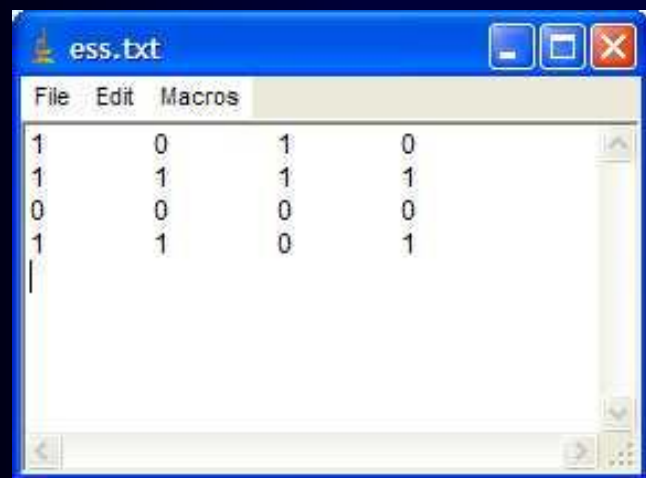
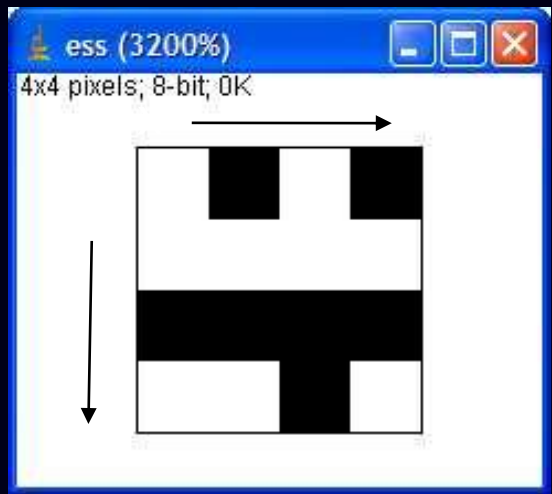


Impression 300 dpi → 8,5cm





Codage binaire



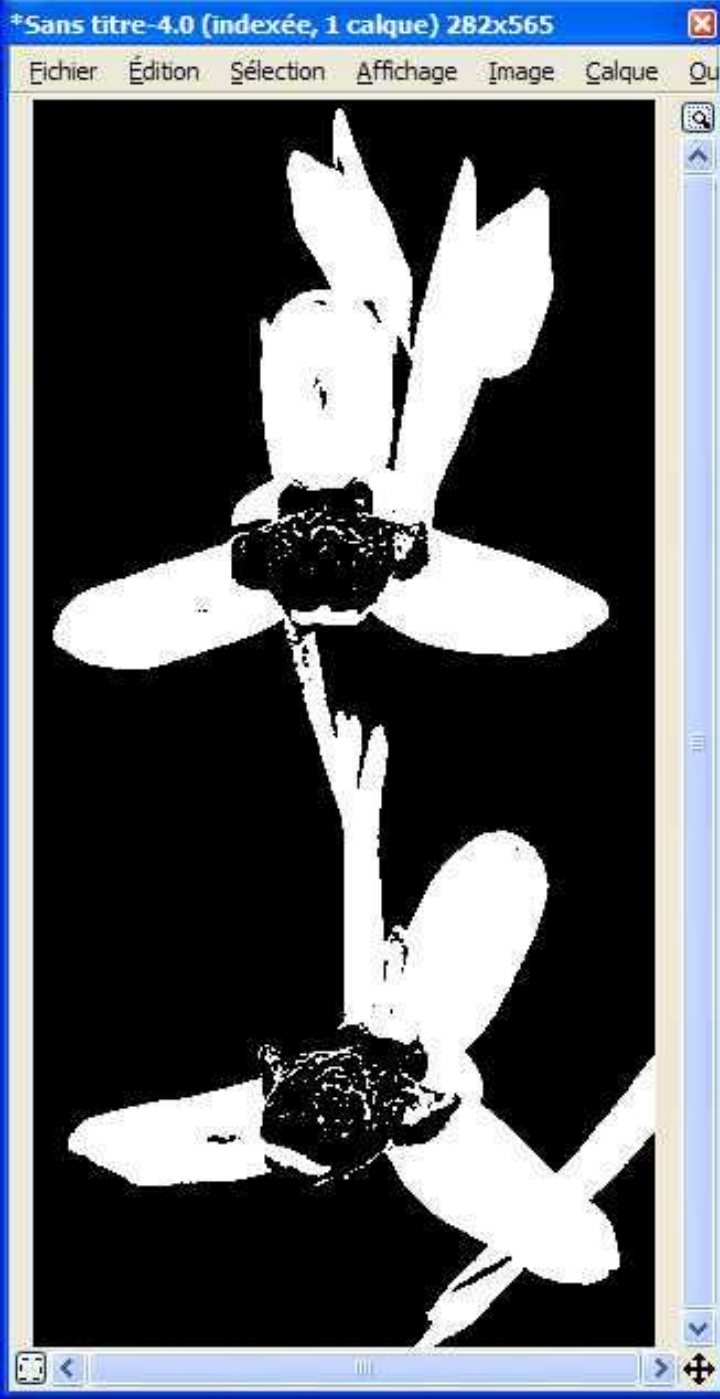


Codage

1bit \rightarrow 2 valeurs

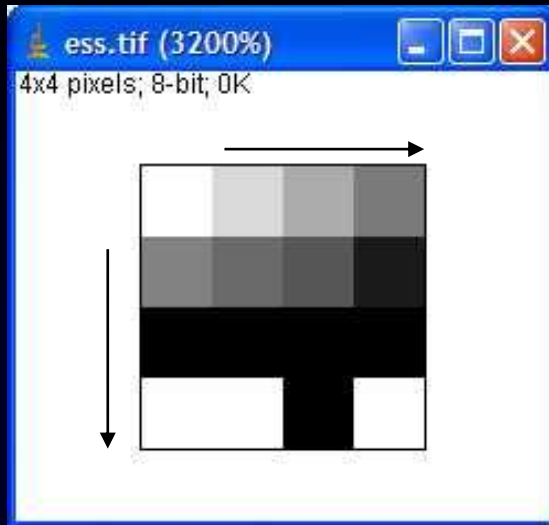
3bits \rightarrow 8 valeurs

5bits \rightarrow 32 valeurs





Codage 8 bits 0→255 Valeurs de Niveaux de gris

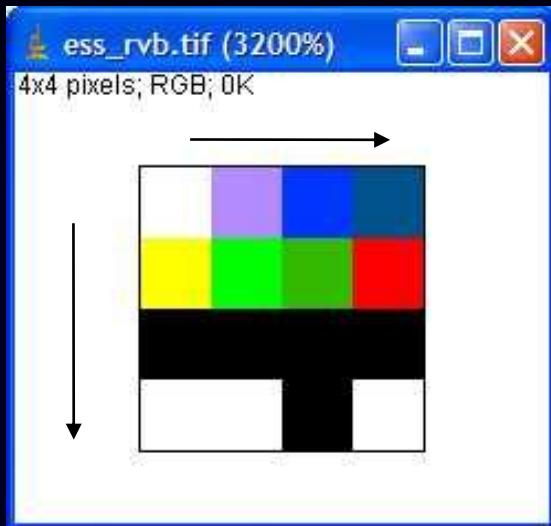


File	Edit	Macros	
255	217	172	123
130	106	87	27
0	0	0	0
255	255	0	255





Codage couleur 24 bits RVB



ess_rvb.txt

File	Edit	Macros		
255,255,255	180,139,125	0,54,255	0,82,139	
255,255,0	0,255,0	51,185,0	255,0,0	
0,0,0	0,0,0	0,0,0	0,0,0	
255,255,255	255,255,255	0,0,0	255,255,255	





Piles d'images : Stack

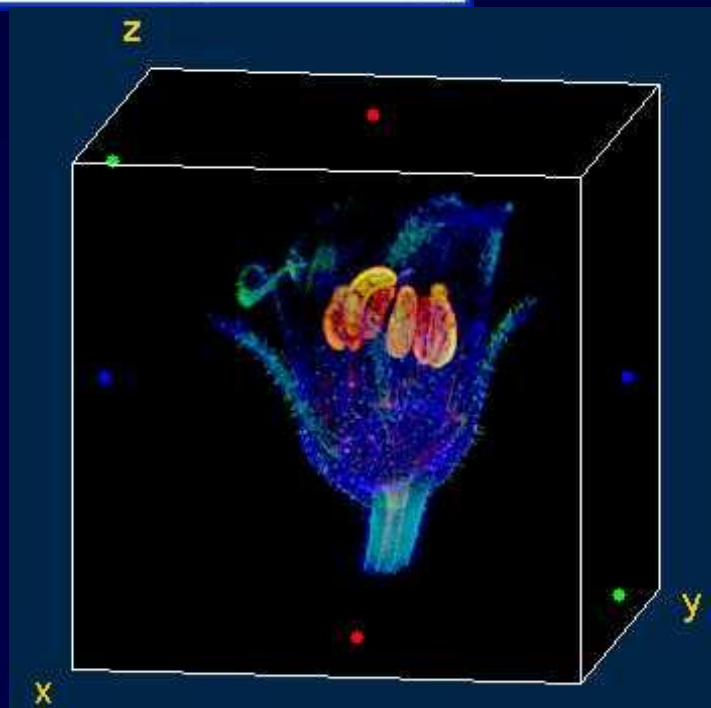
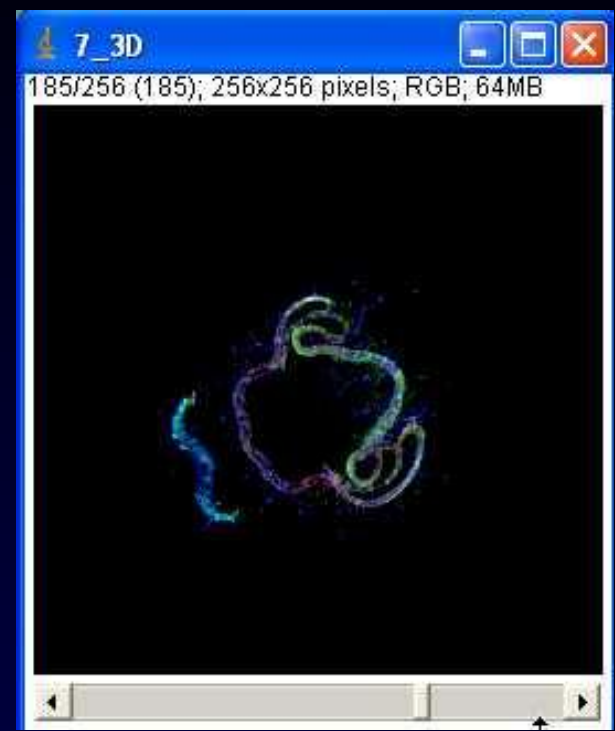
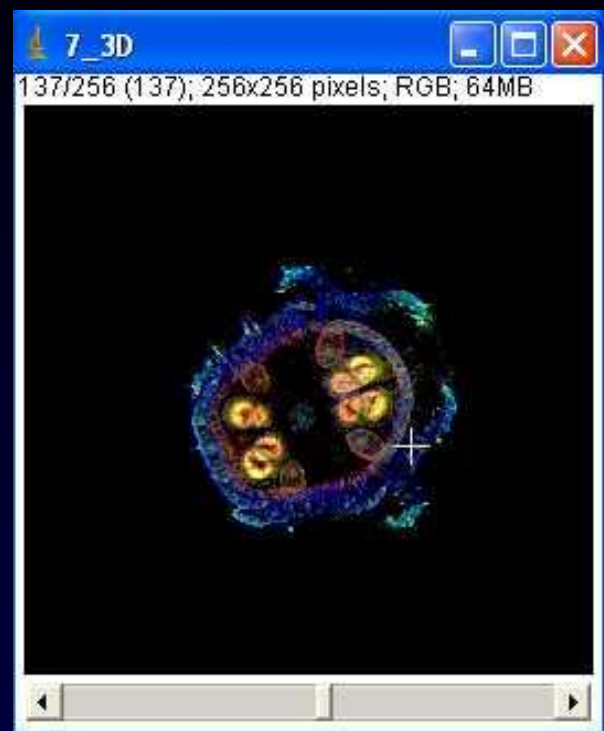
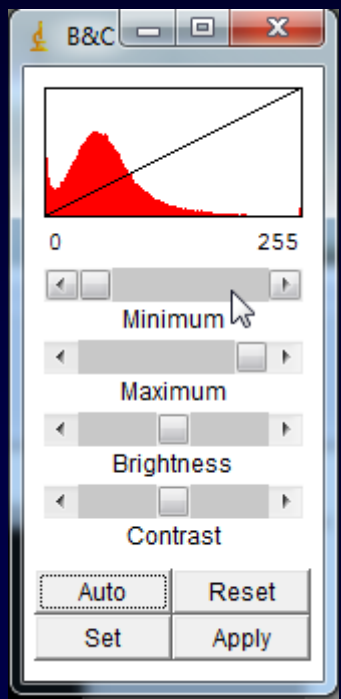
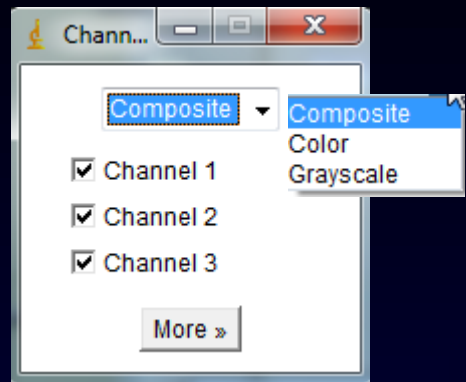
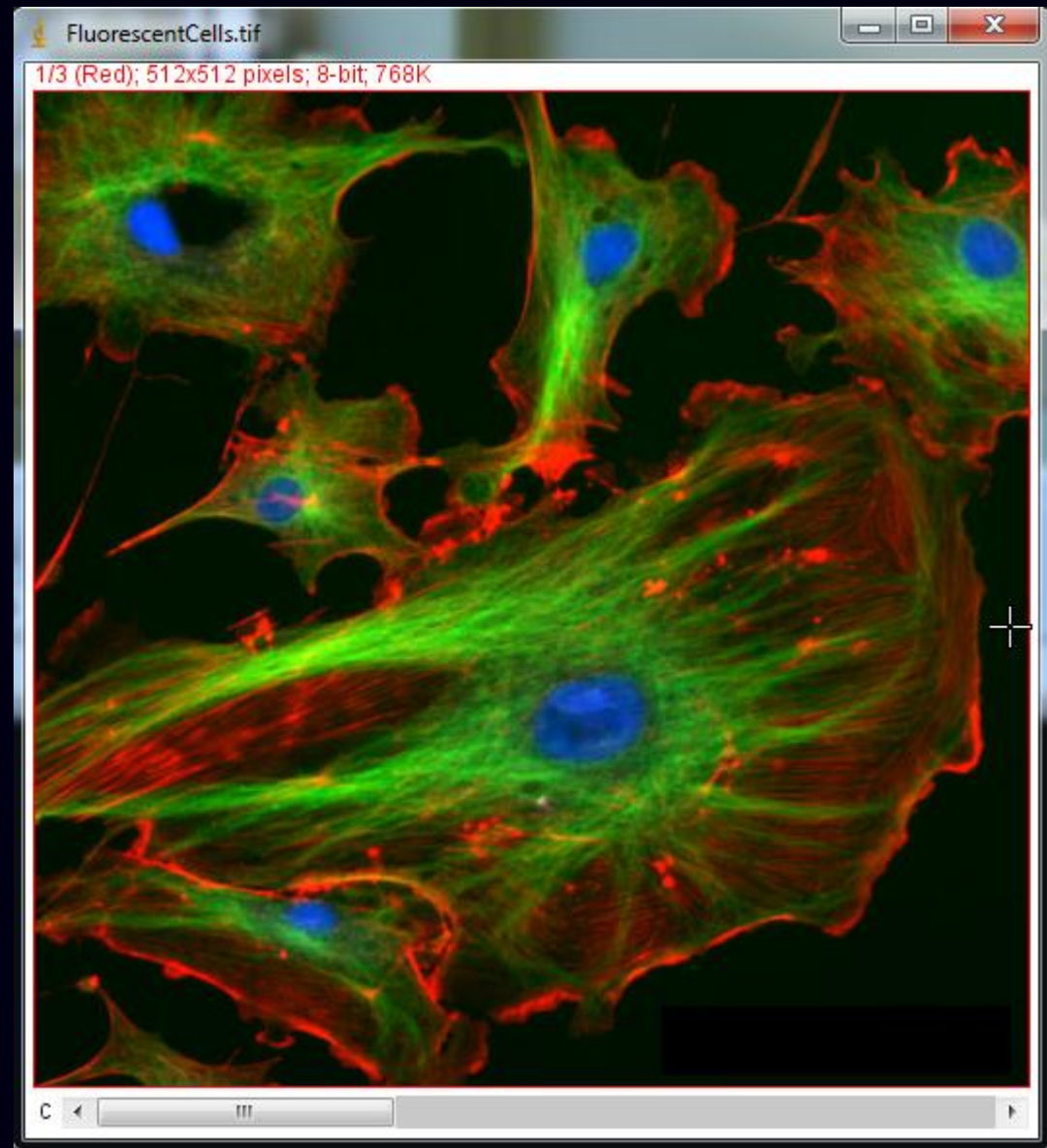




Image Composite





Format d'image

8bit [0,255]

16bit [0,65 535],

32bit [-3.4*10³⁸ , +3.4*10³⁸]

8bit color (LUT)

RGB 24bit [(0.0.0),(255.255.)]

Stack

HyperStack

Format de fichier

RAW : image brute

TIFF : sans perte + metadonnées

JPEG : compression avec perte d'information

LSM : format propriétaire de chez Zeiss

OME-TIFF : format Open Microscopy Environment



Topic 04 – What is a digital image?



L'image numérique

Les Prétraitements

Amélioration de la visualisation

Filtres et opérations

La Segmentation

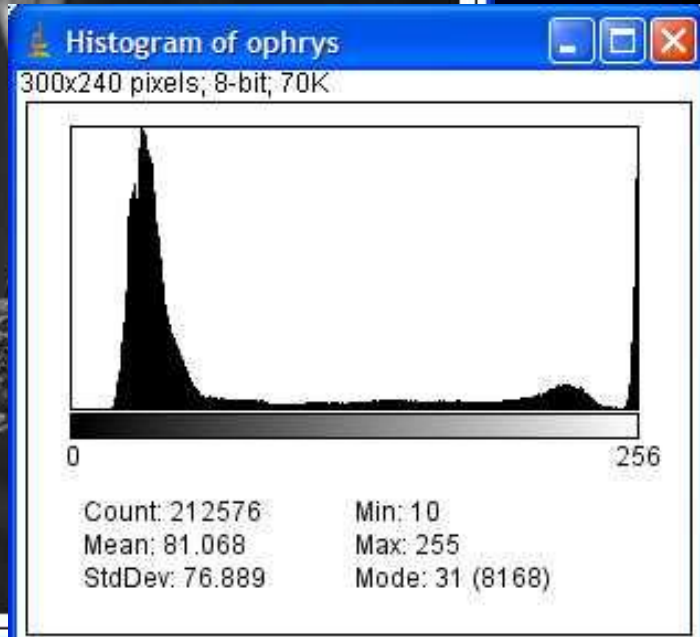
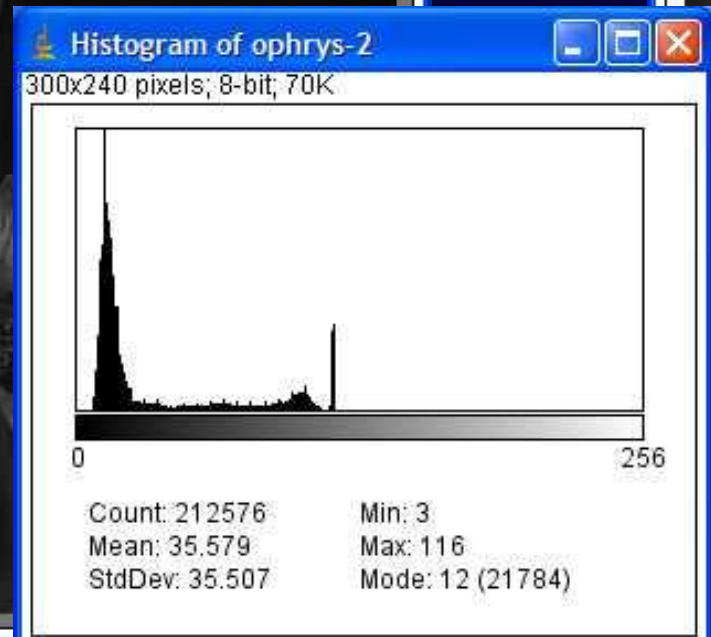
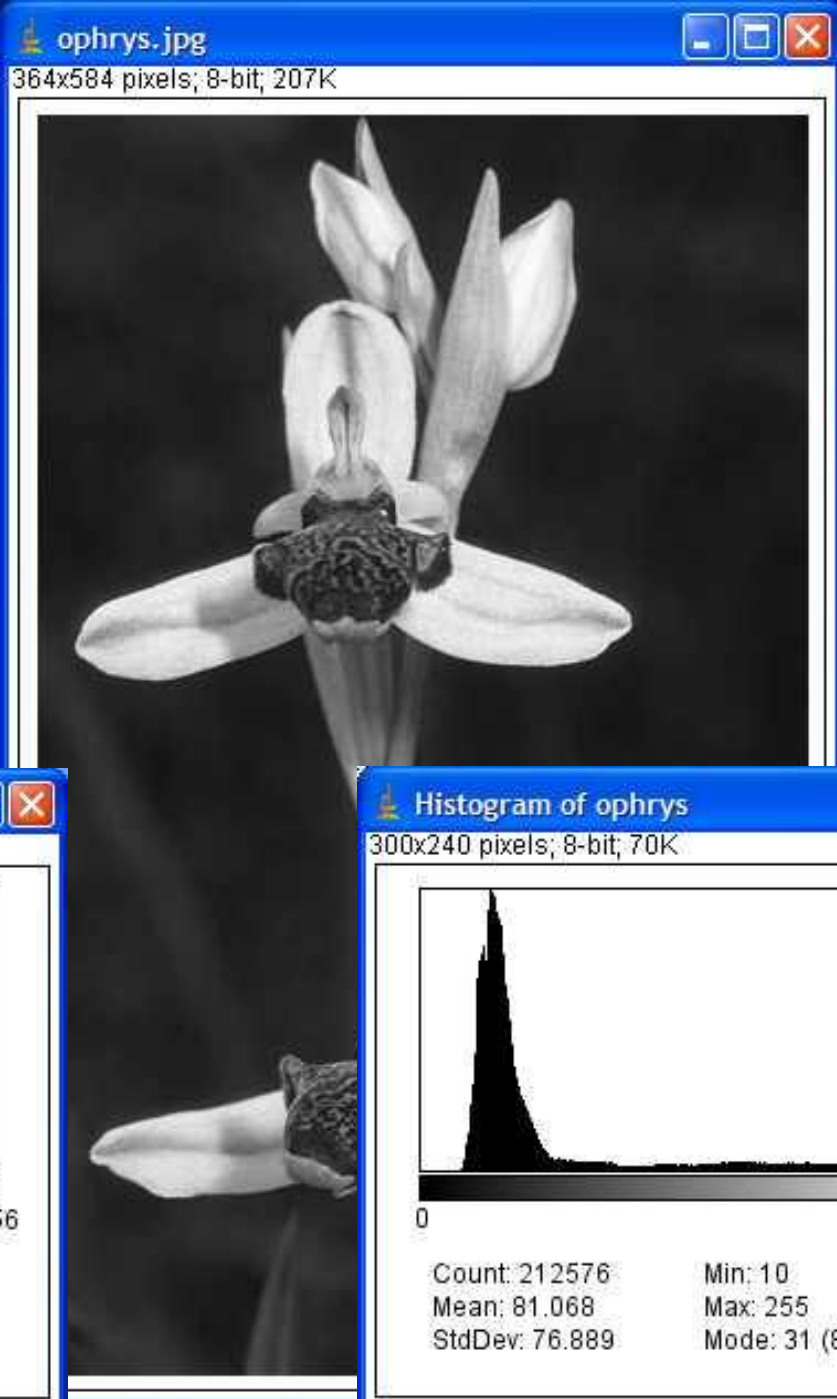
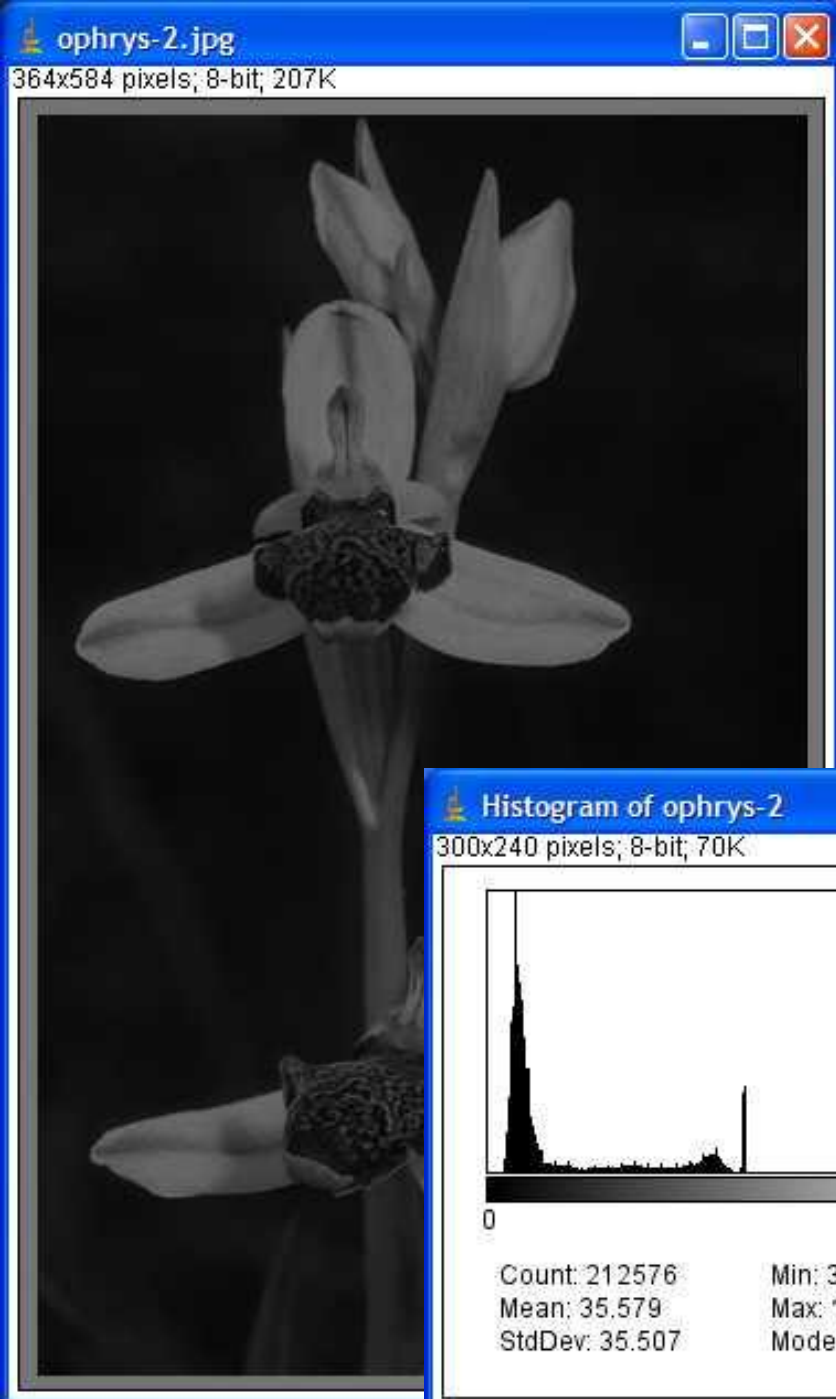
Les Post-traitements

La Quantification



Histogramme

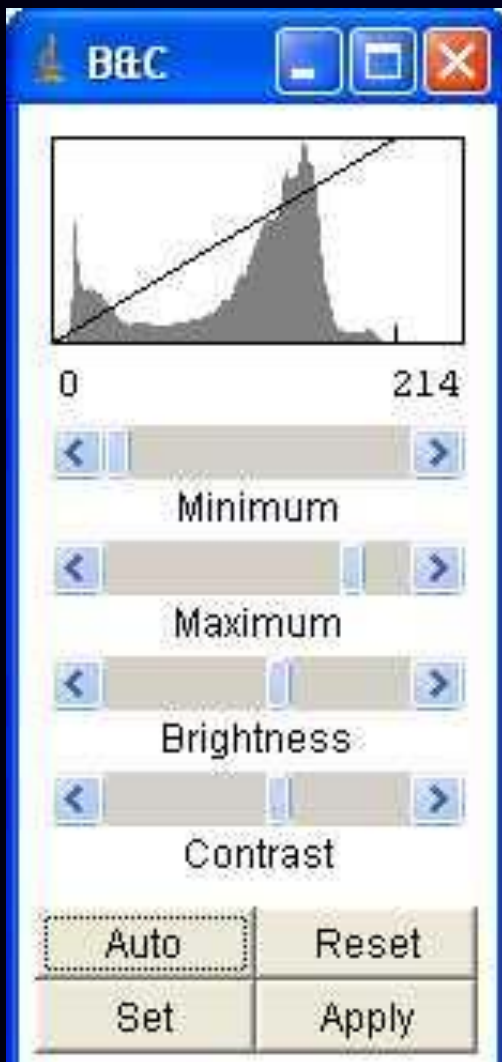
Dynamique = [valeur_mini , valeur_maxi]





Corrections linéaires

Luminosité Contraste



← Mini

← Maxi

← Luminosité

← Contraste

Niveaux

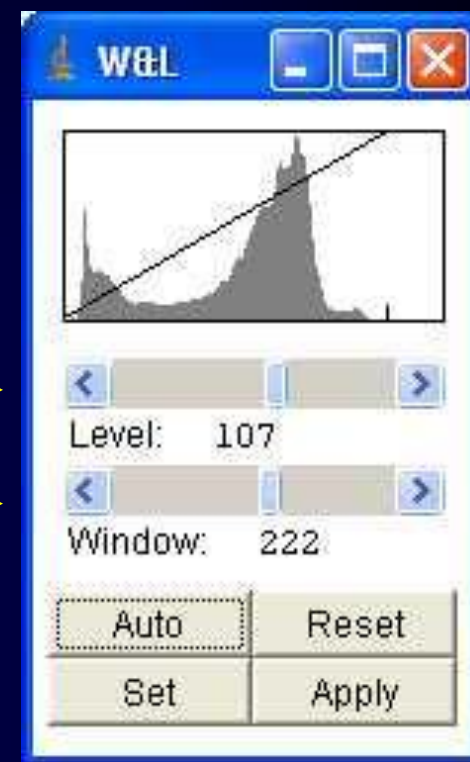


Image → Adjust → Brightness/Contrast...



Correction non linéaire : Egalisation de l'histogramme

Densité de probabilité normalisée pour aplatir l'histogramme



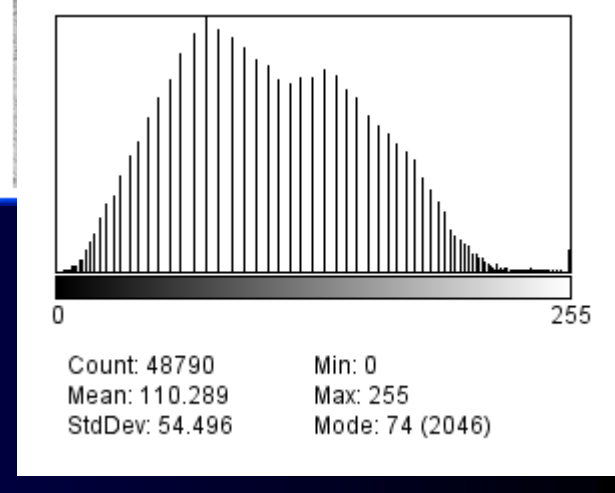
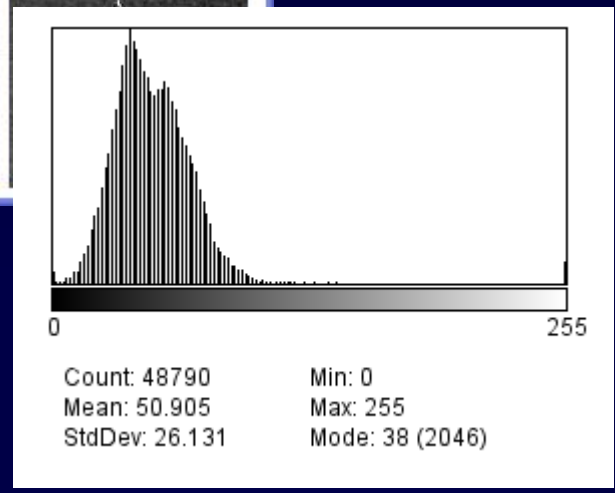
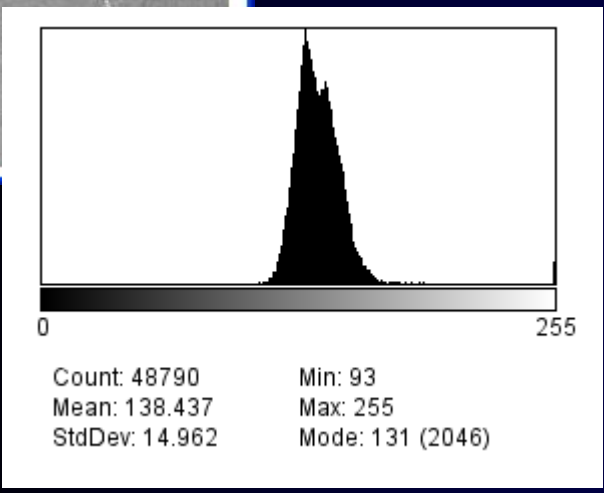
Enhance Contrast

Saturated Pixels: 0.4 %

Normalize

Equalize Histogram

OK Cancel



Normalisation

Egalisation

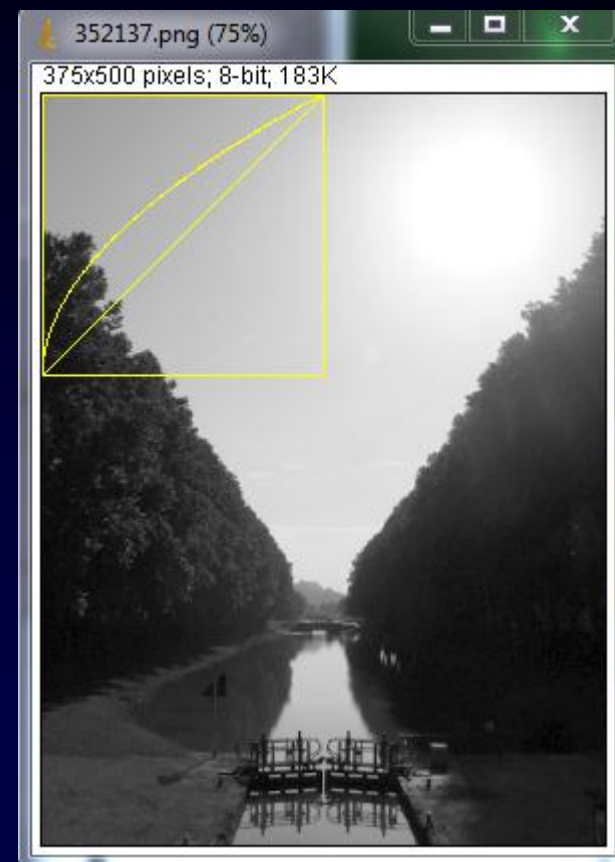
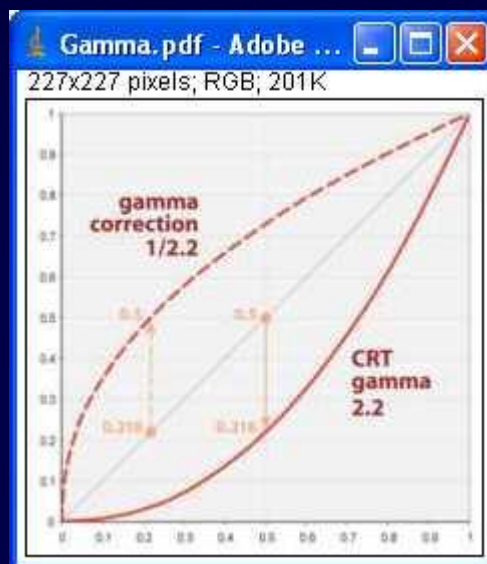
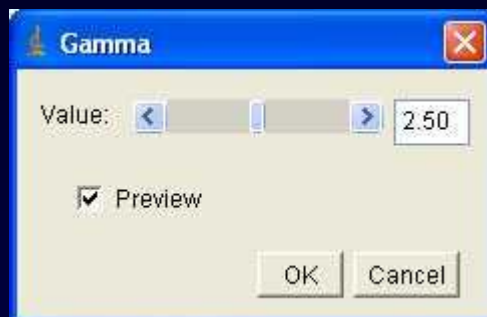
Process → Enhance Contrast



Correction non linéaire du Gamma

$$y = \text{range} * (x / \text{range}) ^ \text{gamma}$$

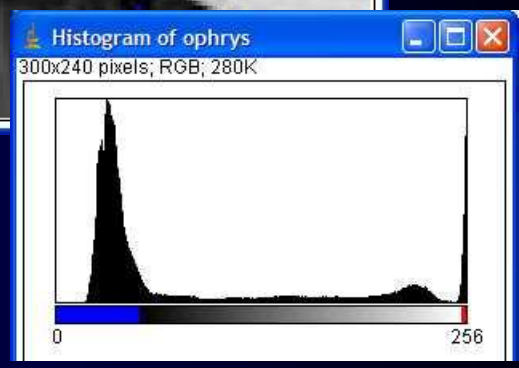
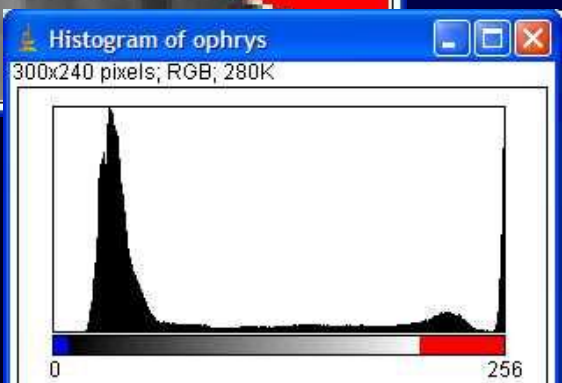
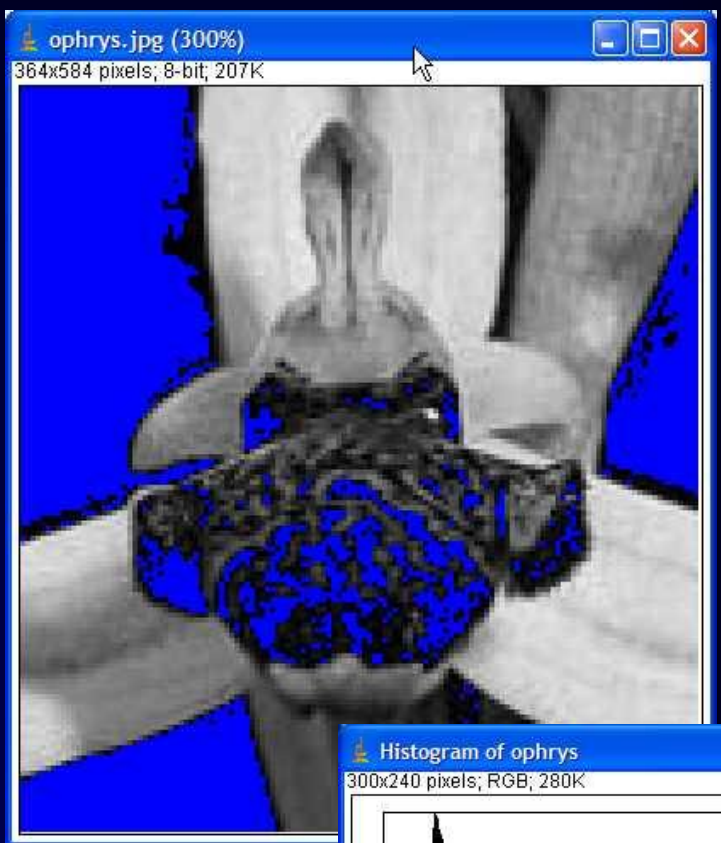
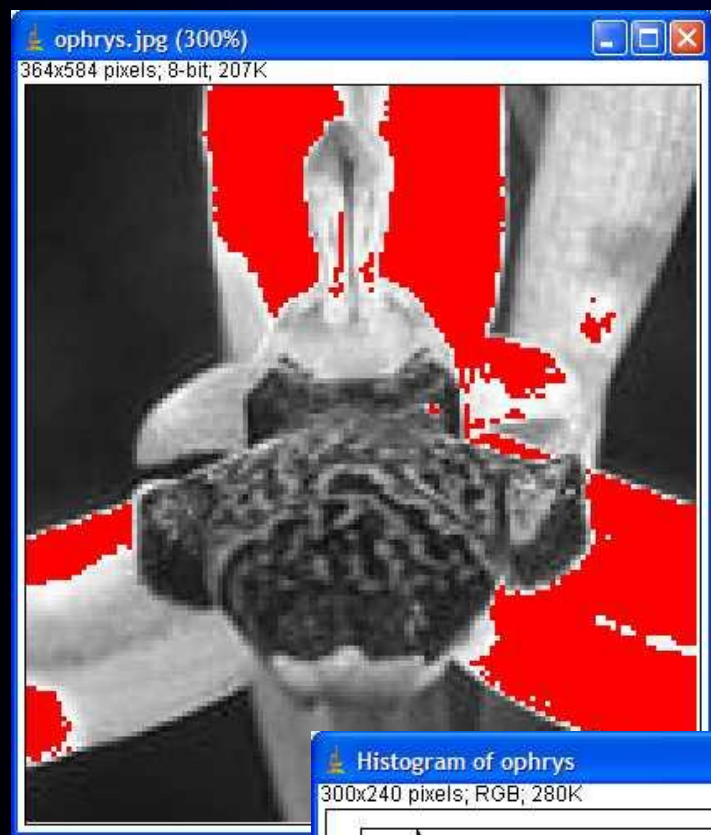
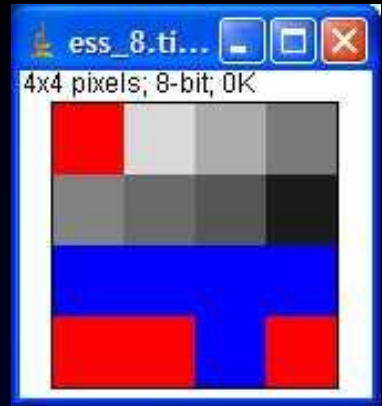
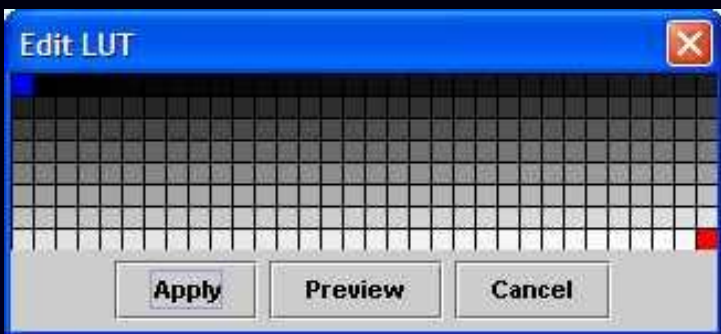
range = gamme de valeurs des pixels de l'image



Process → Math → Gamma...

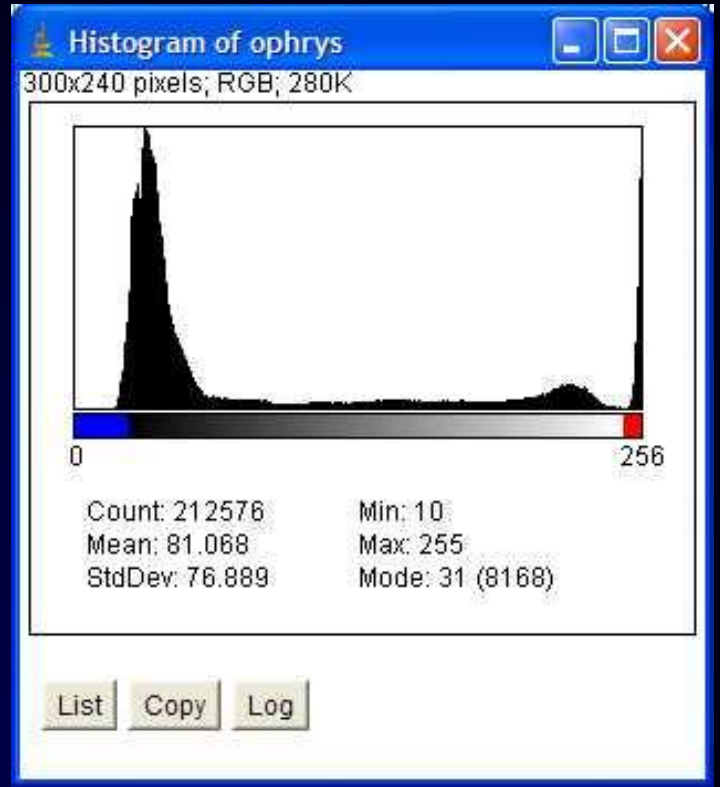
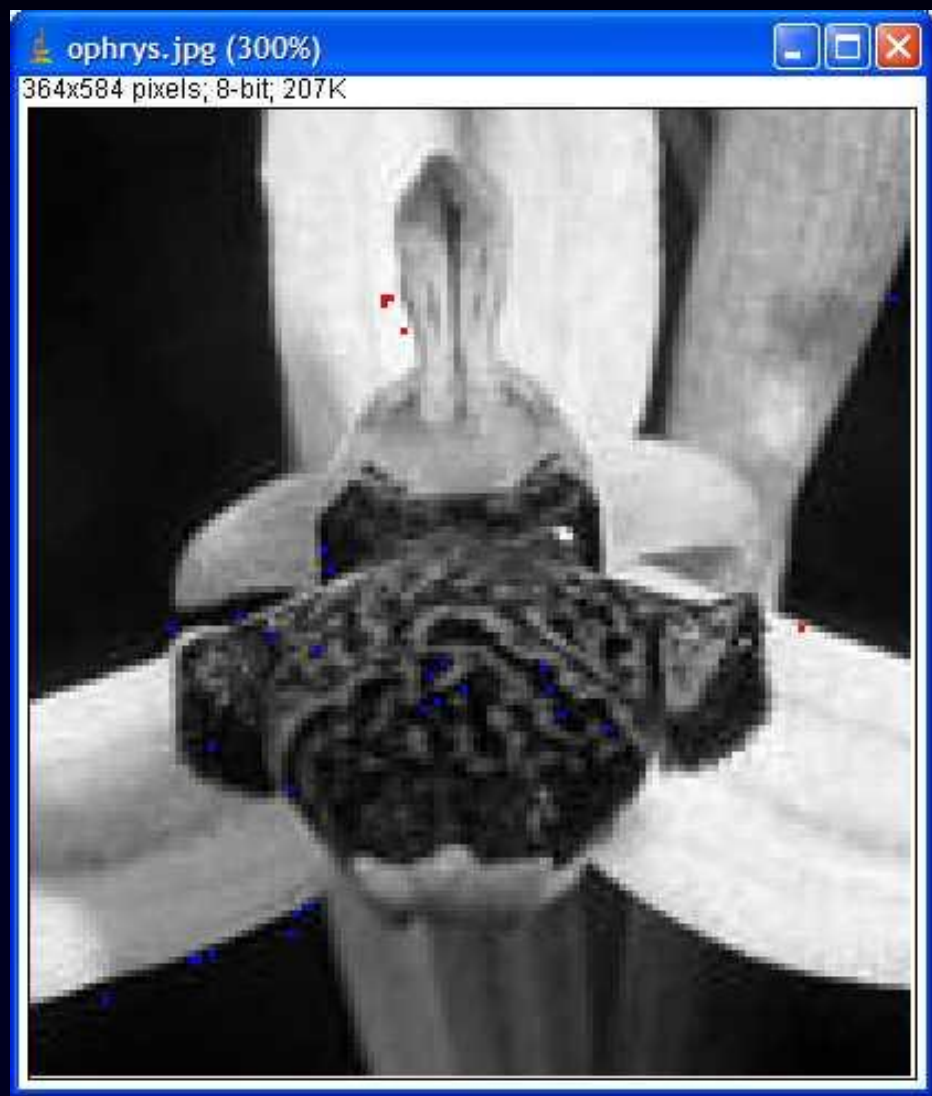


Réglages avec la LUT Hi Lo



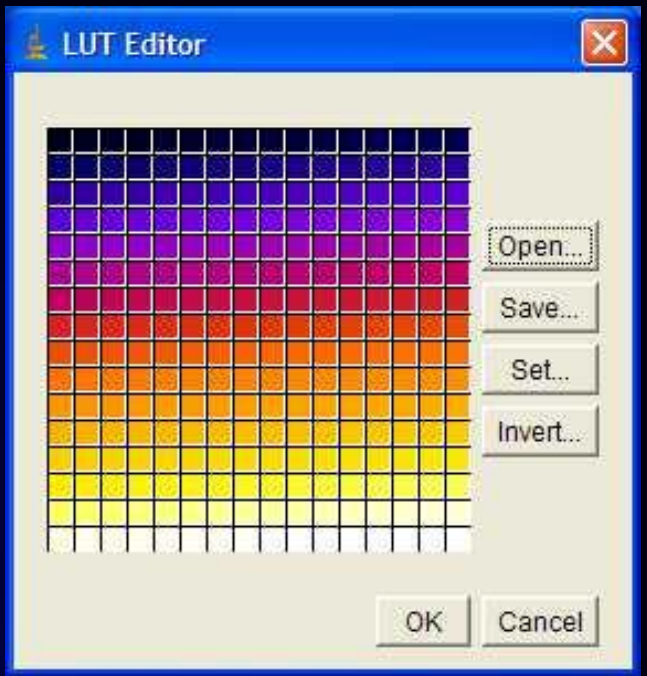
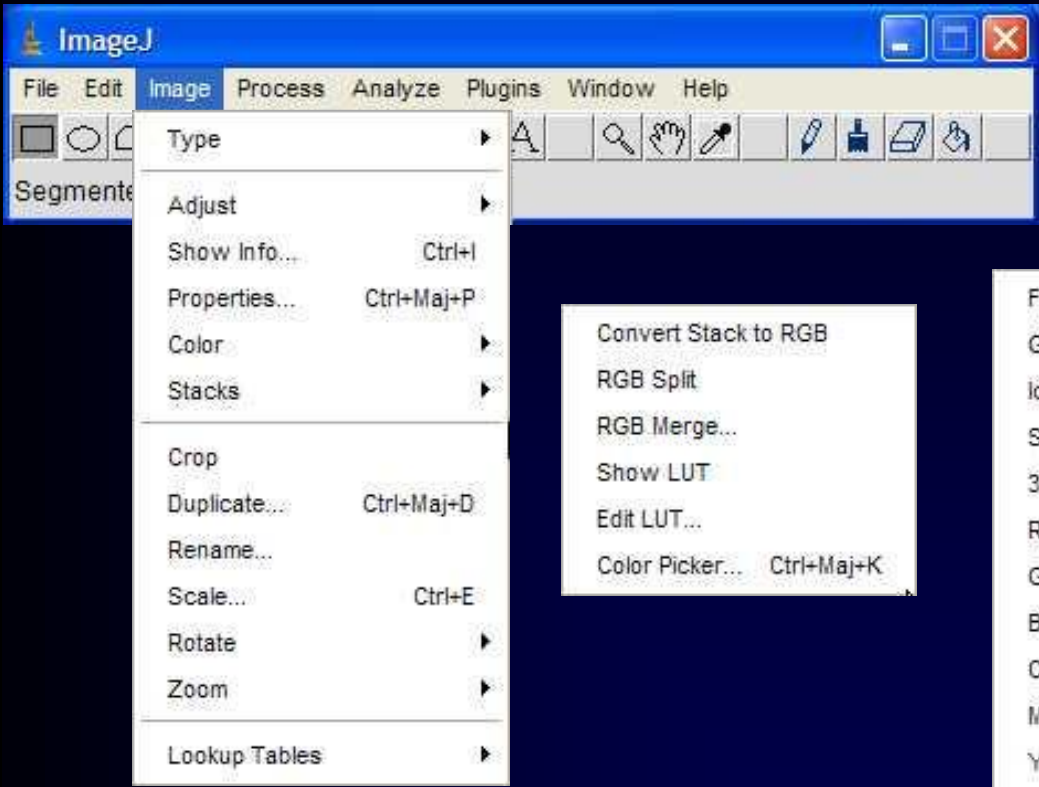


Réglages avec la LUT Hi Lo





Outils LUT dans ImageJ



Réglages d'images composites

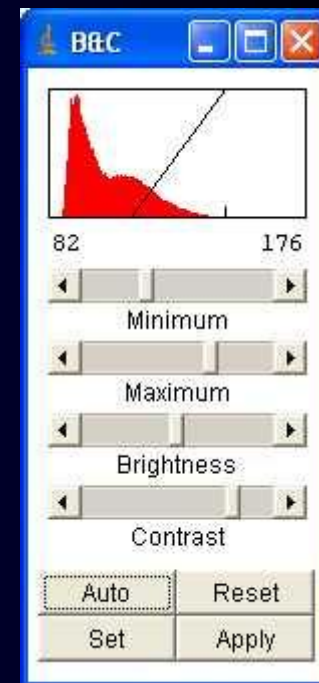
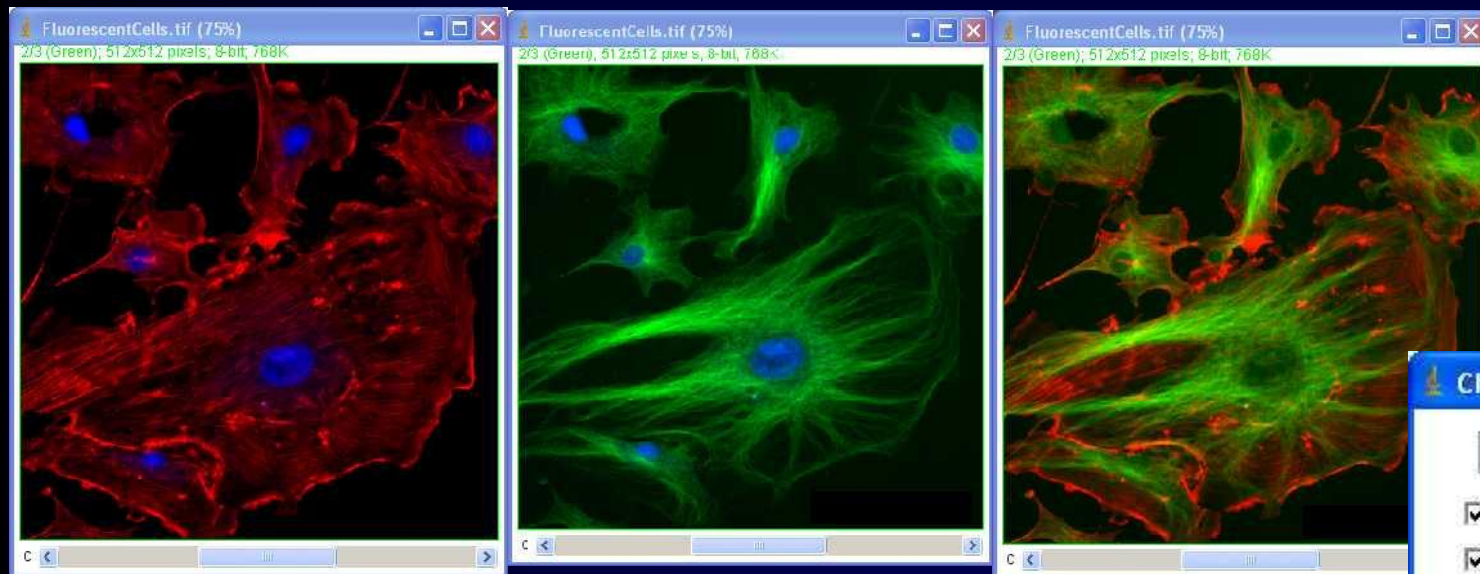
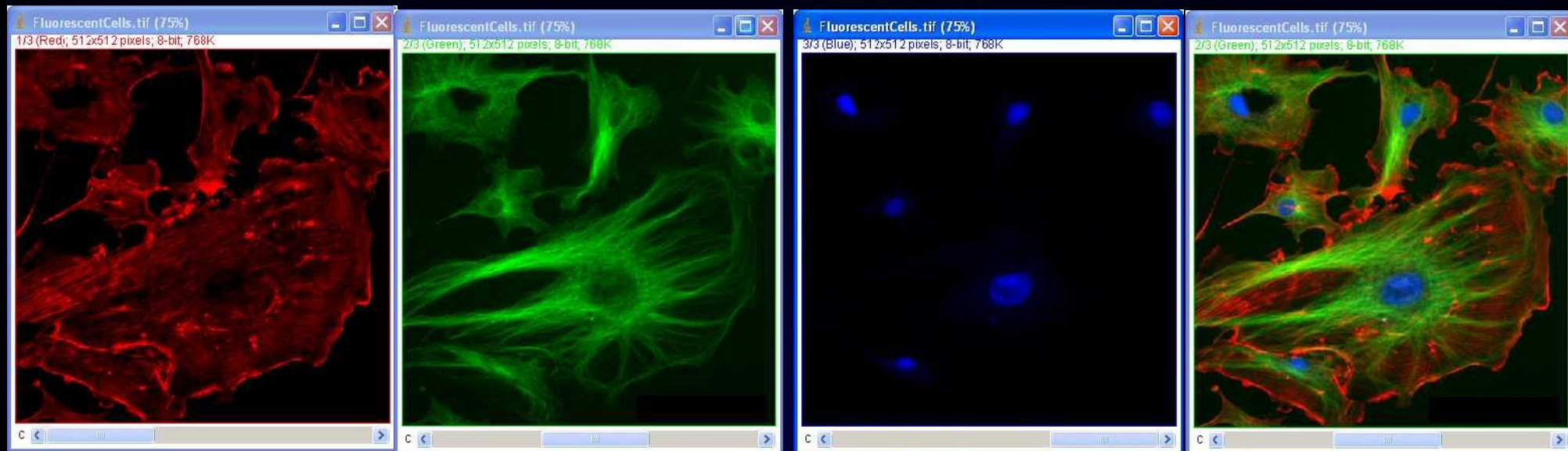


Image → Color → Make Composite



Topic 05 – Brightness and Contrast Adjustment



L'image numérique

Les Prétraitements

Amélioration de la visualisation
Filtres et opérations

La Segmentation

Les Post-traitements

La Quantification



Filtres de convolution

Image source

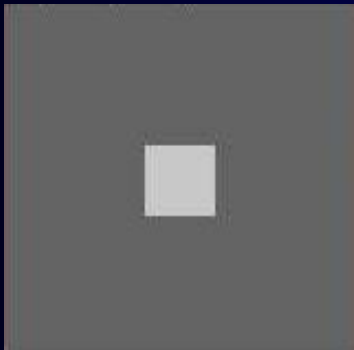
100	100	100	100	100
100	100	100	100	100
100	100	200	100	100
100	100	100	100	100
100	100	100	100	100

Noyau

$$\begin{array}{|c|c|c|} \hline 1 & 1 & 1 \\ \hline 1 & 4 & 1 \\ \hline 1 & 1 & 1 \\ \hline \end{array} =$$

Image résultante

100	100	100	100	100
100				100
100				100
100				100
100	100	100	100	100





Filtres de convolution

Image source

100	100	100	100	100
100	100	100	100	100
100	100	200	100	100
100	100	100	100	100
100	100	100	100	100

Noyau

1	1	1
1	4	1
1	1	1

Image résultante

100	100	100	100	100
100	108			100
100				100
100				100
100	100	100	100	100

100*1	100*1	100*1
100*1	100*4	100*1
100*1	100*1	200*1

Somme / 12 = 108



Filtres de convolution

Image source

100	100	100	100	100
100	100	100	100	100
100	100	200	100	100
100	100	100	100	100
100	100	100	100	100

Noyau

1	1	1
1	4	1
1	1	1

Image résultante

100	100	100	100	100
100	108	108		100
100				100
100				100
100	100	100	100	100

100*1	100*1	100*1
100*1	100*4	100*1
100*1	200*1	100*1

Somme / 12 = 108



Filtres de convolution

Image source

100	100	100	100	100
100	100	100	100	100
100	100	200	100	100
100	100	100	100	100
100	100	100	100	100

Noyau

1	1	1
1	4	1
1	1	1

Image résultante

100	100	100	100	100
100	108	108	108	100
100				100
100				100
100	100	100	100	100

100*1	100*1	100*1
100*1	100*4	100*1
200*1	100*1	100*1

Somme / 12 = 108



Filtres de convolution

Image source

100	100	100	100	100
100	100	100	100	100
100	100	200	100	100
100	100	100	100	100
100	100	100	100	100

Noyau

1	1	1
1	4	1
1	1	1

Image résultante

100	100	100	100	100
100	108	108	108	100
100	108			100
100				100
100	100	100	100	100

100*1	100*1	100*1
100*1	100*4	200*1
100*1	100*1	100*1

Somme / 12 = 108



Filtres de convolution

Image source

100	100	100	100	100
100	100	100	100	100
100	100	200	100	100
100	100	100	100	100
100	100	100	100	100

Noyau

1	1	1
1	4	1
1	1	1

Image résultante

100	100	100	100	100
100	108	108	108	100
100	108	133		100
100				100
100	100	100	100	100

100*1	100*1	100*1
100*1	200*4	100*1
100*1	100*1	100*1

Somme / 12 = 133



Filtres de convolution

Image source

100	100	100	100	100
100	100	100	100	100
100	100	200	100	100
100	100	100	100	100
100	100	100	100	100

Noyau

1	1	1
1	4	1
1	1	1

Image résultante

100	100	100	100	100
100	108	108	108	100
100	108	133	108	100
100				100
100	100	100	100	100

100*1	100*1	100*1
200*1	100*4	100*1
100*1	100*1	100*1

Somme / 12 = 108



Filtres de convolution

Image source

100	100	100	100	100
100	100	100	100	100
100	100	200	100	100
100	100	100	100	100
100	100	100	100	100

Noyau

1	1	1
1	4	1
1	1	1

Image résultante

100	100	100	100	100
100	108	108	108	100
100	108	133	108	100
100	108			100
100	100	100	100	100

100*1	100*1	200*1
100*1	100*4	100*1
100*1	100*1	100*1

Somme / 12 = 108



Filtres de convolution

Image source

100	100	100	100	100
100	100	100	100	100
100	100	200	100	100
100	100	100	100	100
100	100	100	100	100

Noyau

1	1	1
1	4	1
1	1	1

Image résultante

100	100	100	100	100
100	108	108	108	100
100	108	133	108	100
100	108	108		100
100	100	100	100	100

100*1	200*1	100*1
100*1	100*4	100*1
100*1	100*1	100*1

Somme / 12 = 108



Filtres de convolution

Image source

100	100	100	100	100
100	100	100	100	100
100	100	200	100	100
100	100	100	100	100
100	100	100	100	100

Noyau

1	1	1
1	4	1
1	1	1

Image résultante

100	100	100	100	100
100	108	108	108	100
100	108	133	108	100
100	108	108	108	100
100	100	100	100	100

200*1	100*1	100*1
100*1	100*4	100*1
100*1	100*1	100*1

Somme / 12 = 108



Filtres de convolution

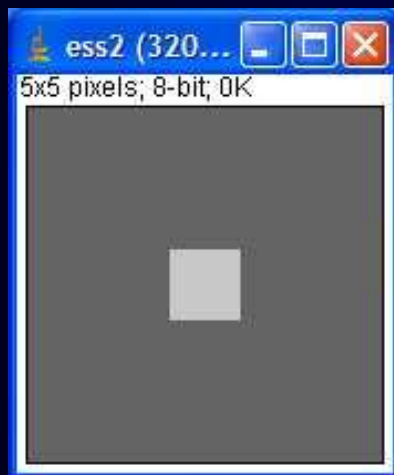
100	100	100	100	100
100	100	100	100	100
100	100	200	100	100
100	100	100	100	100
100	100	100	100	100

*

1	1	1
1	4	1
1	1	1

=

100	100	100	100	100
100	108	108	108	100
100	108	133	108	100
100	108	108	108	100
100	100	100	100	100



👉 Le résultat d'un tel filtrage est un lissage de l'image, il s'agit d'un **filtre passe-bas**.



Filtres de convolution

Noyau

1	1	1
1	4	1
1	1	1

$$\Sigma=12$$

Image source

100	100	100	100
100	100	100	100
100	100	200	100
100	100	100	100

Produits du noyau et de la source

$100 \cdot 1$	$100 \cdot 1$	$100 \cdot 1$
$100 \cdot 1$	$200 \cdot 4$	$100 \cdot 1$
$100 \cdot 1$	$100 \cdot 1$	$100 \cdot 1$

$$\Sigma=1600$$

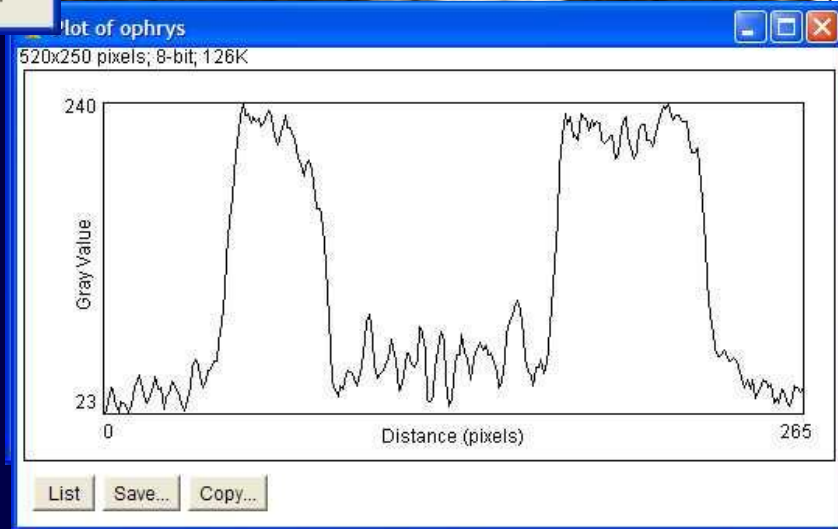
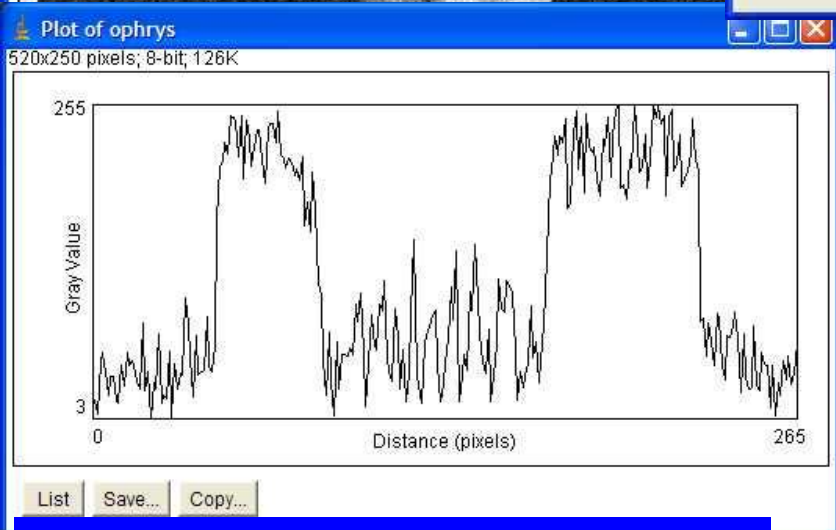
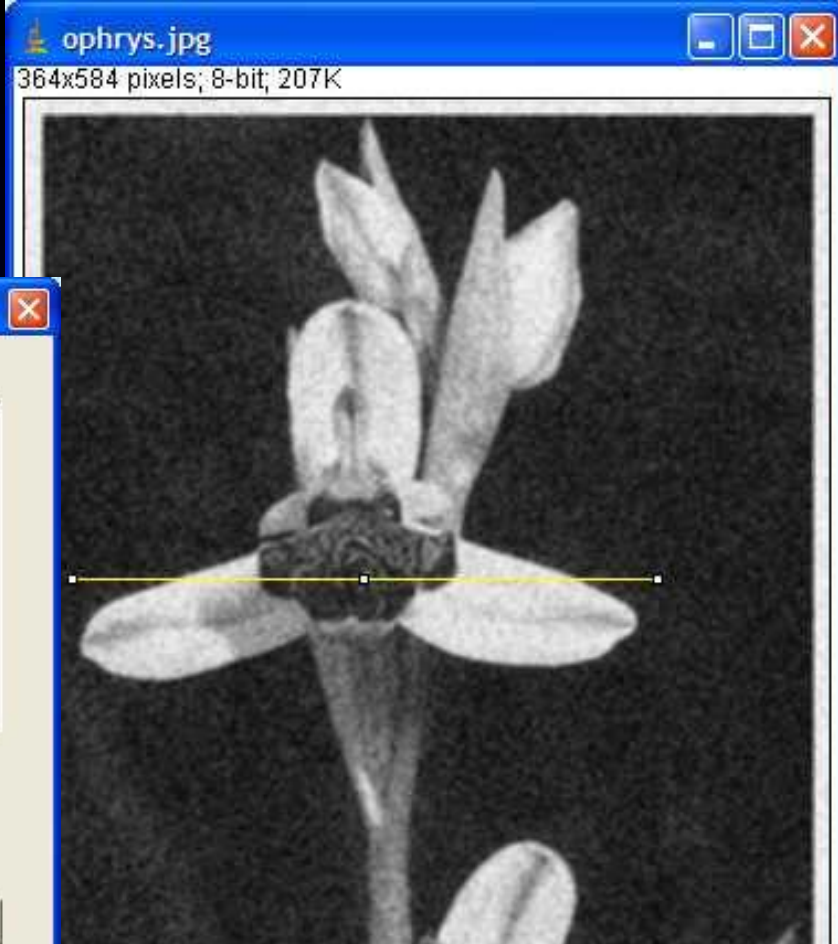
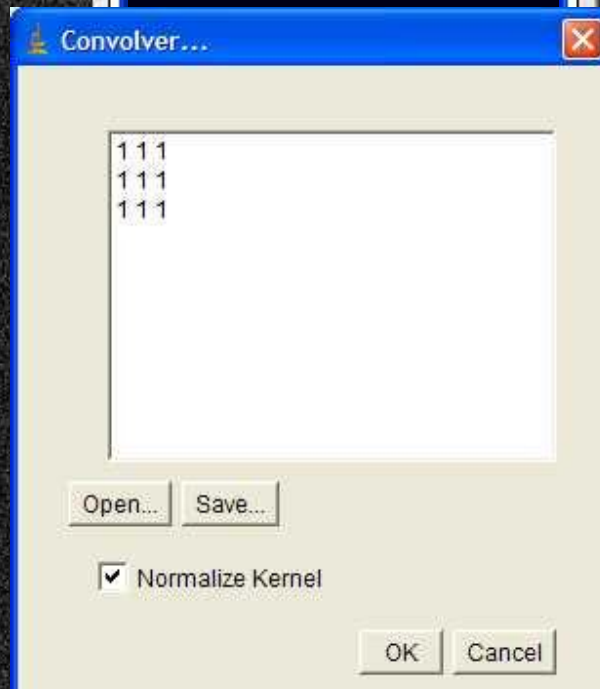
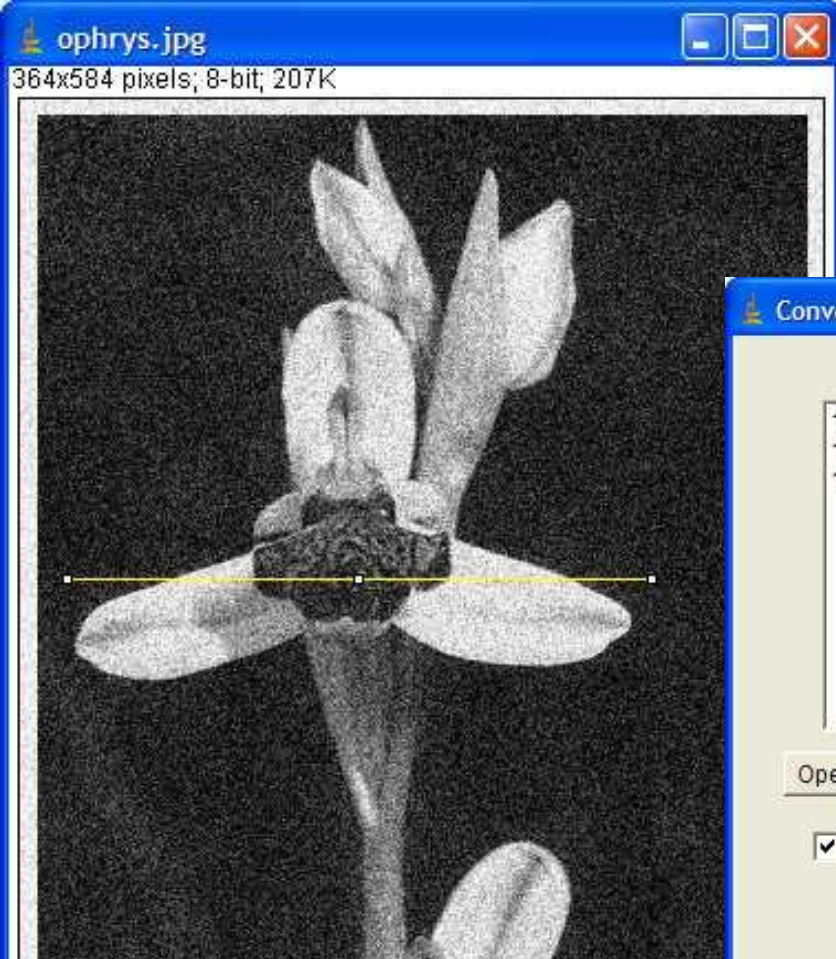
Image résultante

100	100	100	100
100	108	108	100
100	108	133	100
100	100	100	100

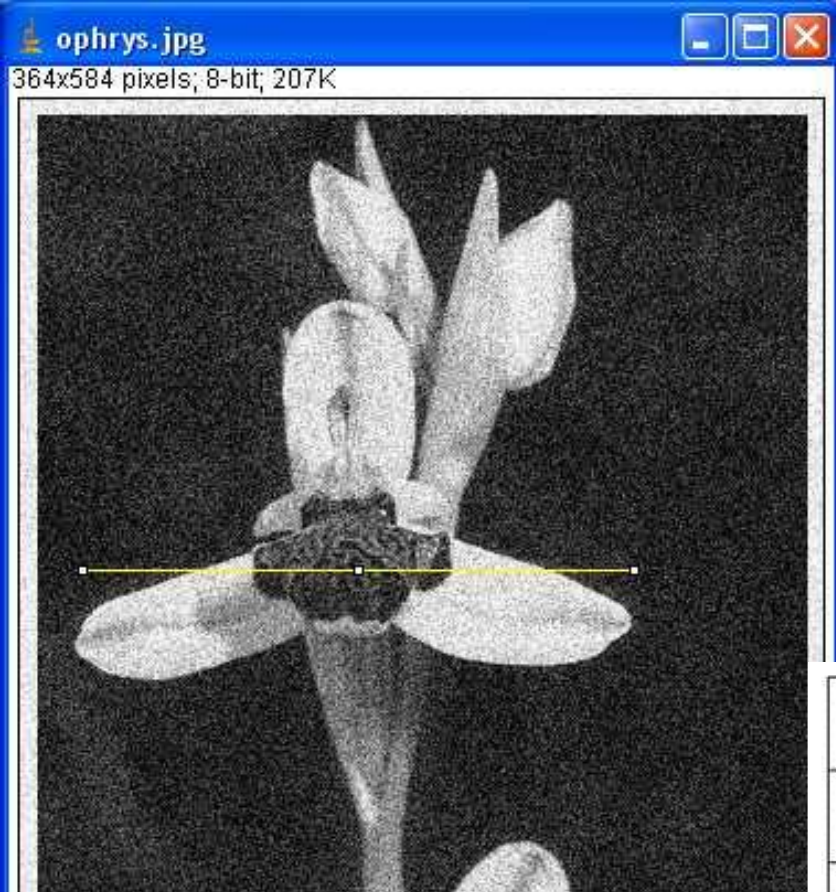
Le pixel cible prend la valeur de la somme des produits normalisée

$$1600/12=133$$

Filtre passe-bas moyen



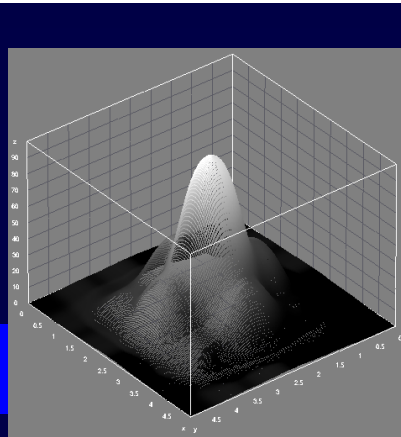
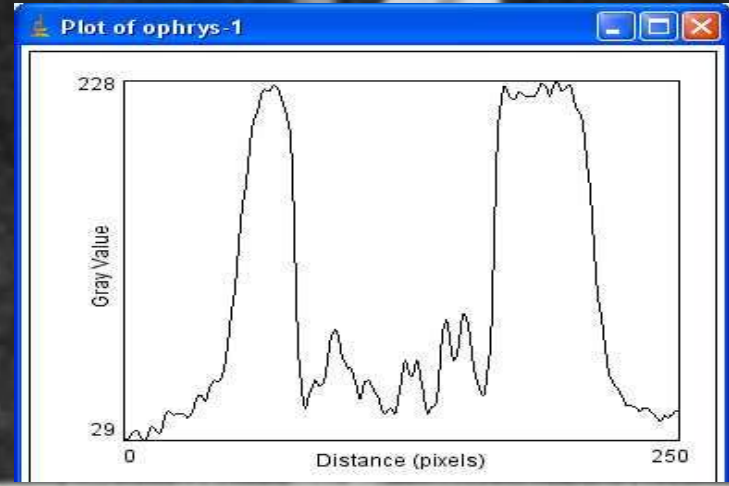
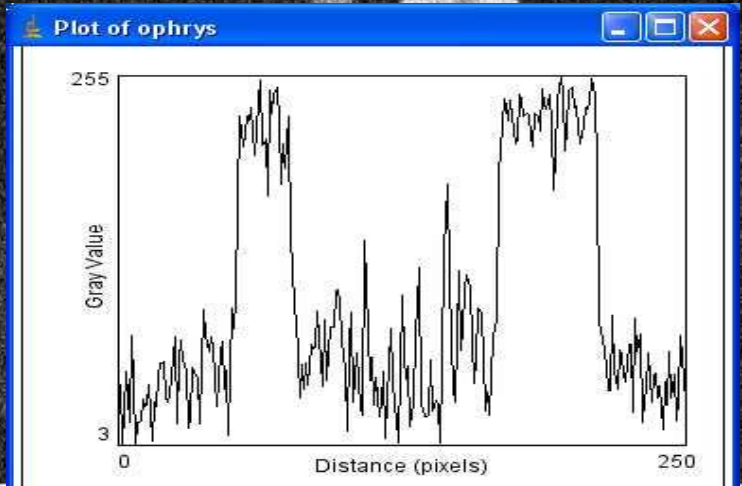
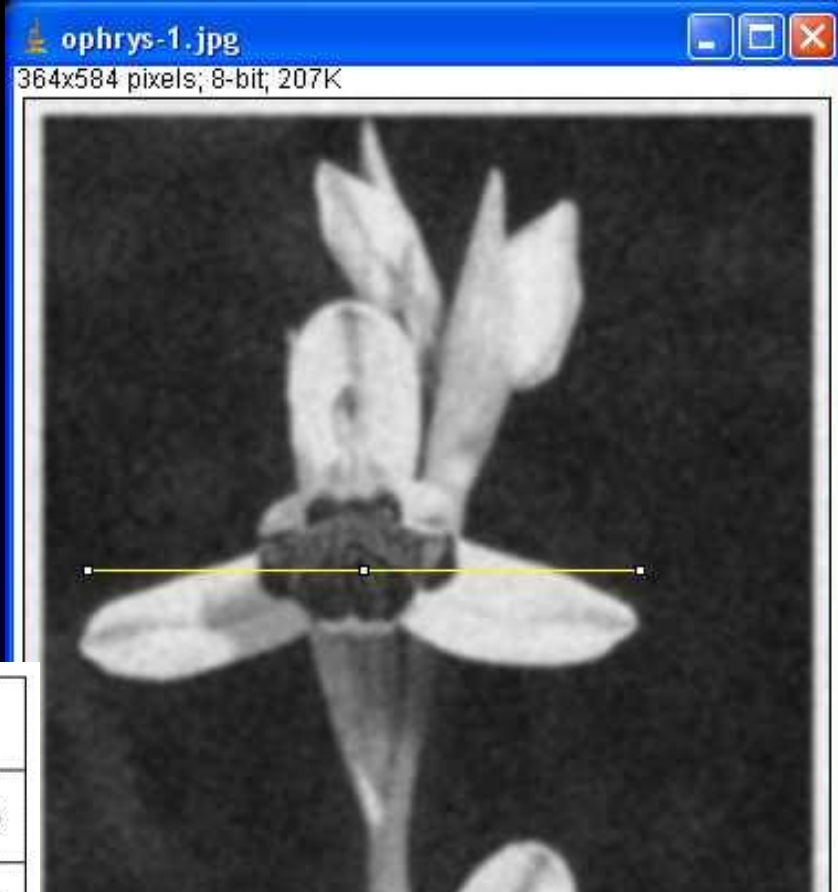
Process → Filters → Convolve...



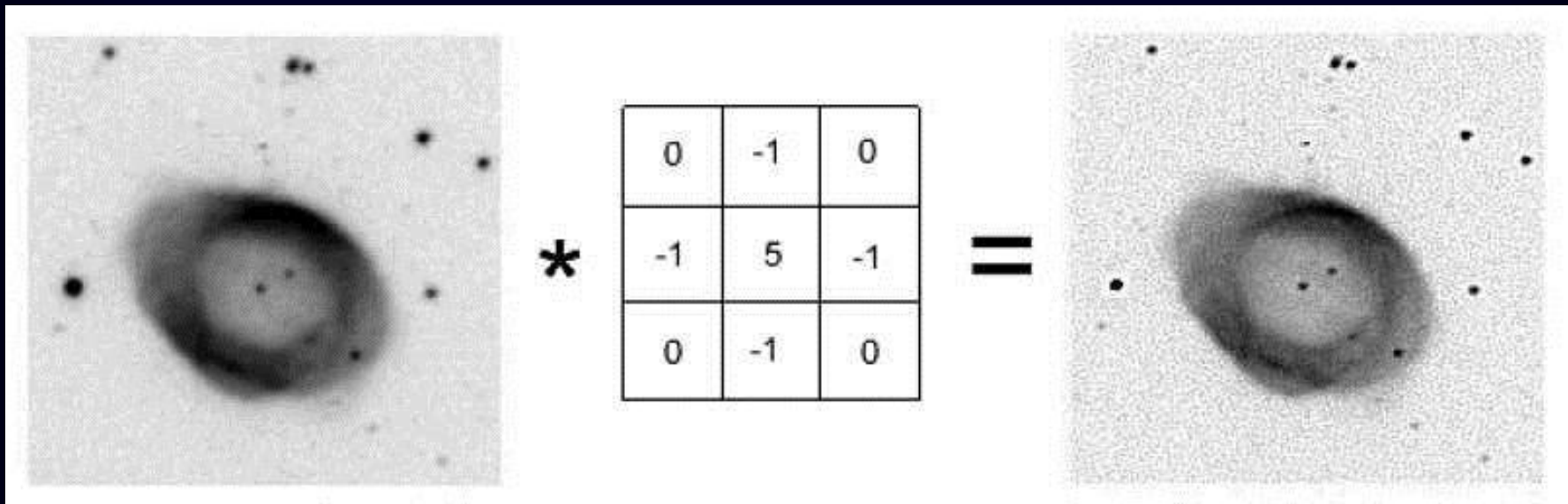
Filtre Gaussien



0	0.6	1.7	0.6	0
0.6	13	36	13	0.6
1.7	36	100	36	1.7
0.6	13	36	13	0.6
0	0.6	1.7	0.6	0



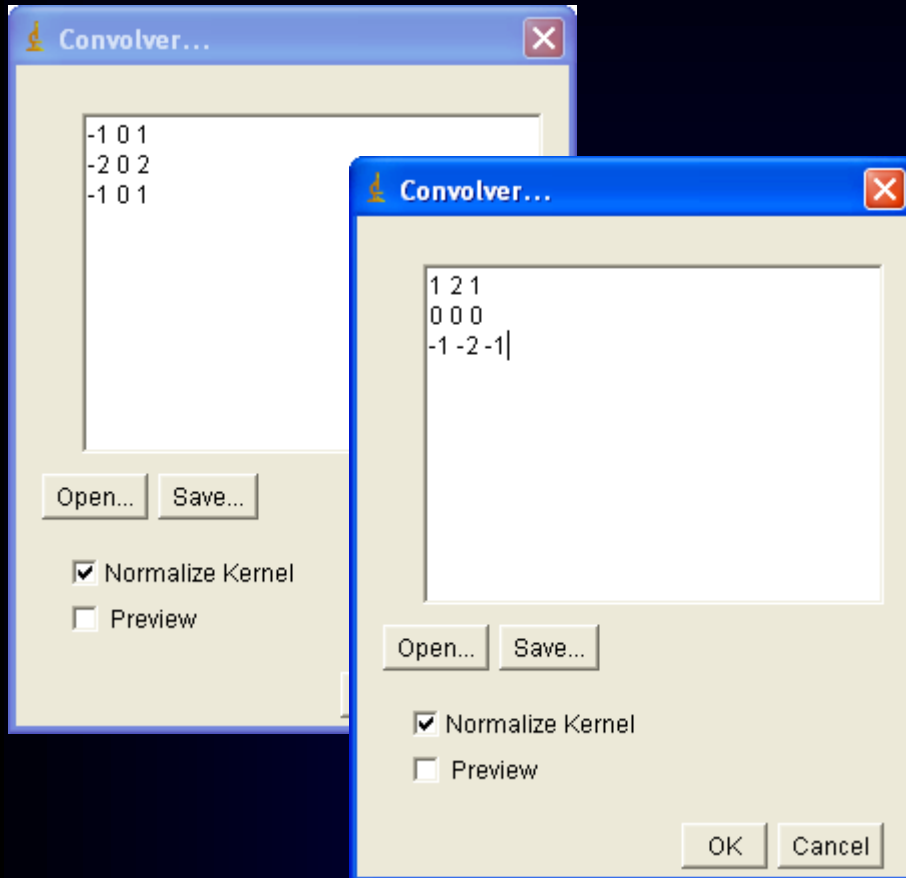
Process → Filters → Gaussian Blur.



Le résultat est une accentuation des détails et du contraste mais aussi une augmentation du bruit



Filtre Détection de bords



Les images sont convoluées
par les filtres de Sobel
Le résultat est la racine carrée
de la somme des carrés des images

Process → Finds Edges


$$\sqrt{D_x^2 + D_y^2}$$



Filtre non linéaire : le filtre médian

Un filtre médian affecte au pixel central la valeur médiane de la série :

15	18	14
29	27	13
12	19	21

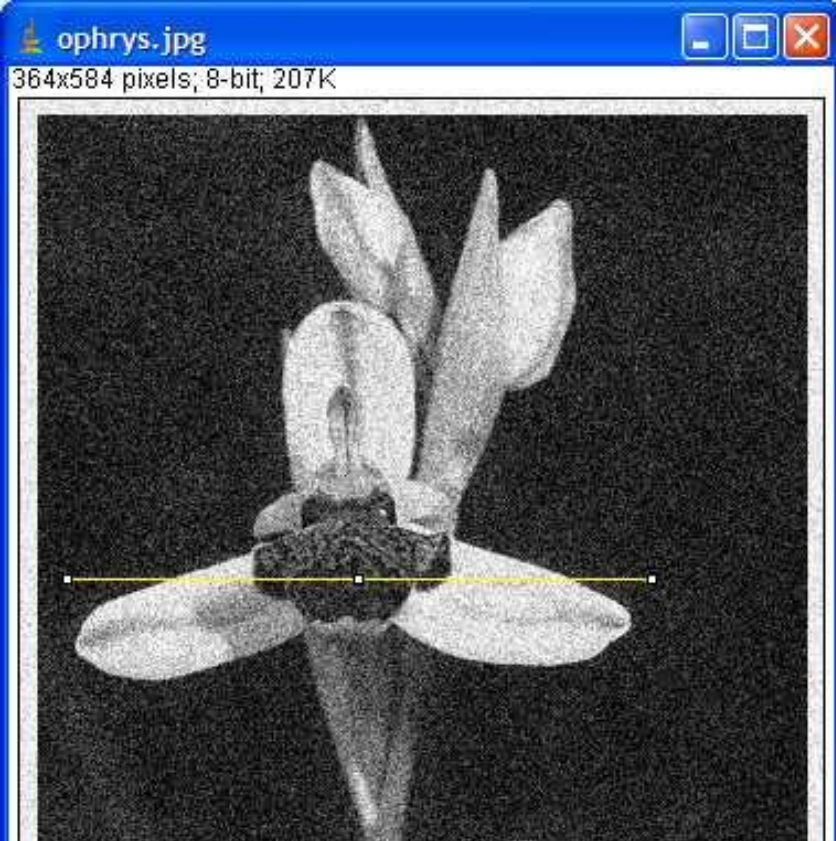


15	18	14
29	18	13
12	19	21

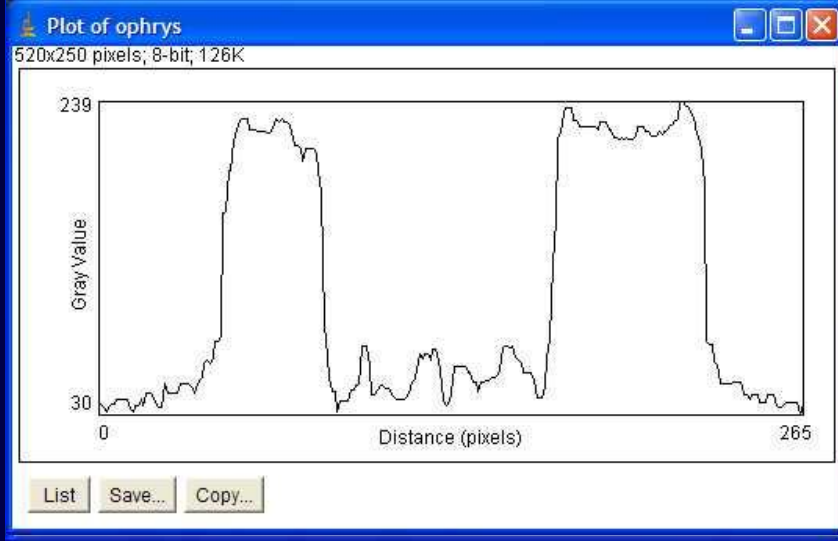
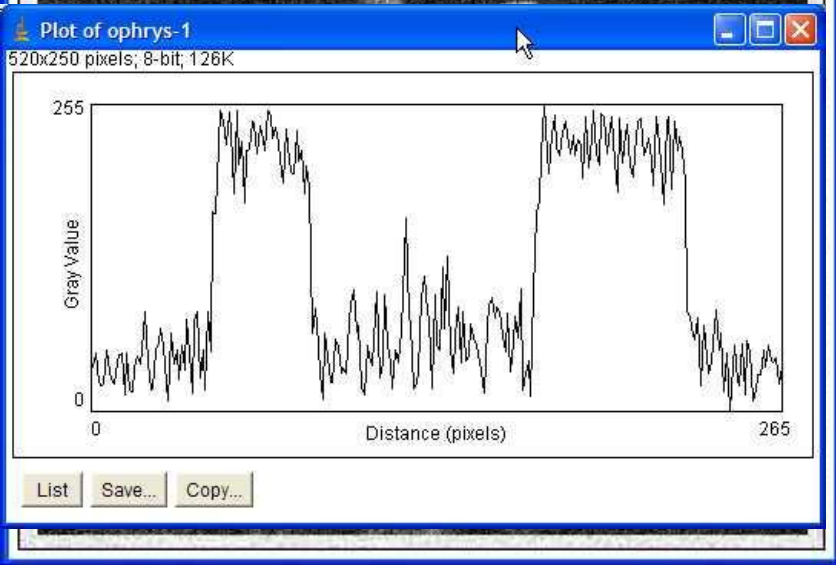
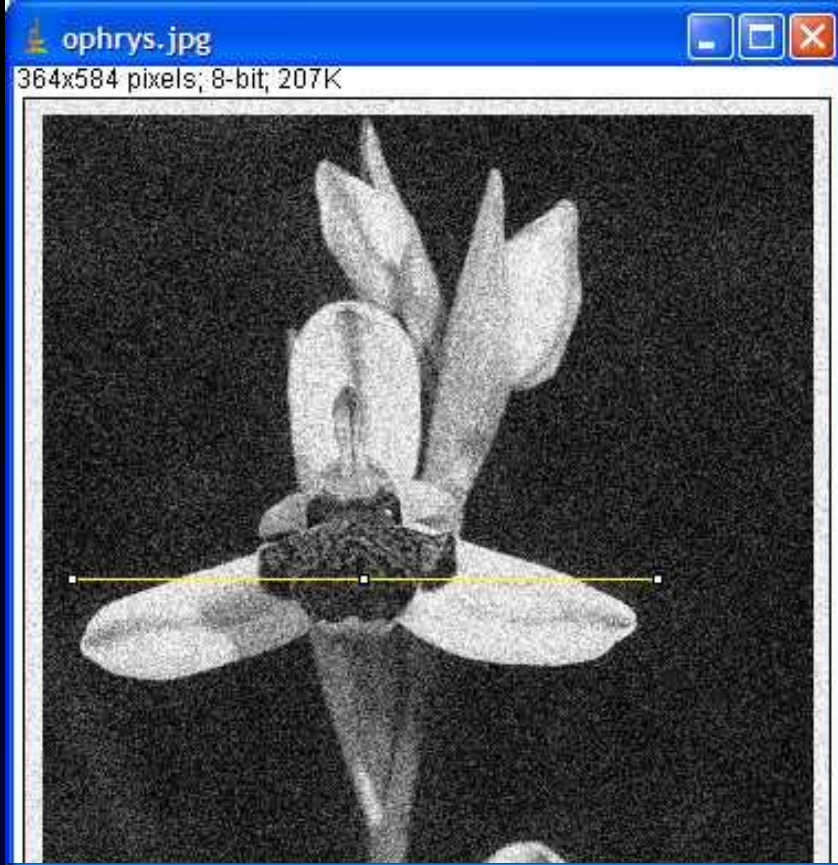
La valeur médiane de : 12,13,14,15,18,19,21,27,29 est **18**.

Filtre min → **12**

Filtre max → **27**



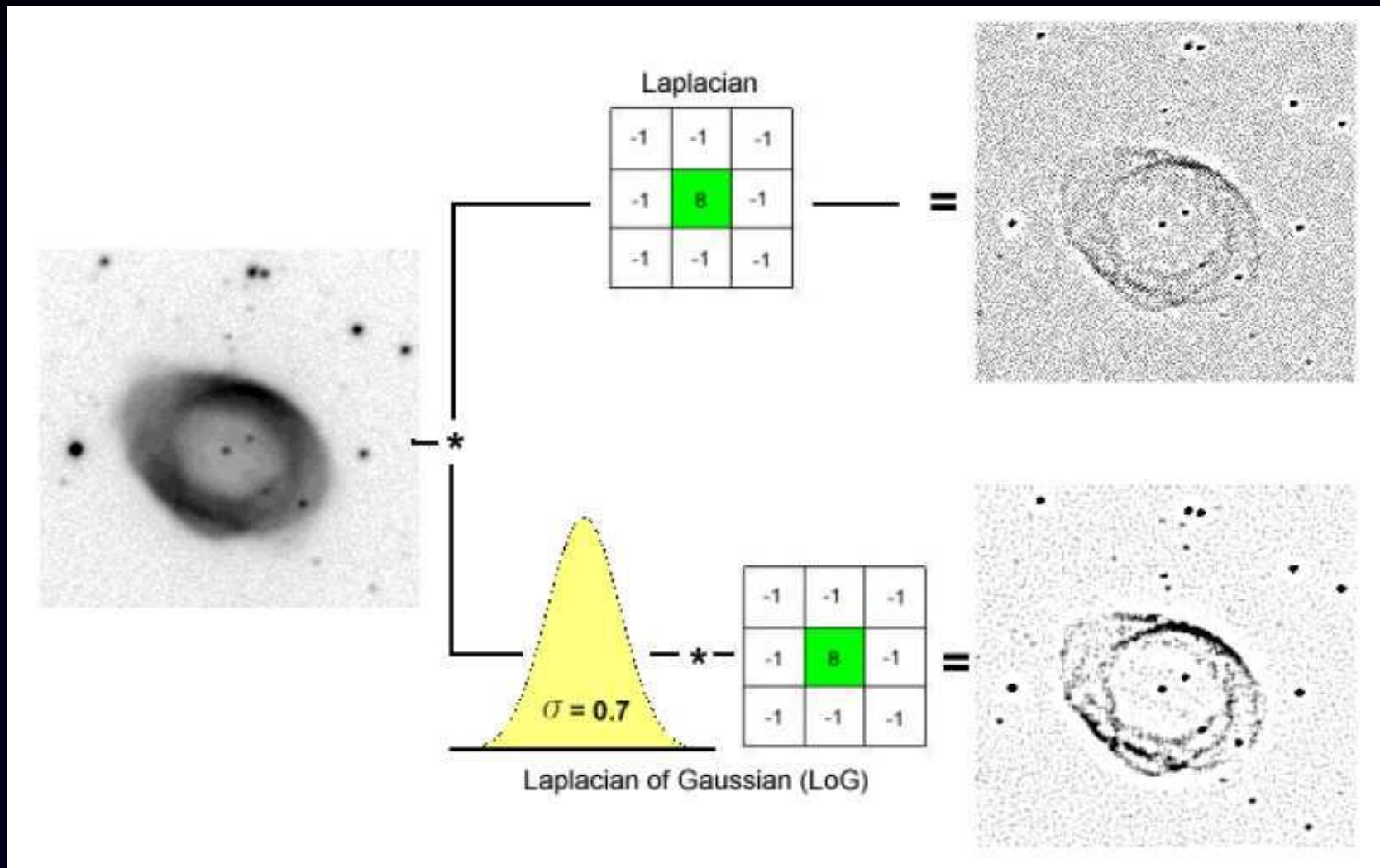
Filtre médian



Process → Filters → Median...



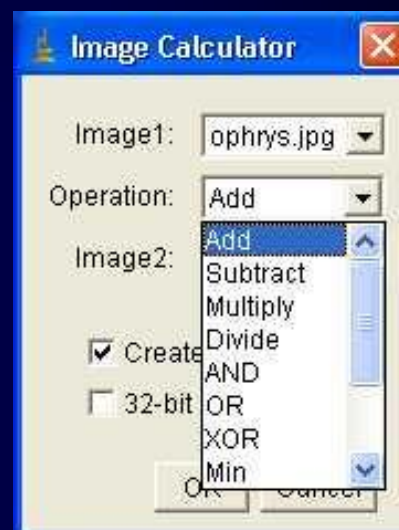
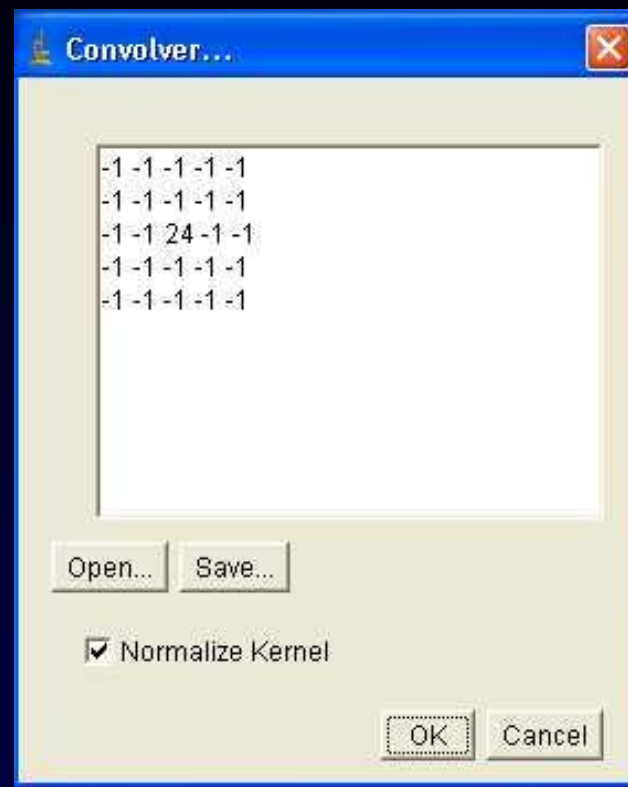
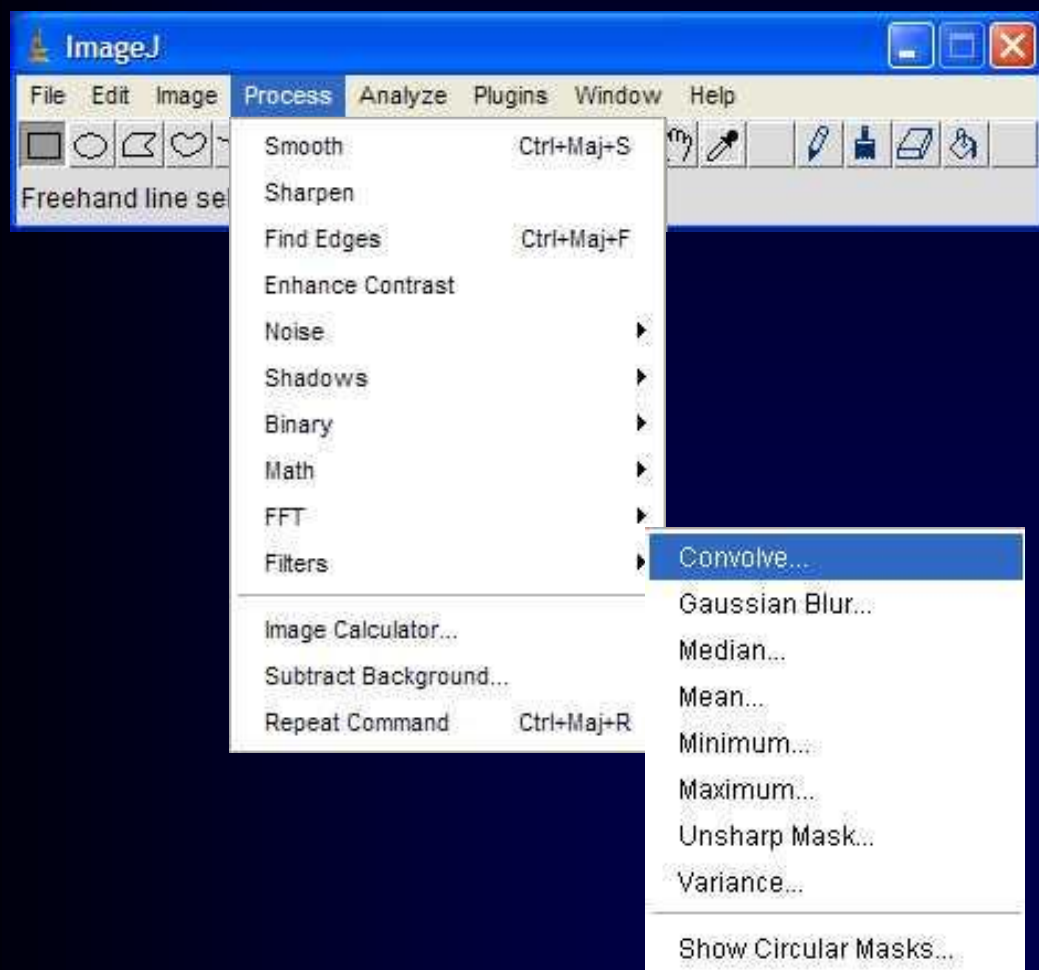
Combinaison Gaussien Laplacien



Les propriétés de réduction de bruit des filtres Gaussiens peuvent être utilisées en combinaisons avec d'autres filtres qui au contraire génèrent du bruit, comme les filtres Laplaciens. On peut par exemple choisir d'appliquer d'abord un filtre Gaussien pour réduire le bruit, avant d'appliquer un filtre Laplacien pour détecter les points autour desquels les variations de luminosité sont importantes.



Filtres et Opérations dans ImageJ





Topic 06 – Noise and filter

Correction du fond

Sources de dégradation

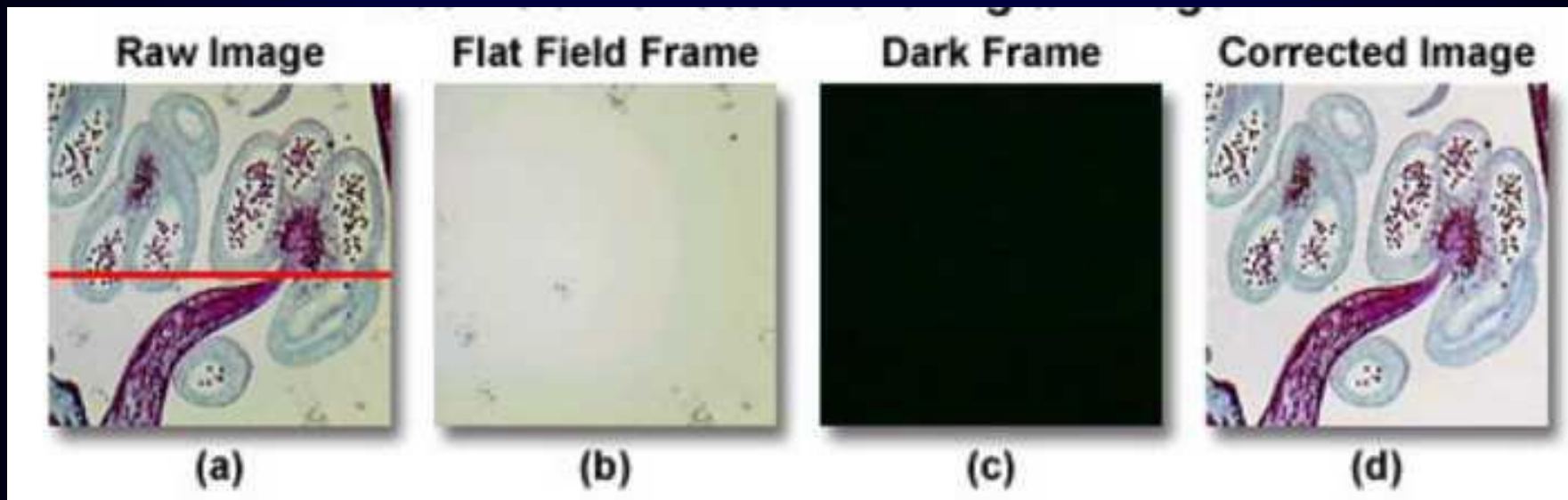
- Bruits de la caméra: bruit aléatoire, «pixels chauds», bruits périodiques
- Illumination non-homogène

Correction à la capture

Fixer les réglages microscope – acquisition

Captures moyennées d'un champs noir CN (en coupant le trajet optique)
d'un champs clair CC (lame sans échantillon) et de l'échantillon

Image corrigée = $(\text{échantillon} - \text{CN}) / (\text{CC} - \text{CN}) * 255$





Correction du fond

Correction après la capture

Bruit aléatoire : filtre gaussien ou médian mais perte de détail

Pixels chauds : filtrer les pixels saturés isolés

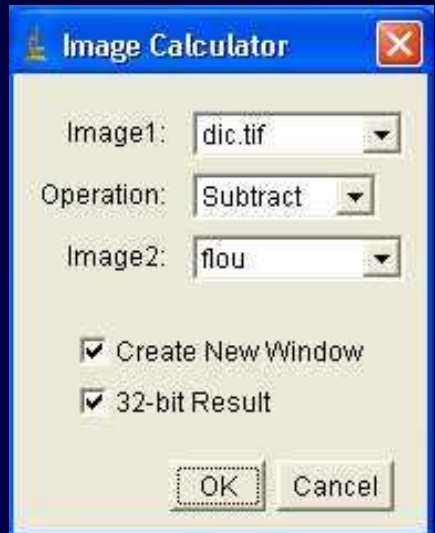
Bruit périodique : filtre de Fourier

Illumination non-homogène :

- Soustraire la même image très floue (filtre gaussien très large)
- Algorithme « rolling ball » (ImageJ Process → Subtract Background)
- Toute une série de plugins implémentés dans ImageJ (Fitting a polynomial surface)



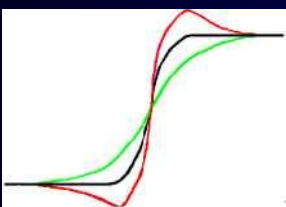
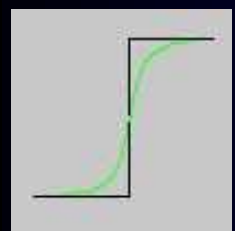
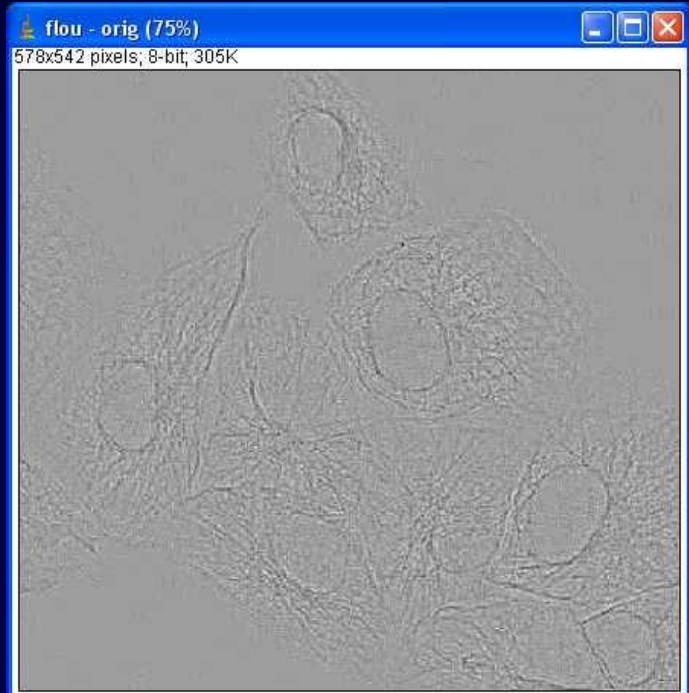
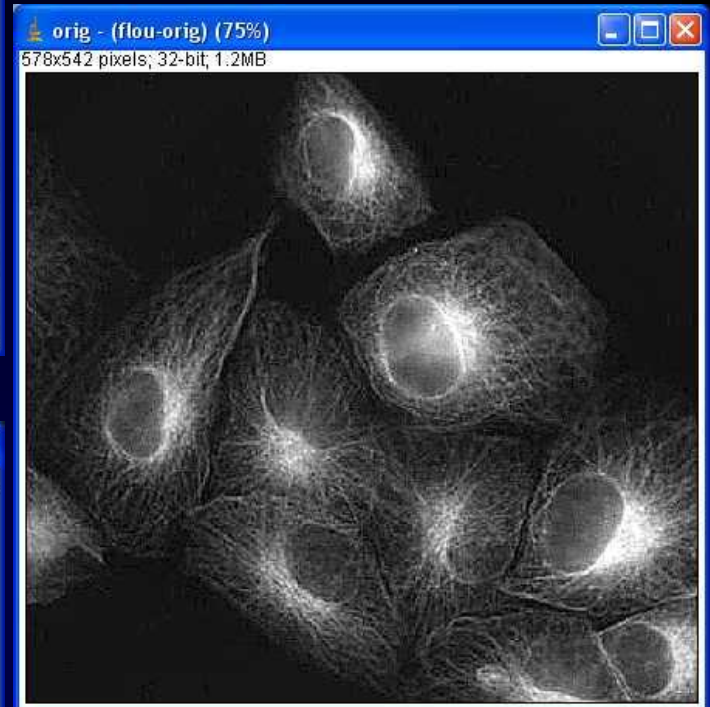
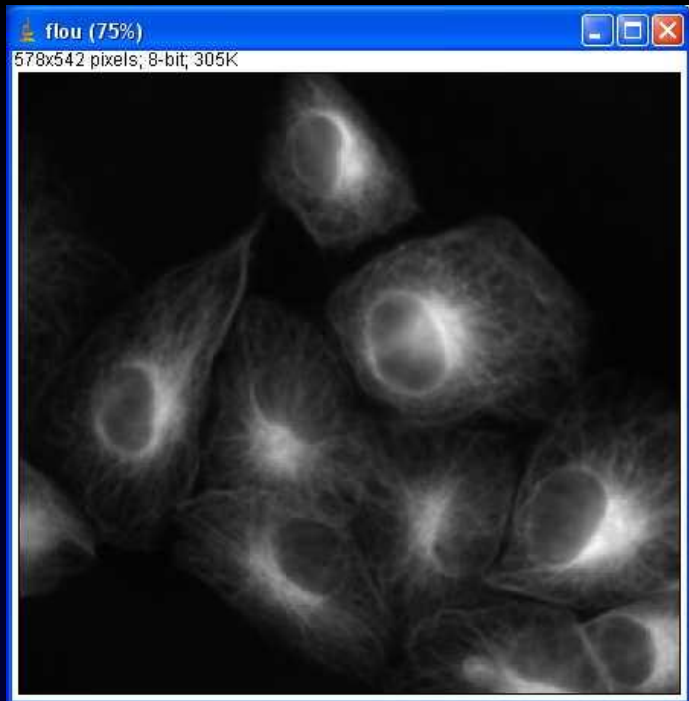
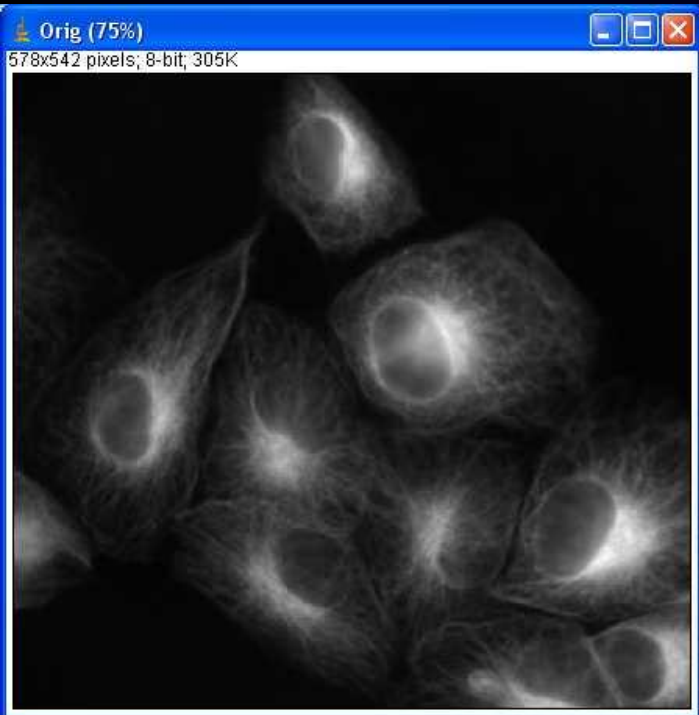
Masquer le fond





Masque de Flou

1 1 1
 1 1 1
 1 1 1



Orig - (Flou - Orig)

Flou - Orig



Topic 07 – Background correction Unsharp masking

L'image numérique

Les Prétraitements

La Segmentation

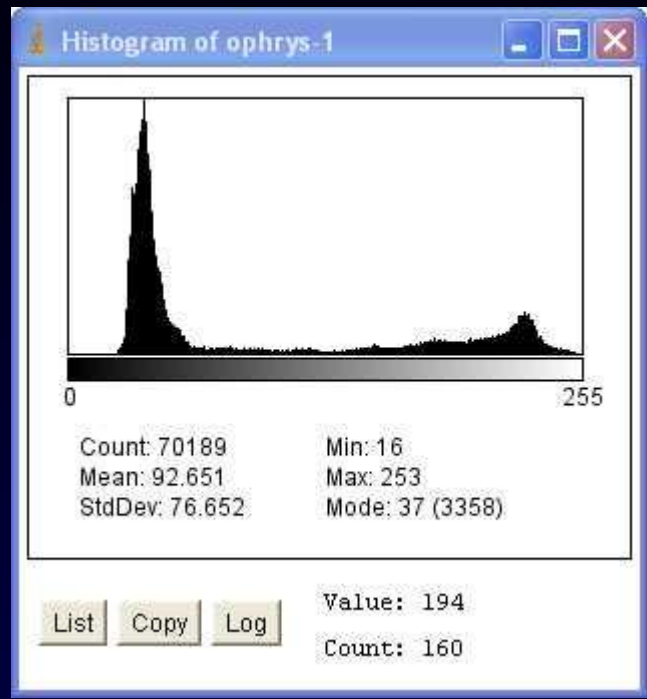
Permet de séparer les
régions d'intérêt du fond.

Les Post-traitements

La Quantification



Le Seuillage automatique



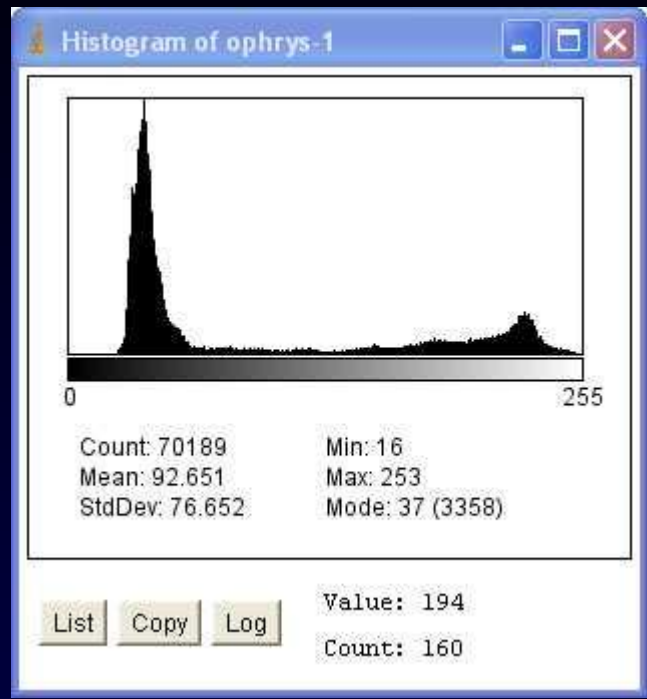
Default Red

Dark background

Image → Adjust → Threshold...



Le Seuillage automatique



Default Red

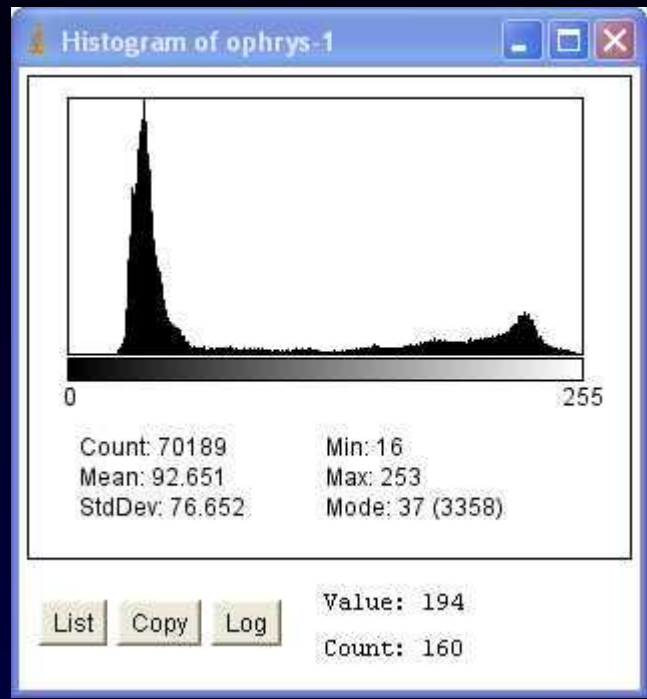
Dark background

Auto Apply Reset Set

Image → Adjust → Threshold...



Le Seuillage automatique



Default [v] Red [v]

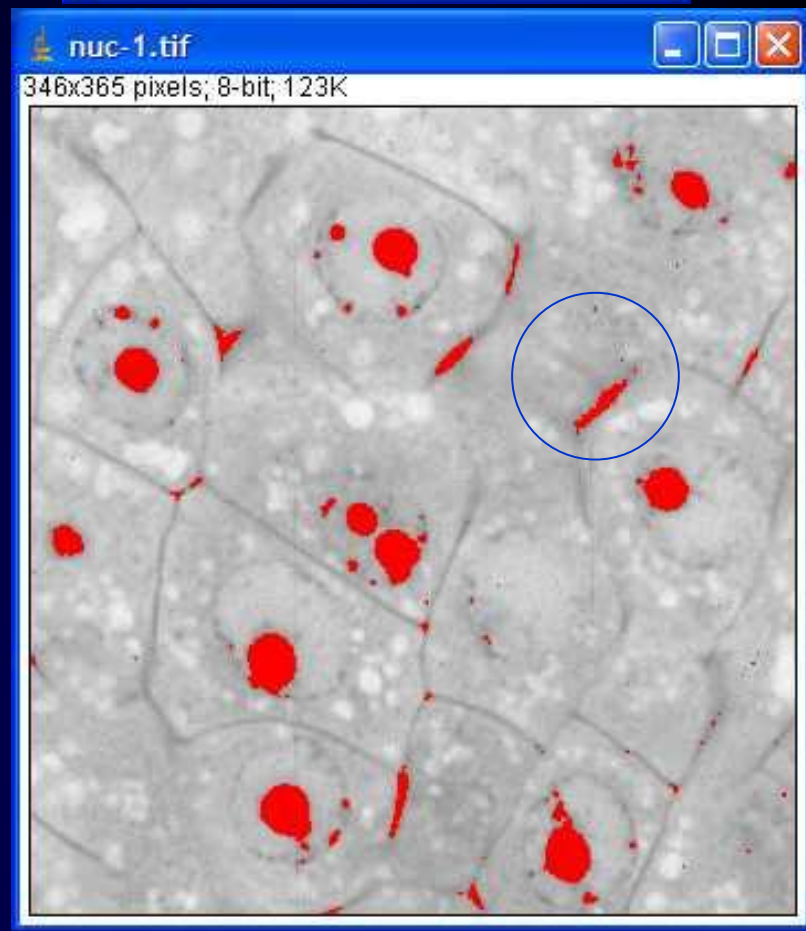
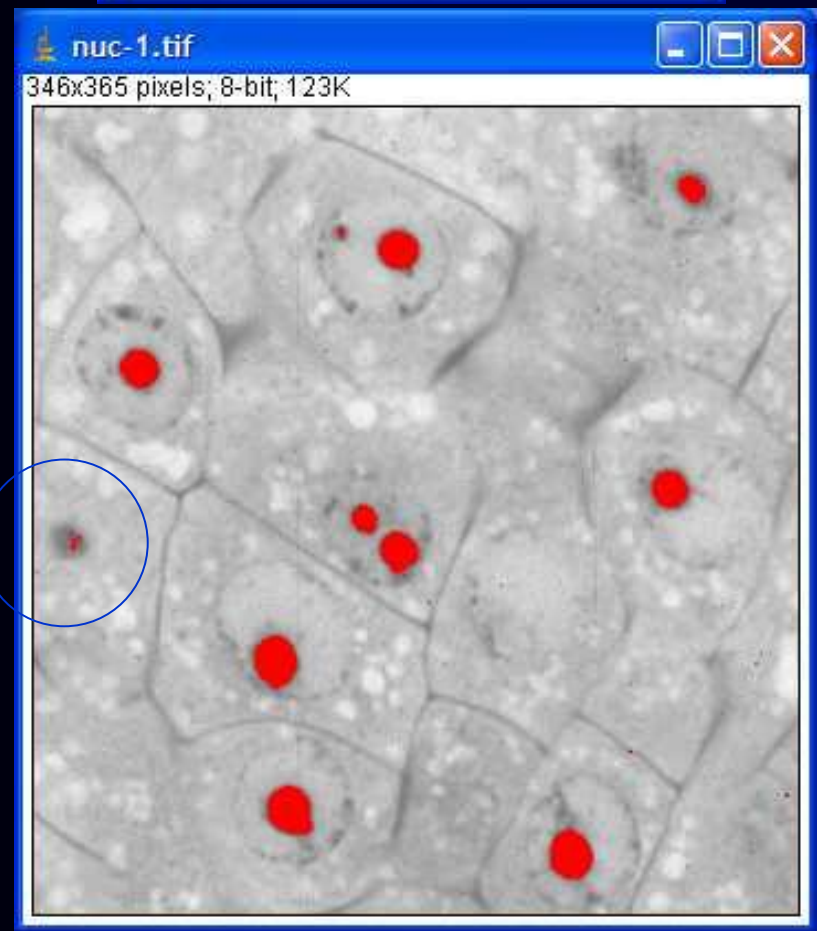
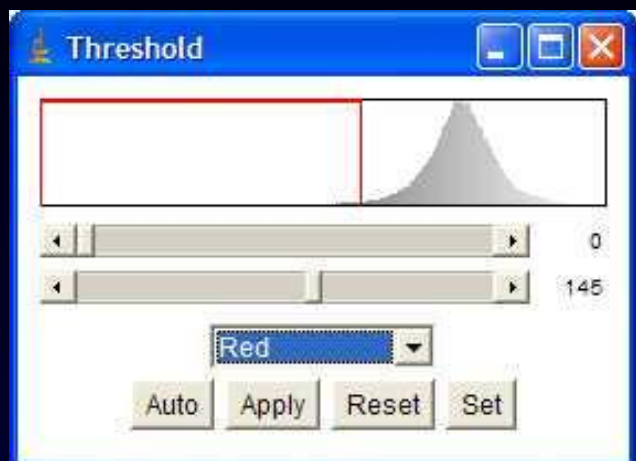
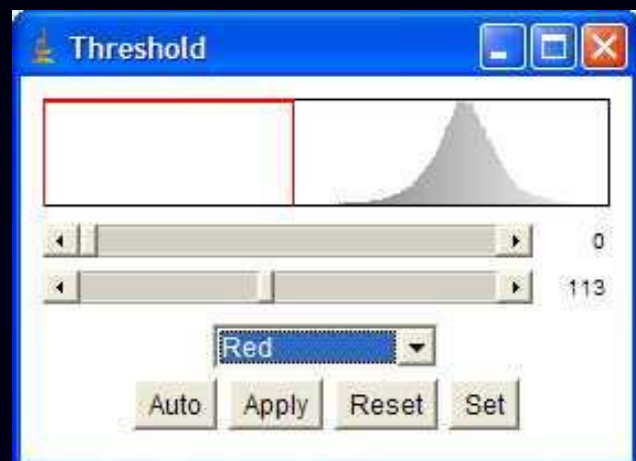
Dark background

Auto Apply Reset Set

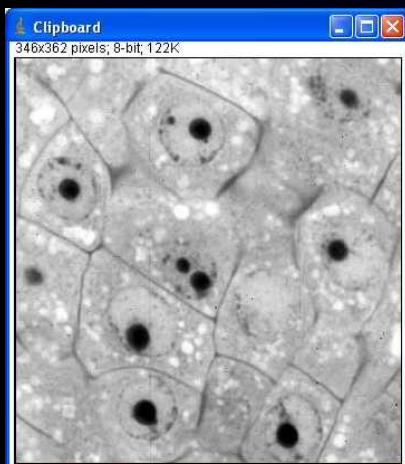
Image → Adjust → Threshold...



Le Seuillage manuel



Le Seuillage automatique



Log	
File Edit Font	
Default:	126
Huang:	187
Intermodes:	96
IsoData:	126
Li:	85
MaxEntropy:	128
Mean:	180
MinError(I):	180
Minimum:	60
Moments:	156
Otsu:	130
Percentile:	184
RenyiEntropy:	134
Shanbhag:	181
Triangle:	182
Yen:	135

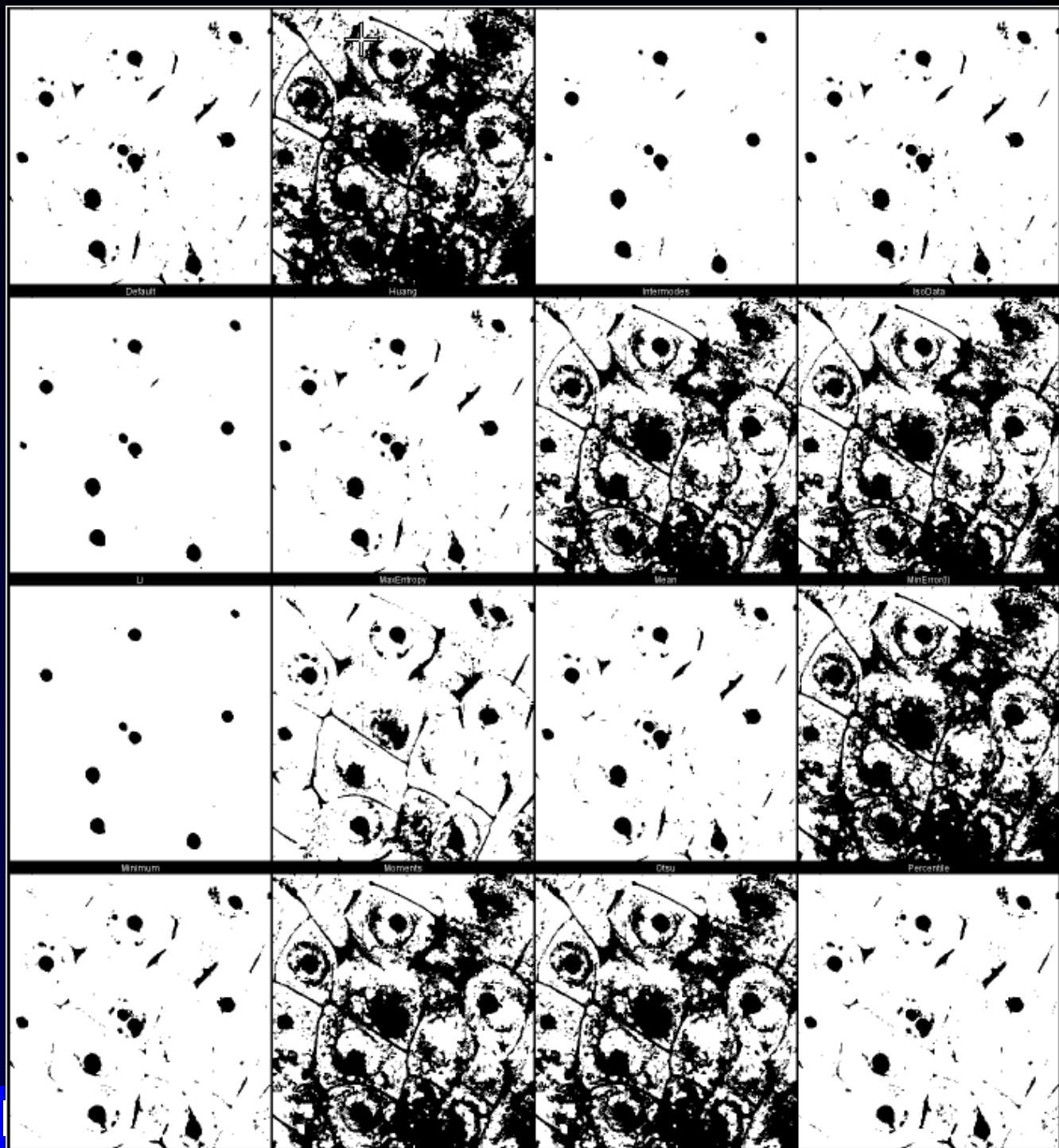
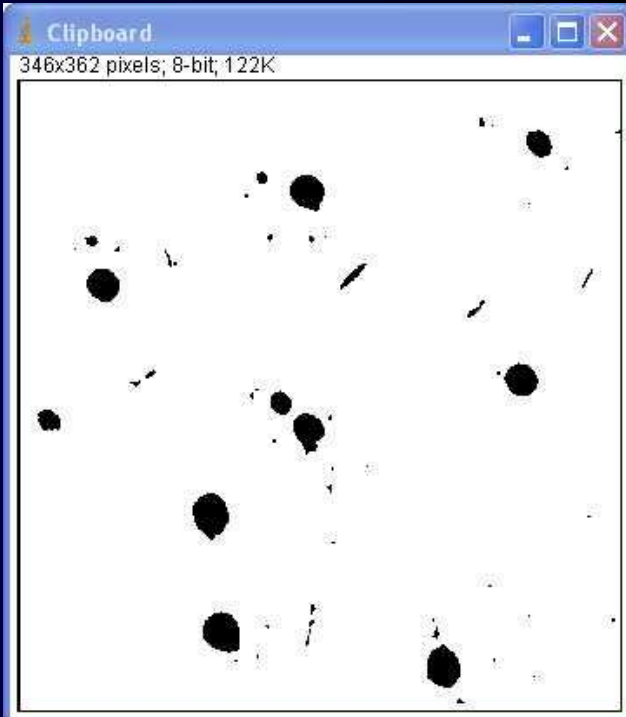
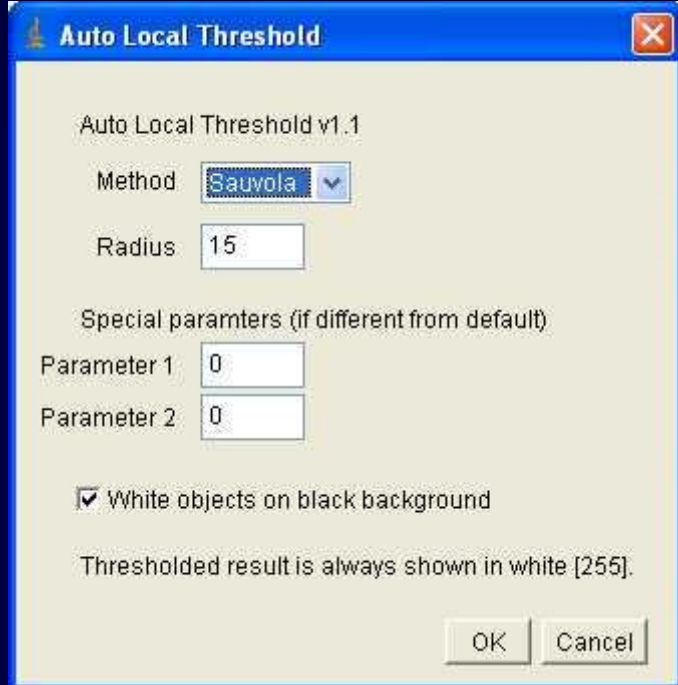
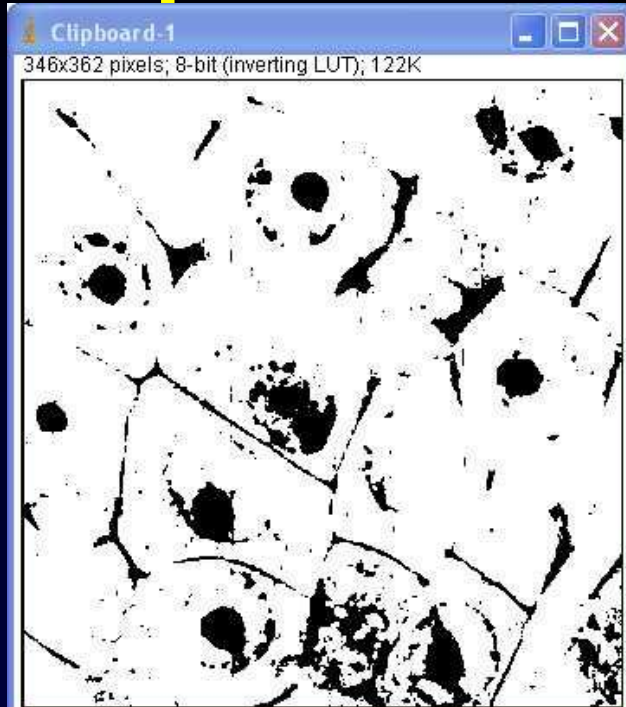
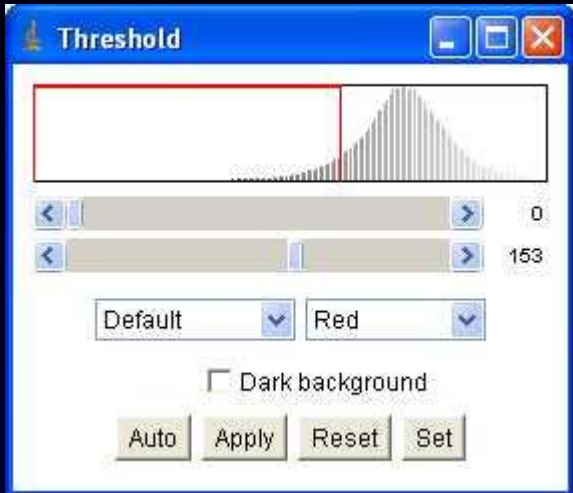


Image → Adjust → AutoThreshold

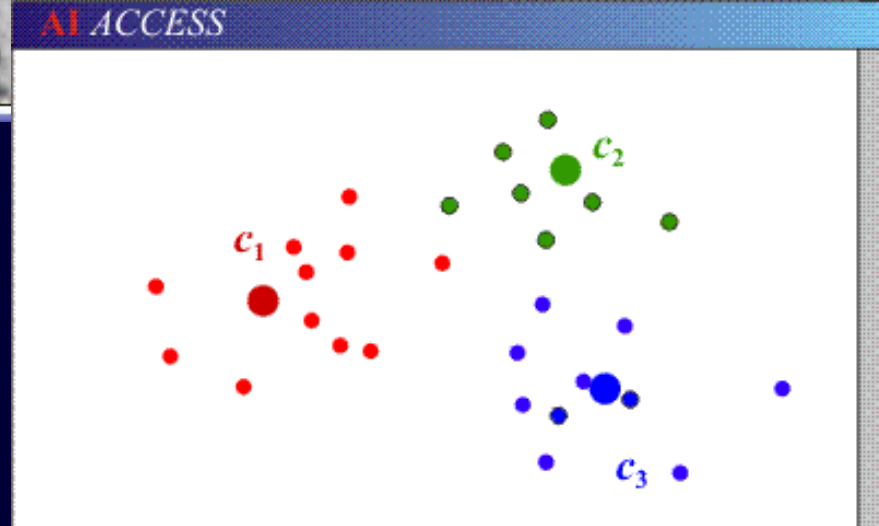
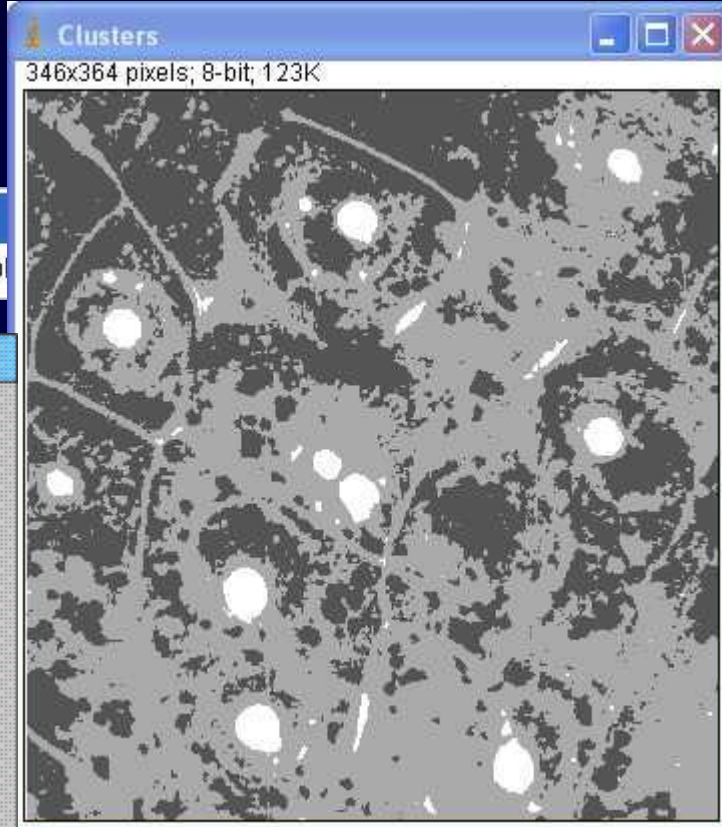
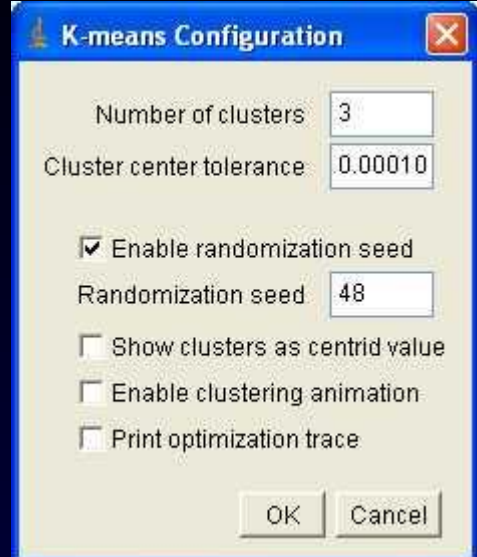
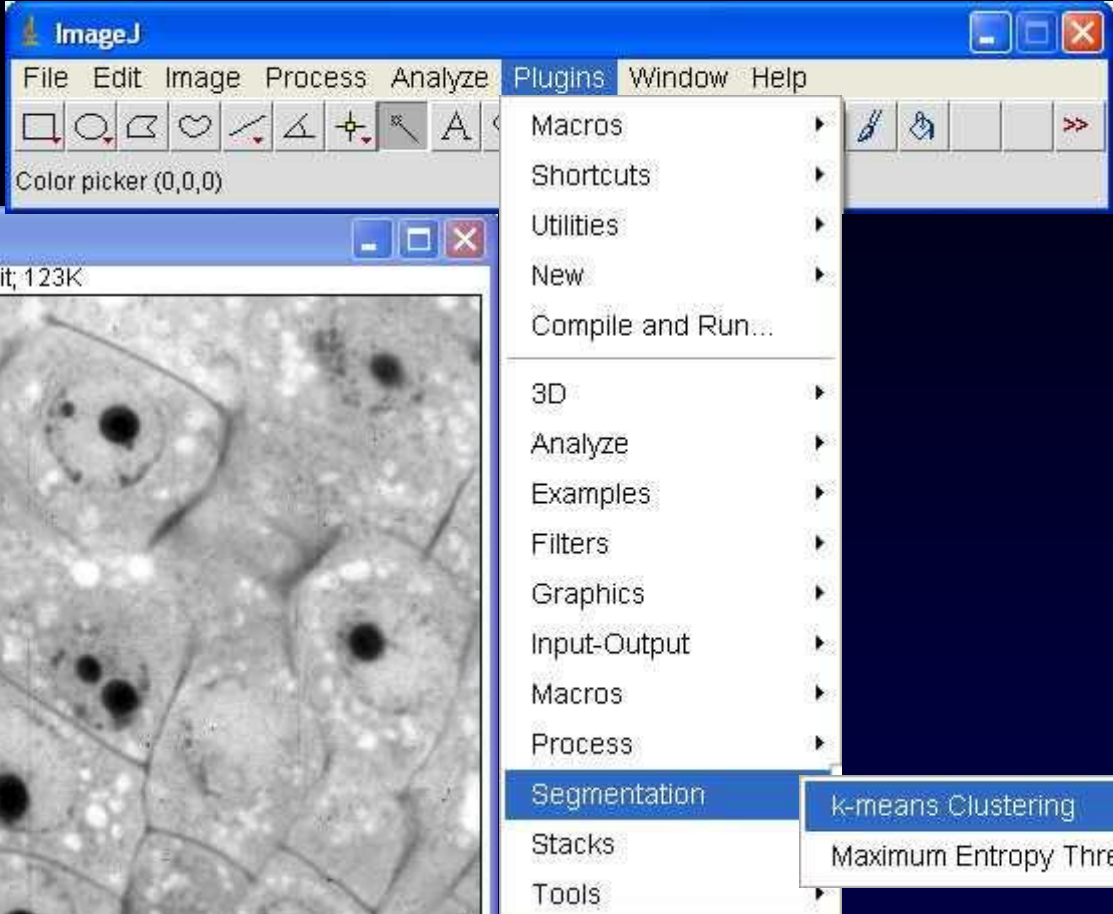


Seuillage local automatique



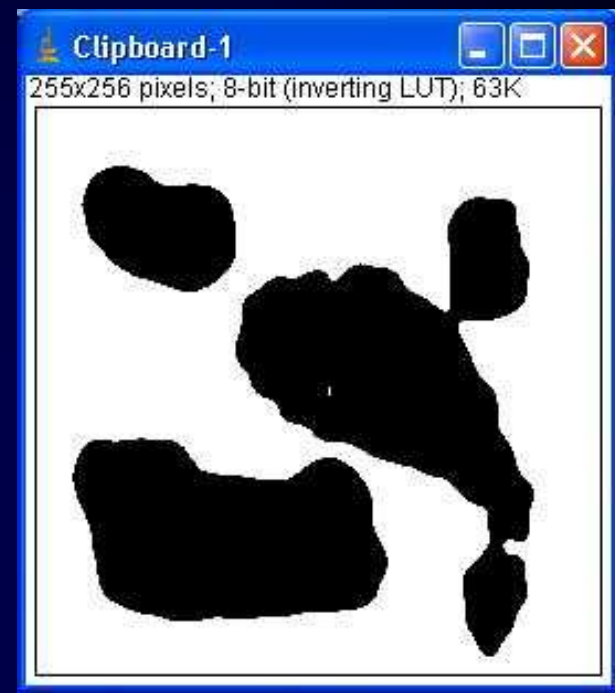
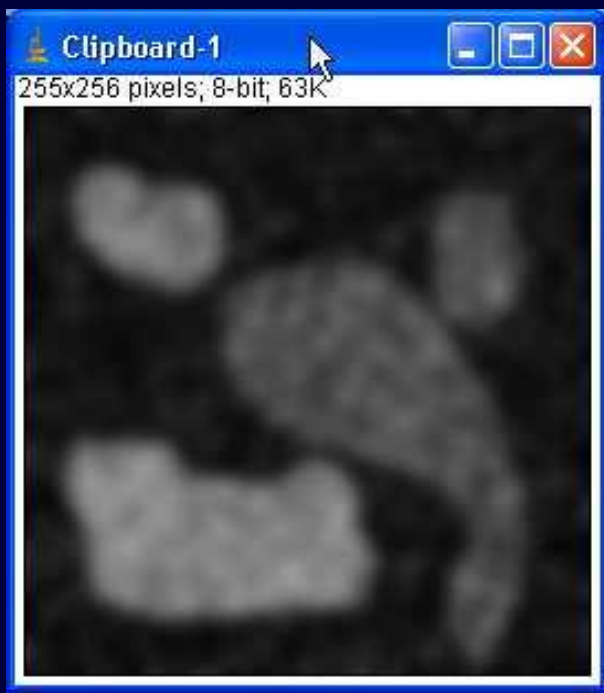
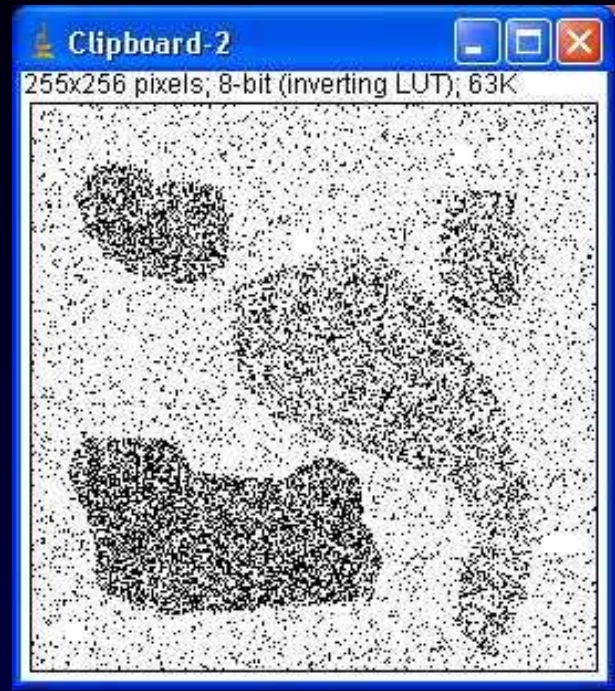
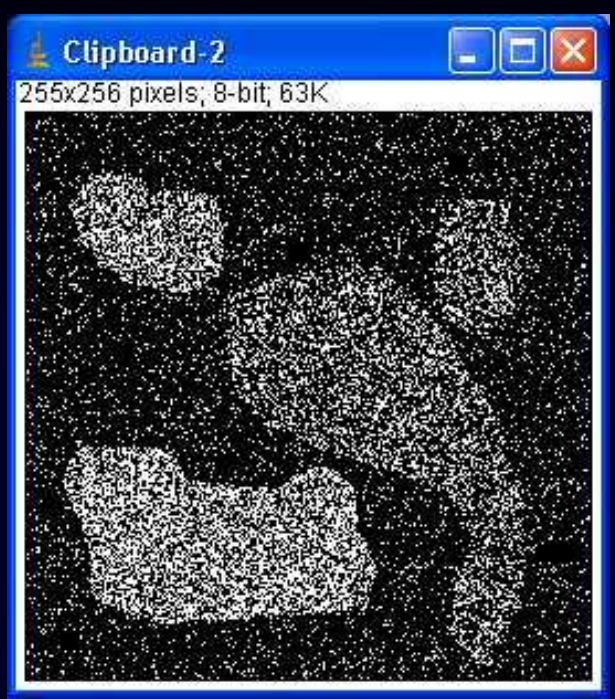


Plugin k-mean clustering



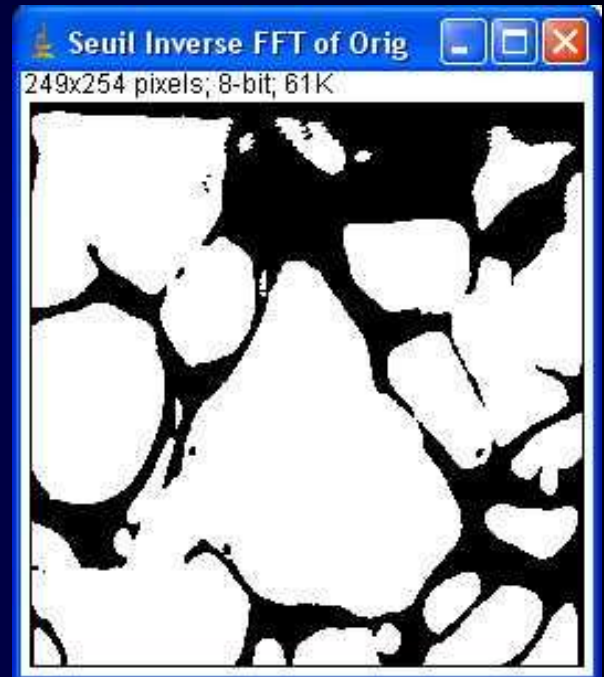
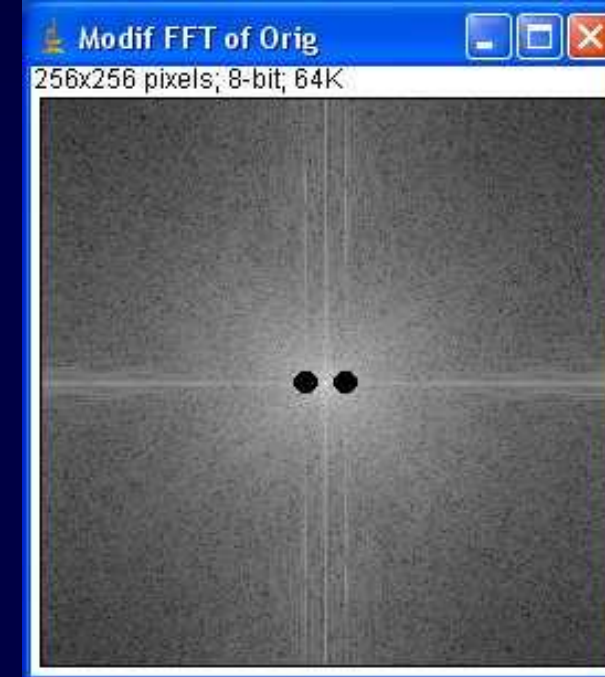
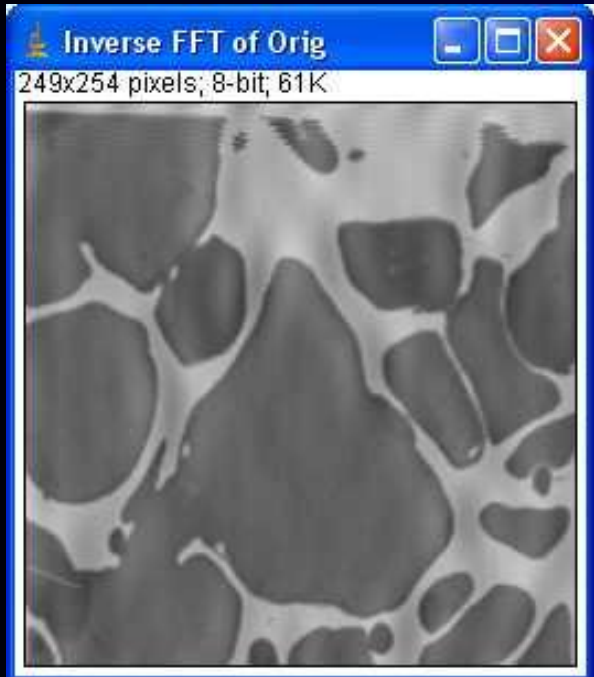
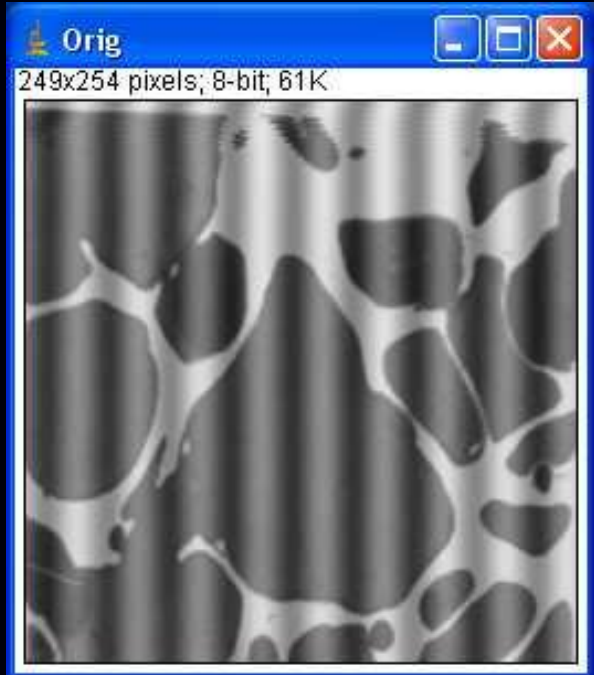


Filtrage avant le seuillage





FFT filtres dans le domaine de Fourier



Couleur et segmentation séparation RGB

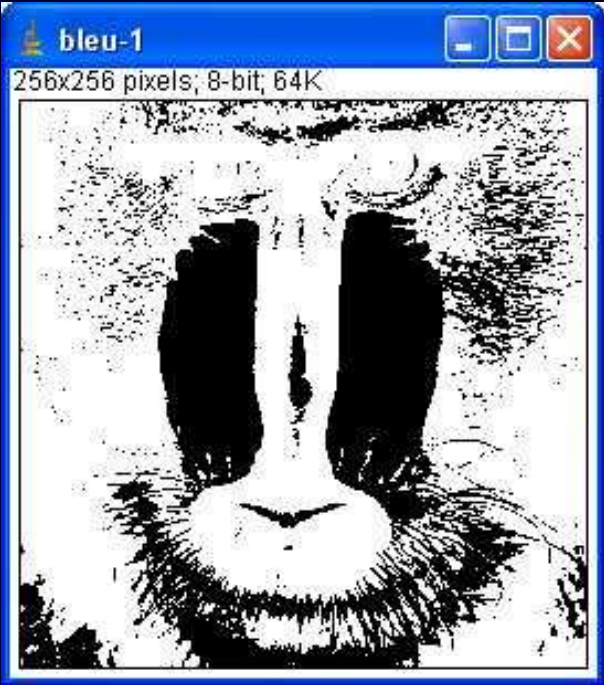
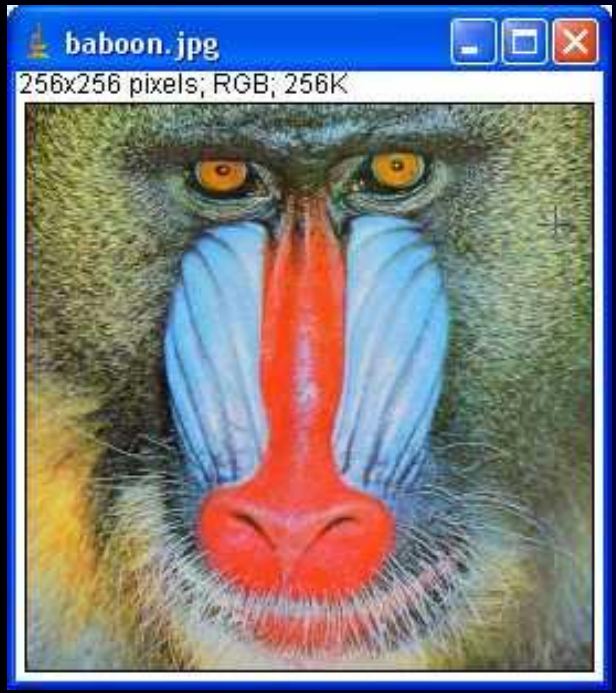


Image → Color → Split Channels...



Décomposition HSI

la Teinte ou Hue se référant à la couleur

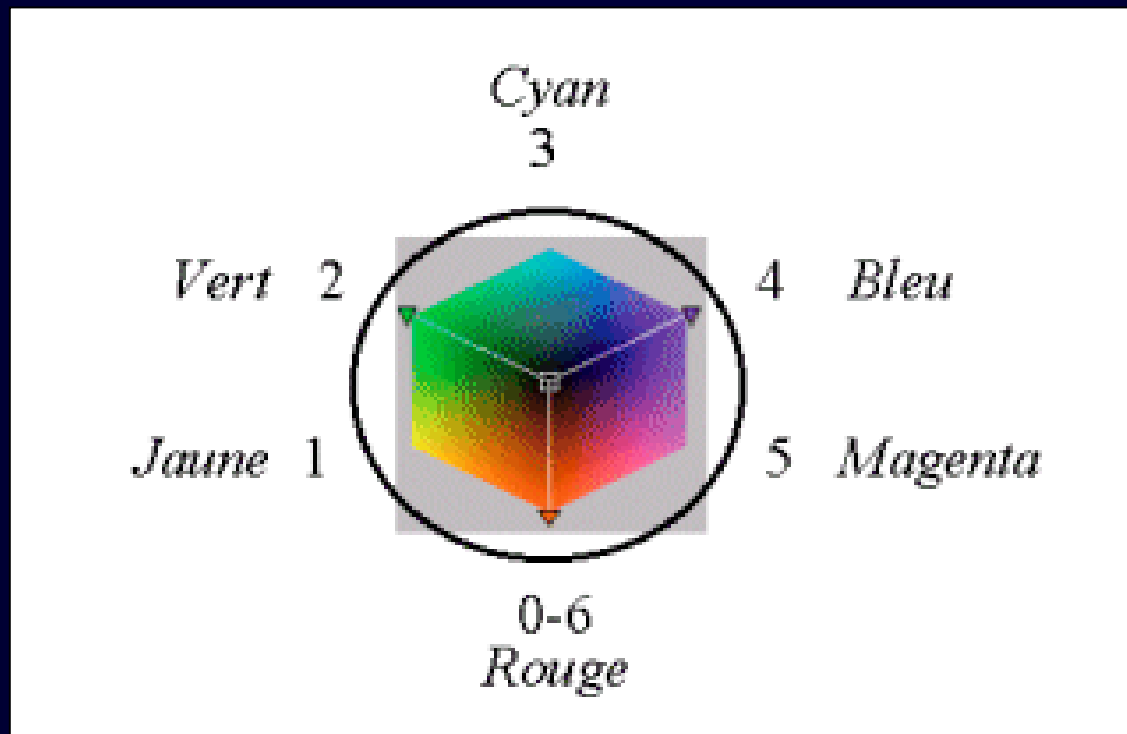
codée de 0 à 6 correspond à une distribution cyclique des couleurs

le noir, le blanc et les nuances de gris sont codés à 0, comme le rouge

la Saturation : mesure de l'absence de blanc dans une couleur

le " rouge pompier " étant une couleur saturée et le rose une couleur non saturée

l'Intensité ou Luminance : mesure de l'intensité d'une couleur, distinction entre clair et foncé





Couleur et segmentation séparation HSI

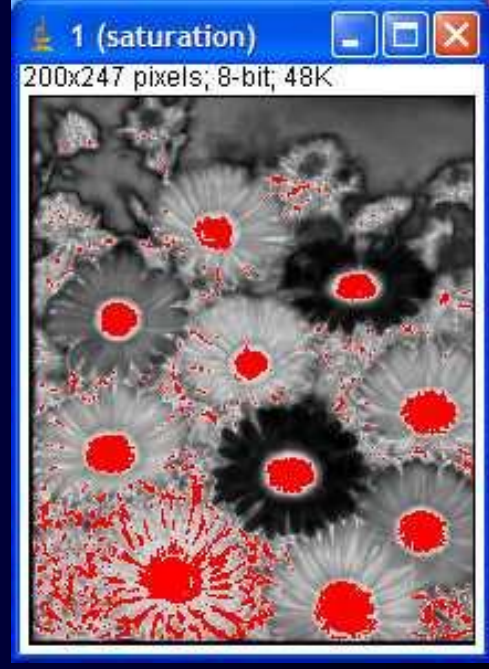
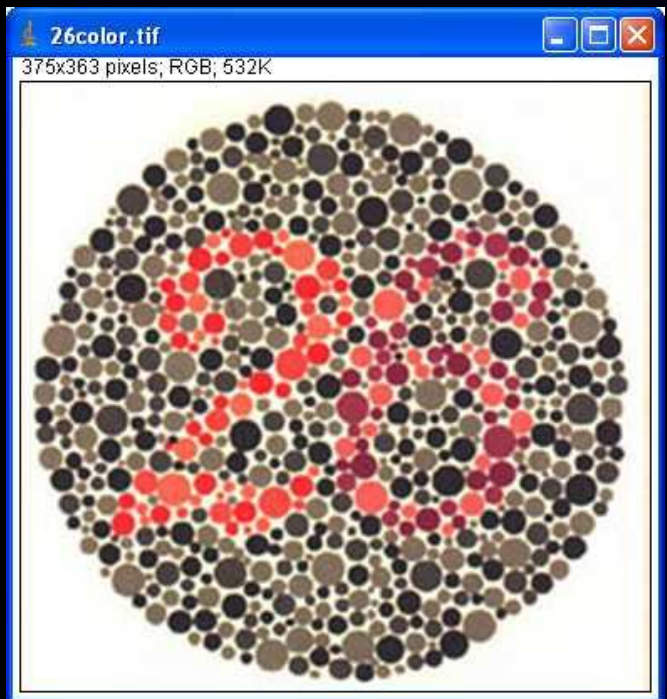


Image → Type → HSB Stack..

Seuillage couleur



Threshold Color (experimental)

Hue

Saturation

Brightness

Thresholding method: Default

Threshold color: B&W

Color space: HSB

Dark background

Original	Filtered	Select	Sample
Stack	Macro	Help	

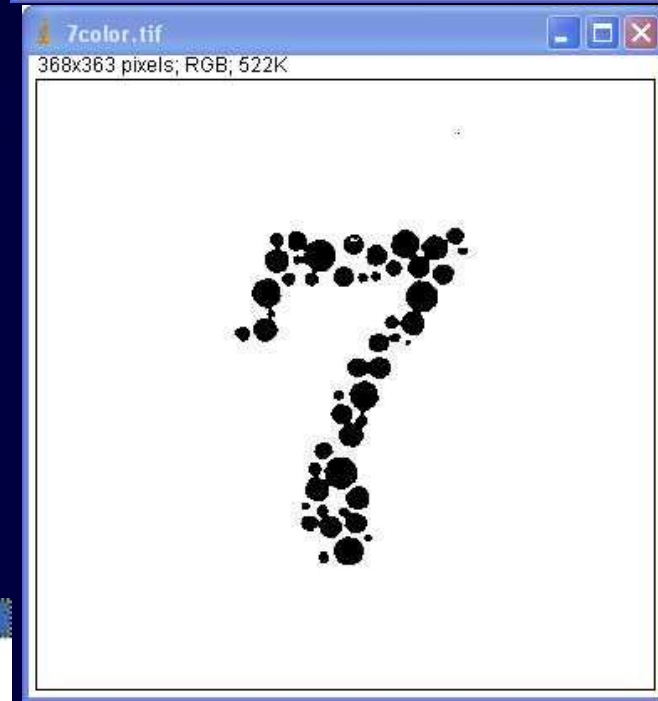
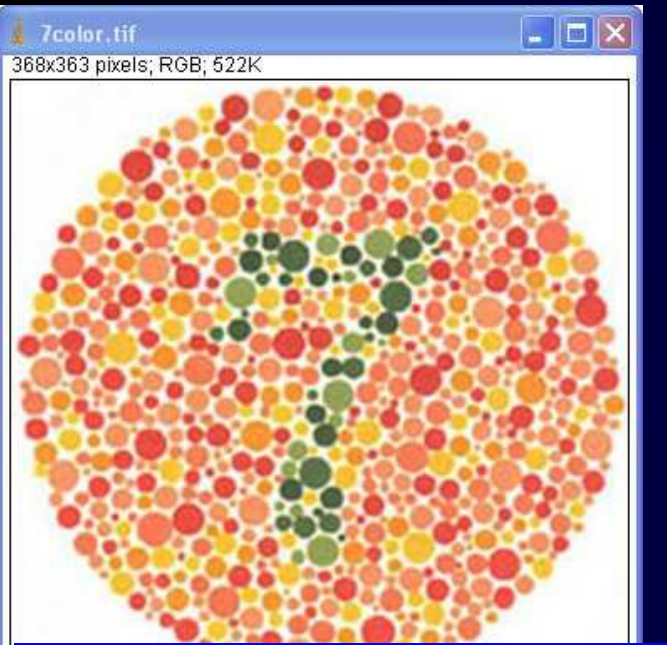
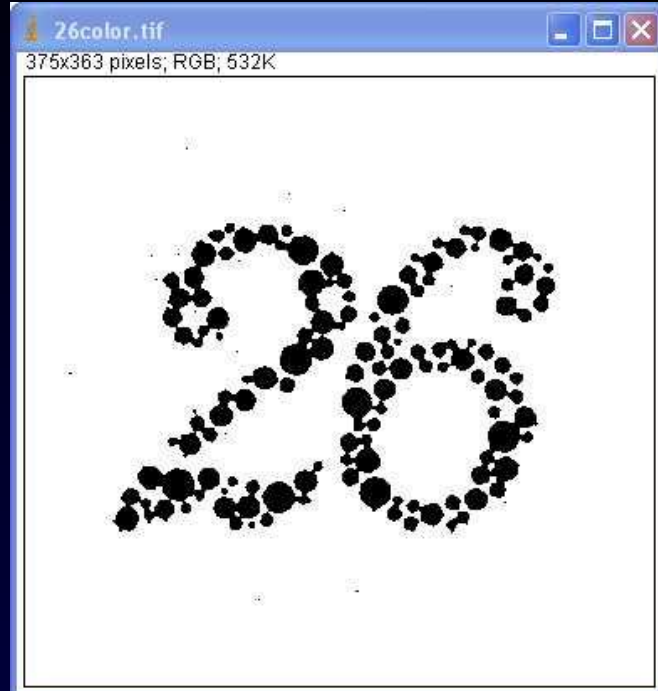
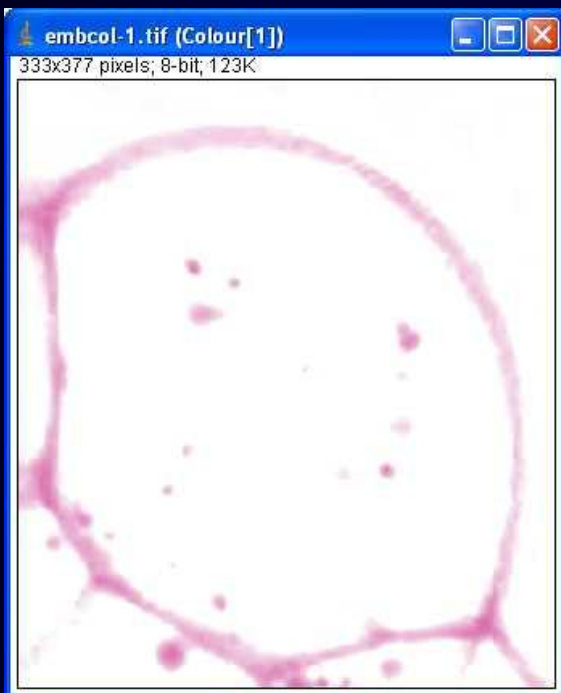
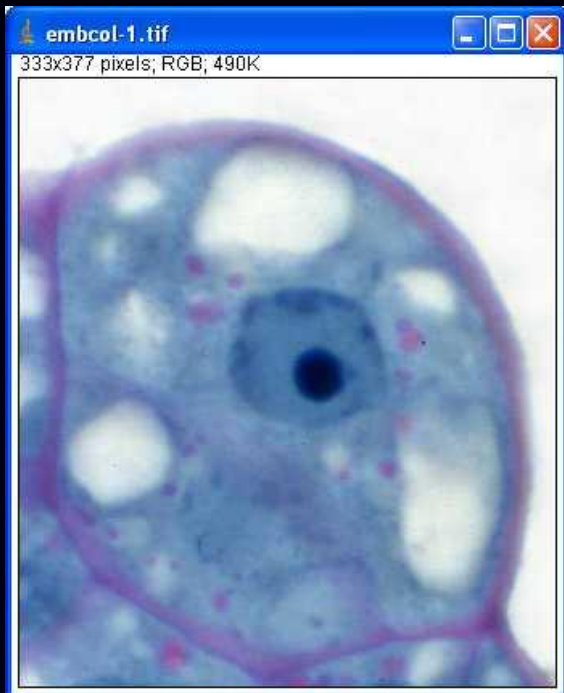


Image → Adjust → Color Threshold..

- HSB
- RGB
- Lab
- YUV



Plugin Colour Deconvolution





Topic 08 – Segmentation



L'image numérique

Les Prétraitements

La Segmentation

Les Post-traitements

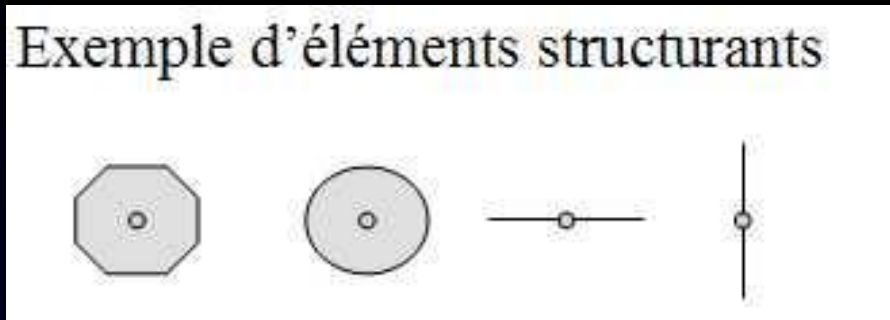
Transformations de
morphologie
mathématique

La Quantification



Principe

Elément structurant



On déplace l'élément structurant sur toute l'image

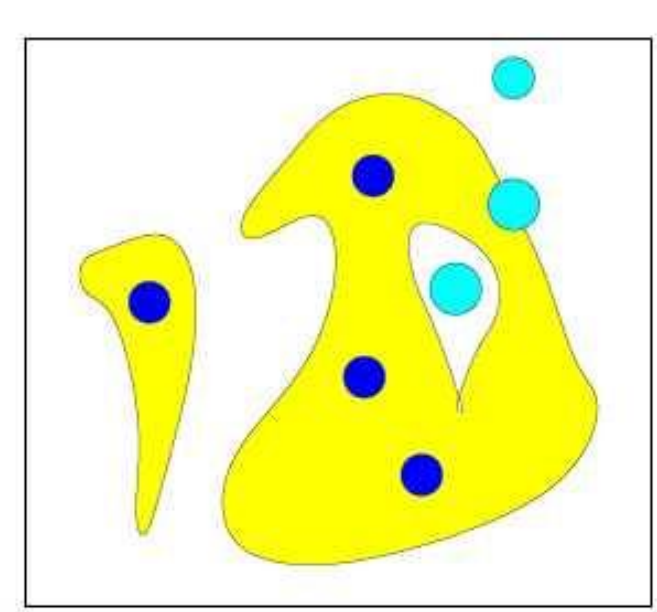
Le pixel sera noir si:

l'élément structurant est inclus dans un objet de l'image

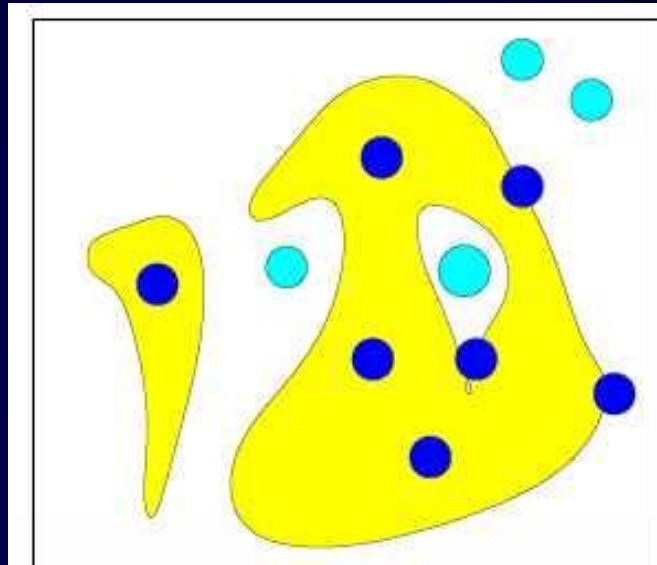
→ EROSION

l'élément structurant touche un objet de l'image

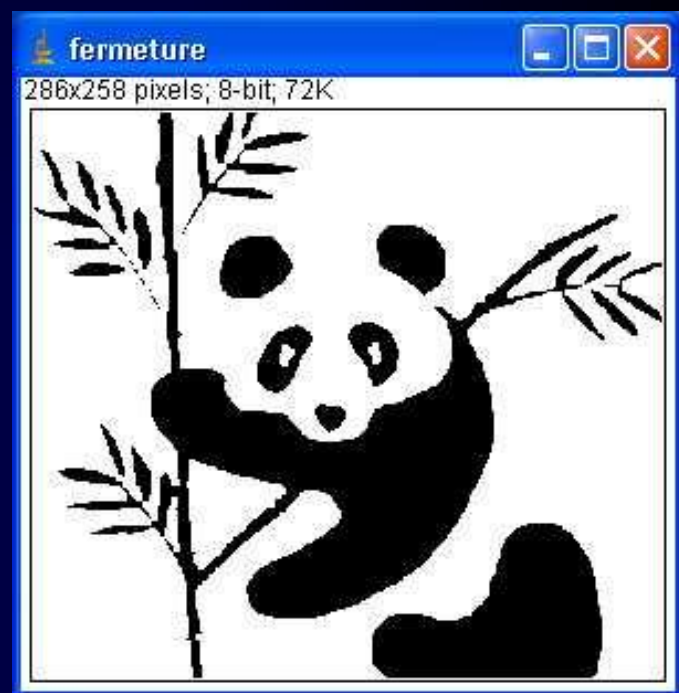
→ DILATATION



- reponse negative
- reponse positive

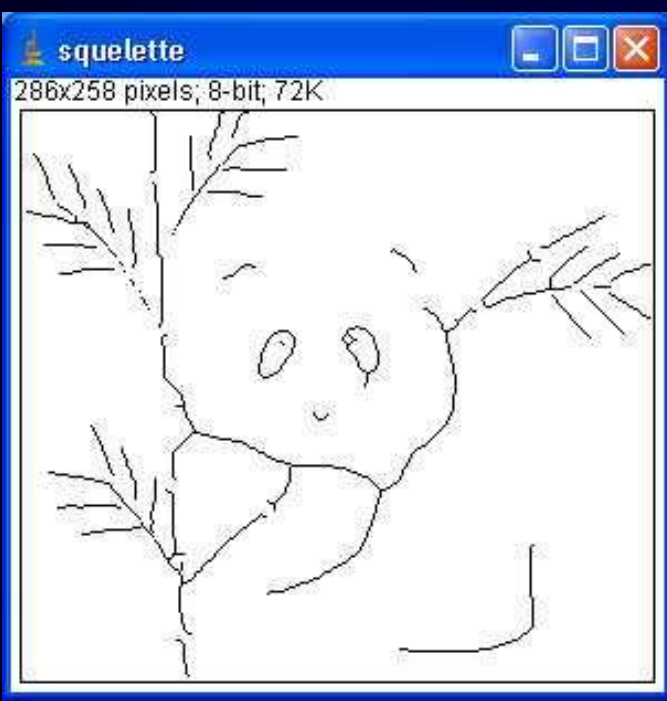


- reponse negative
- reponse positive



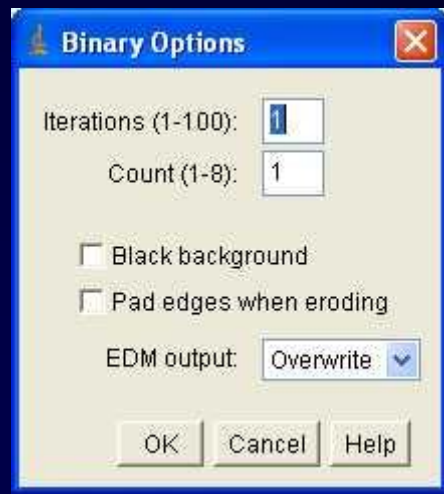
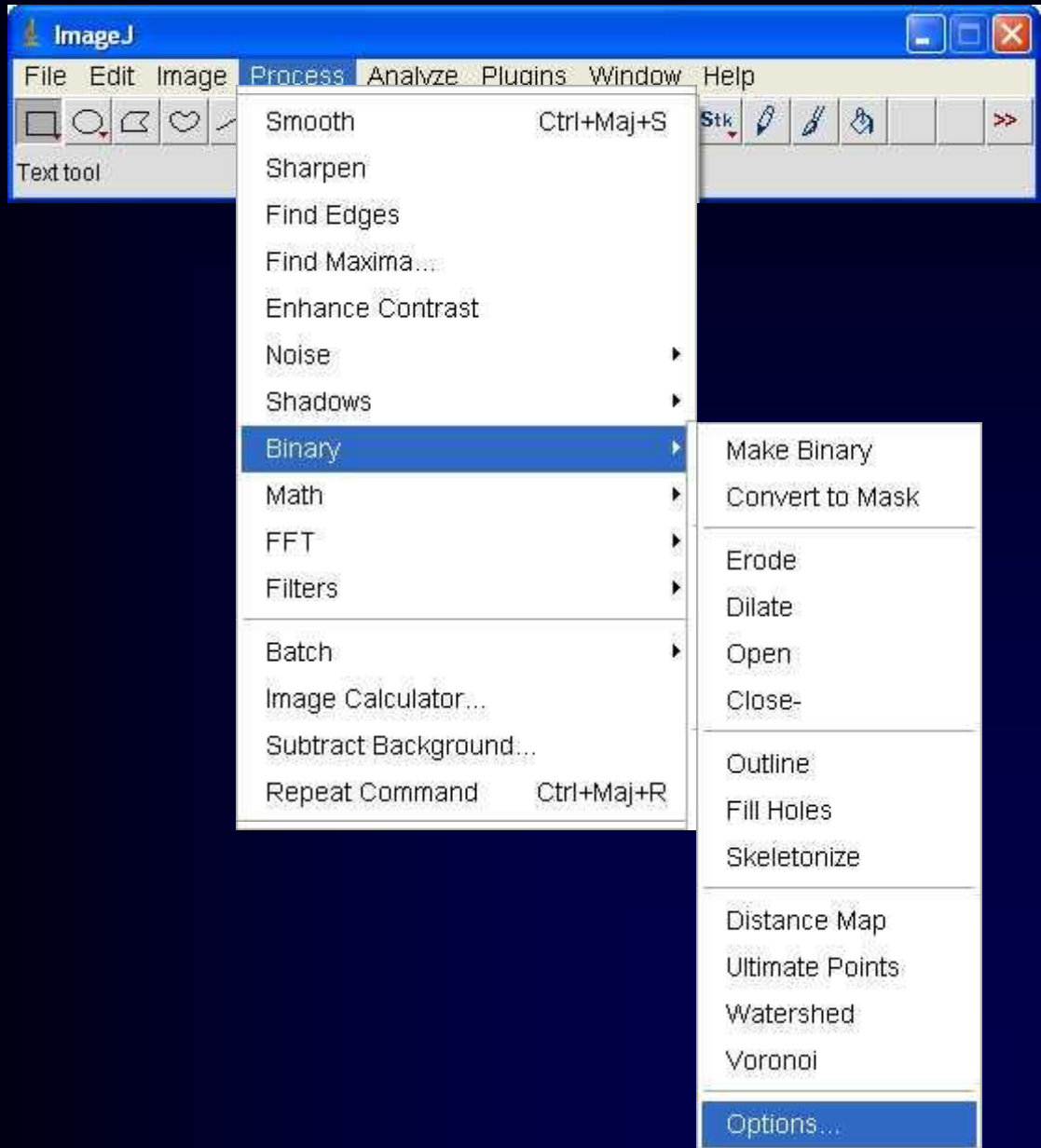


Morpho_math





Menu Binary

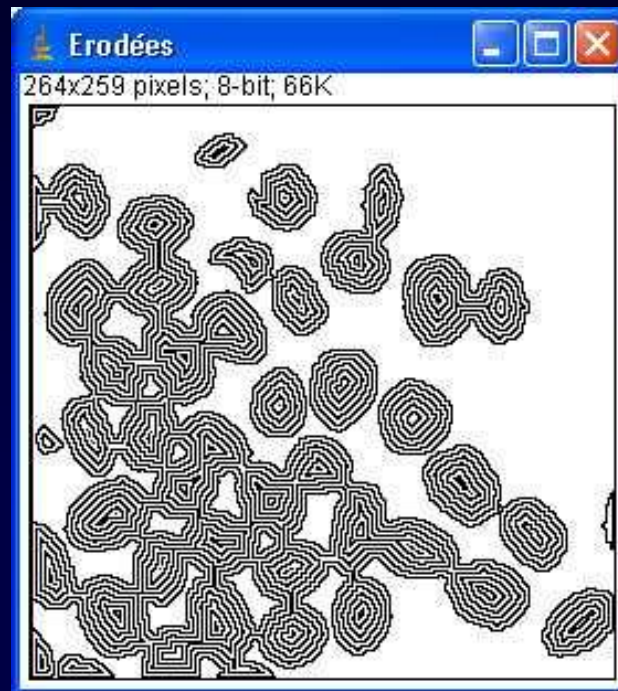
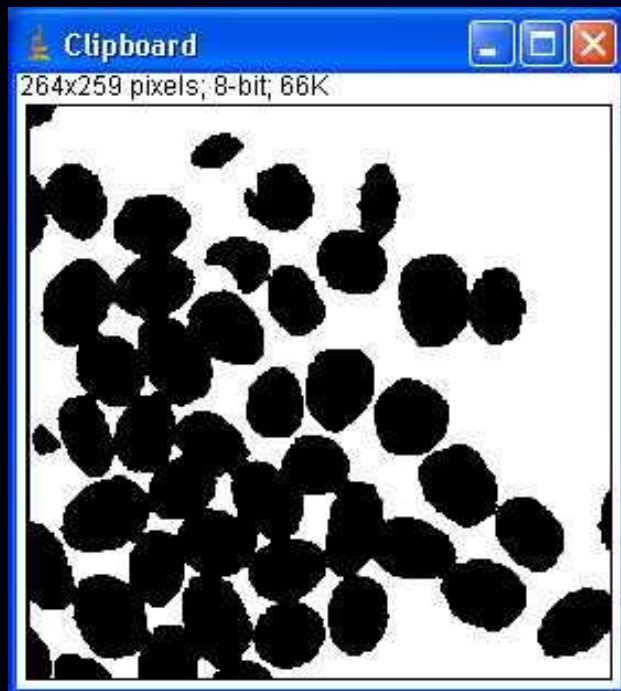


Process → Binary → Options



Erodé Ultime

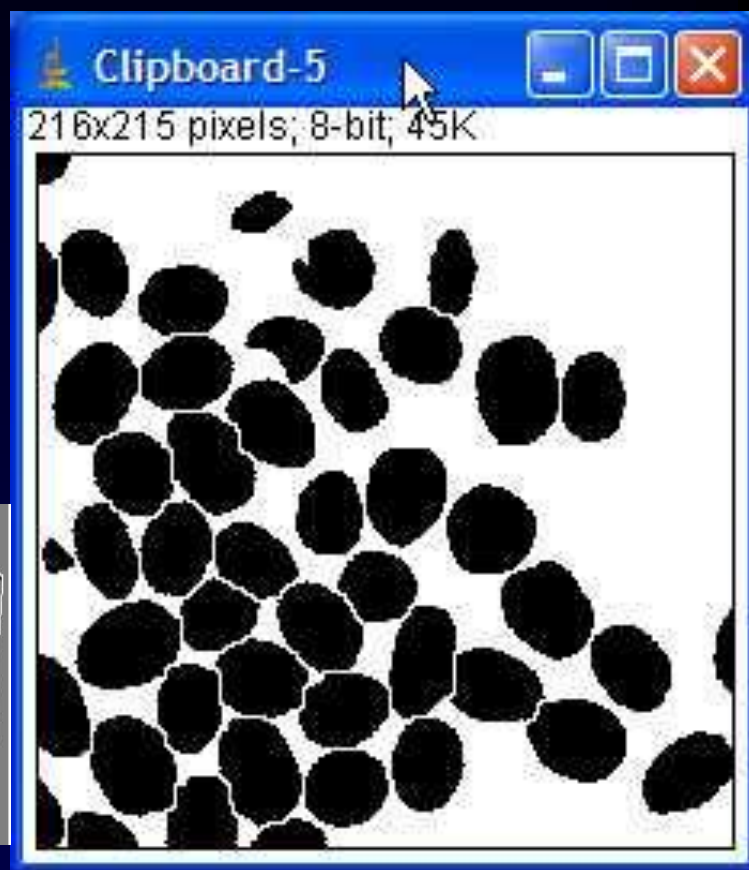
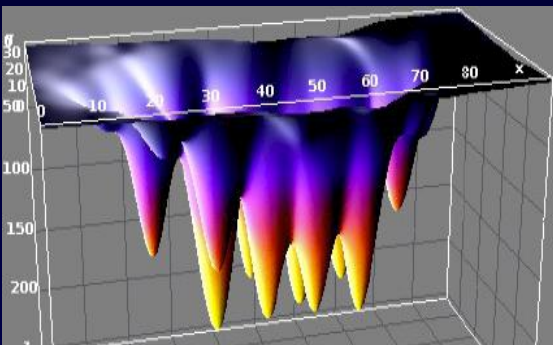
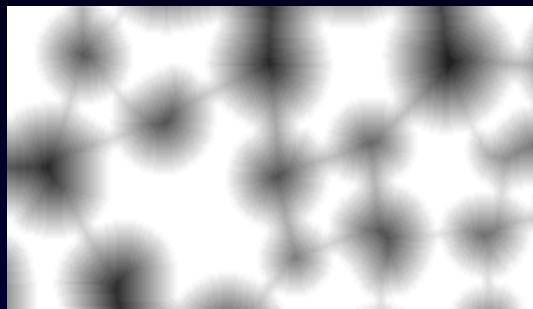
L'érodé ultime : la dernière fraction de l'objet restant avant sa disparition lors d'érosions répétées.



Process → Binary → Ultimate Points



La ligne de partage des eaux : watershed

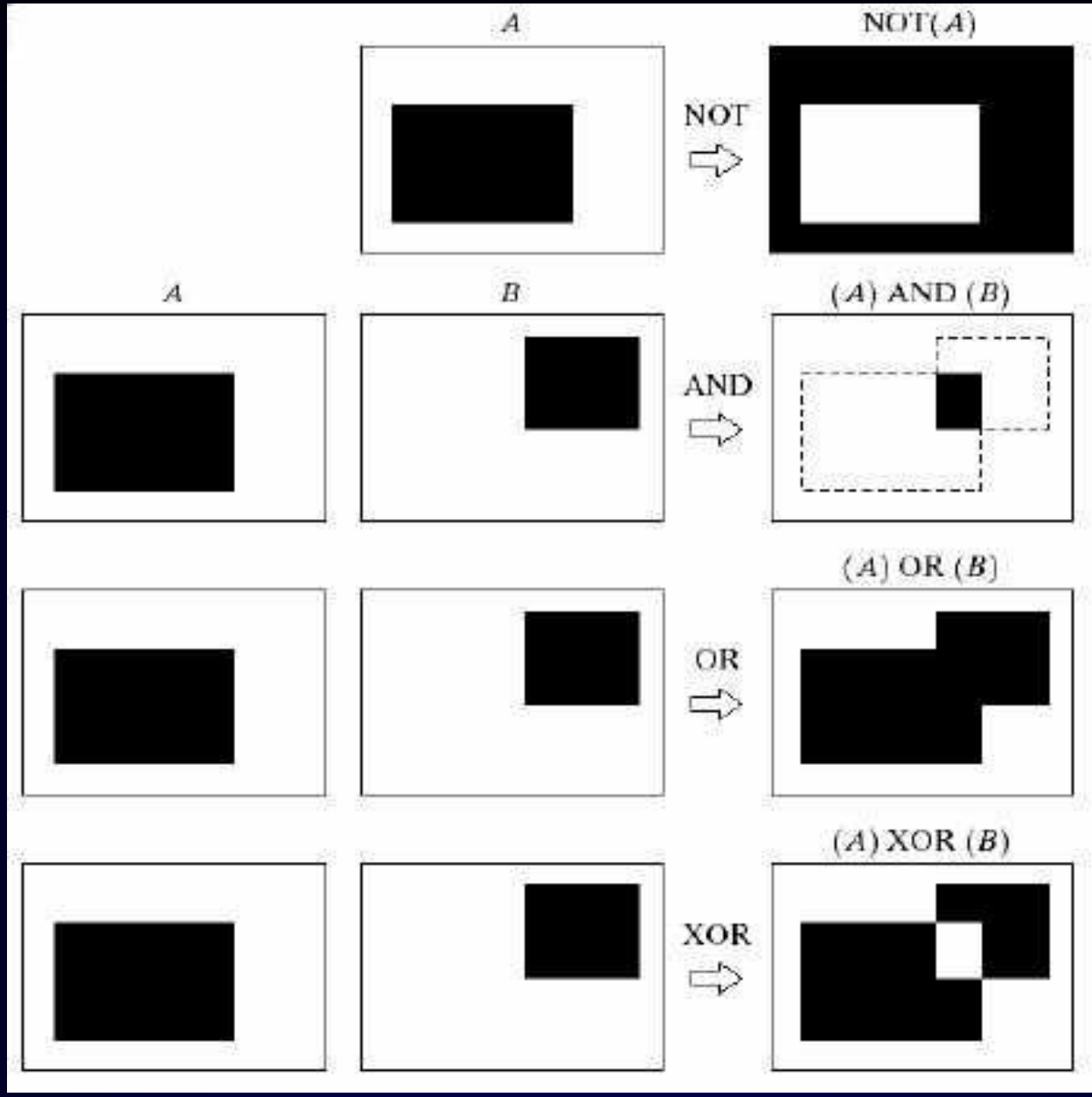


Cette transformation morphologique est la principale méthode de segmentation d'images proposées par la morphologie mathématique.

Process → Binary → Watershed



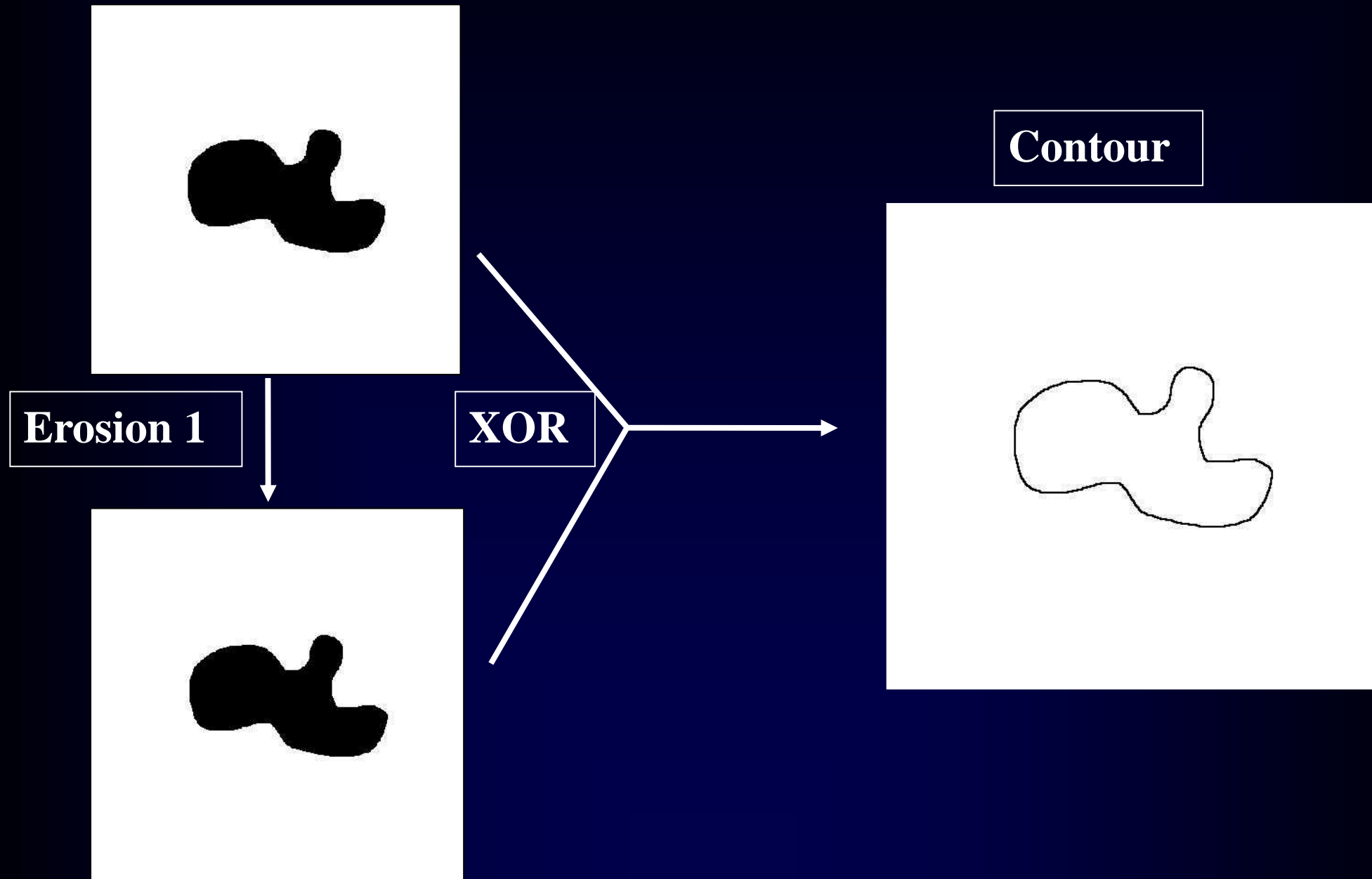
Opérations logiques

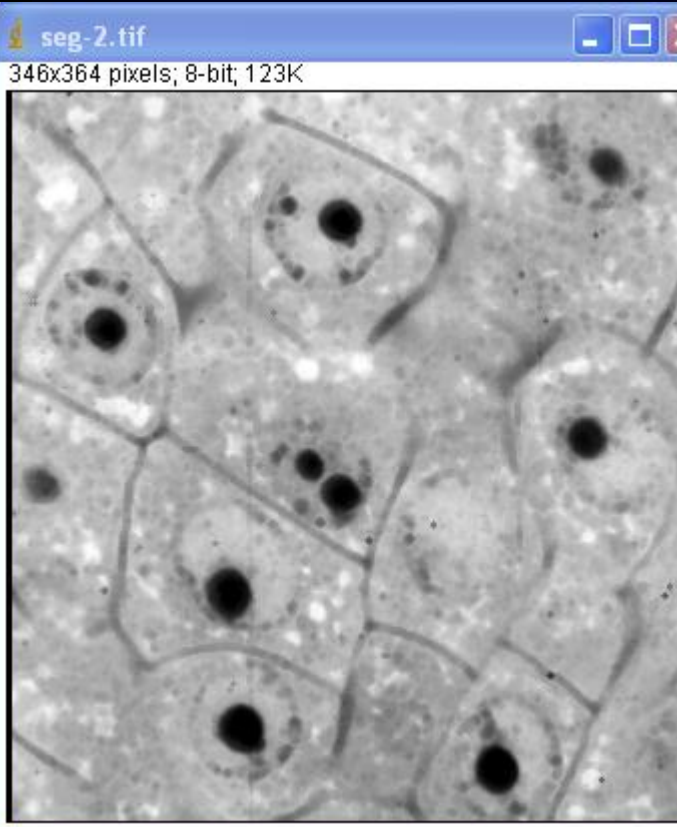


Process→Image Calculator...

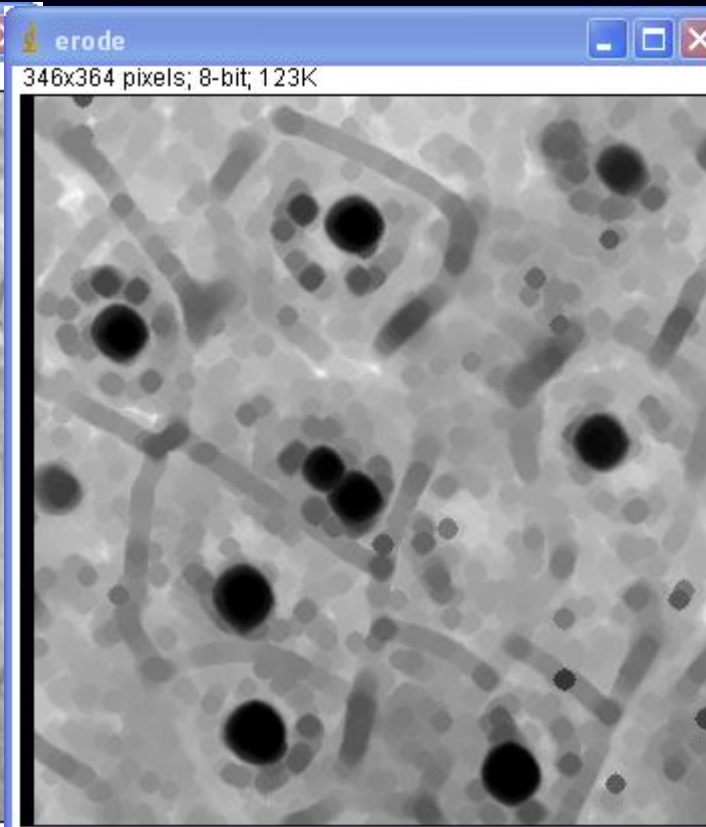


Construction d'une fonction contour

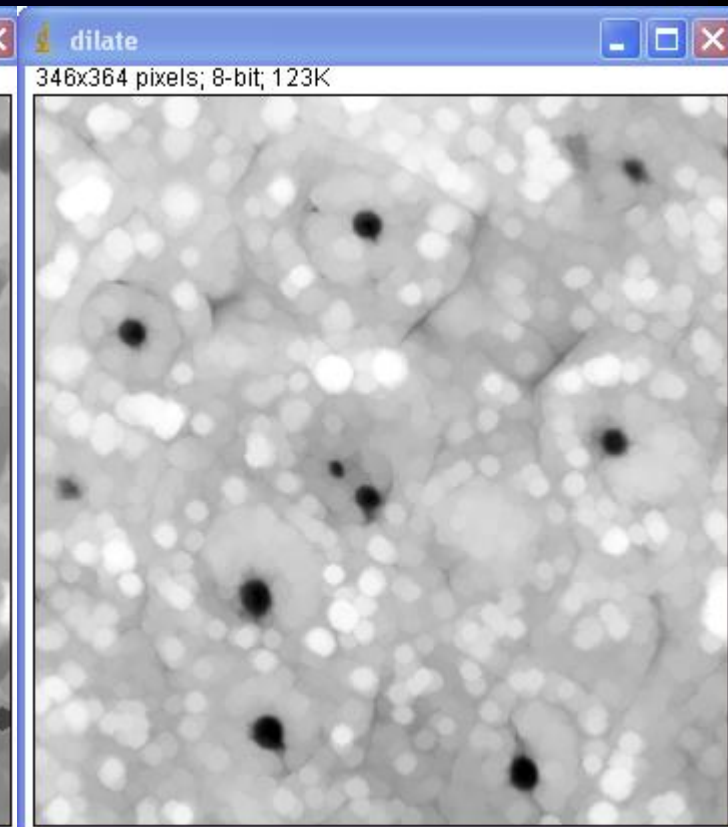




**Plugin
Grayscale Morphology**



**Erosion
agrandit les zones
sombres**

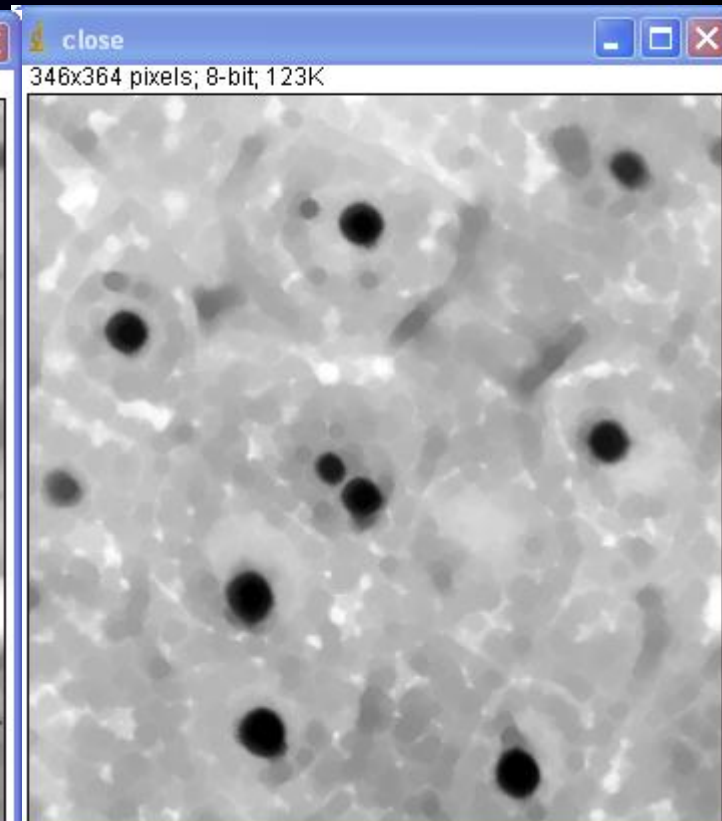
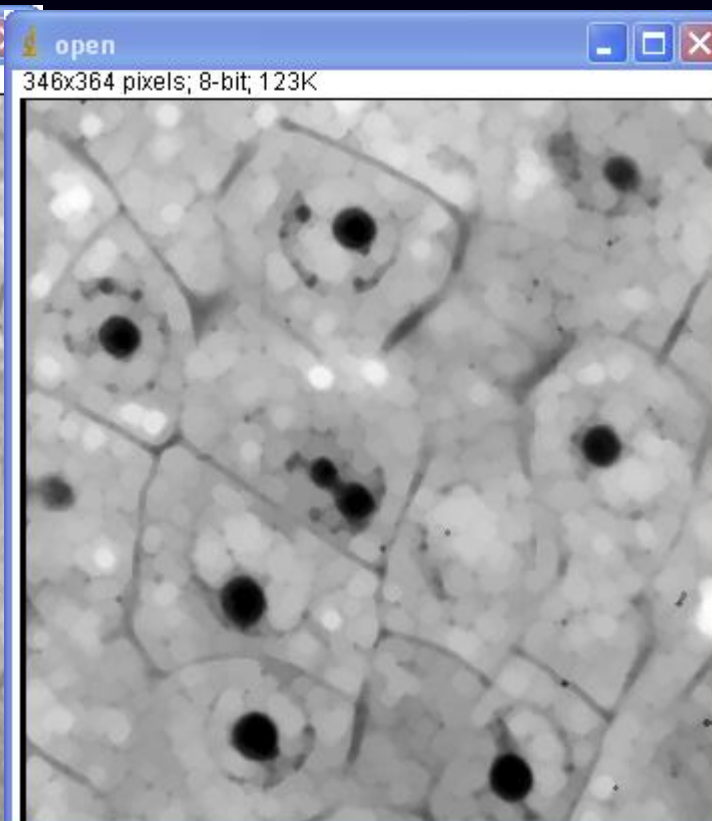
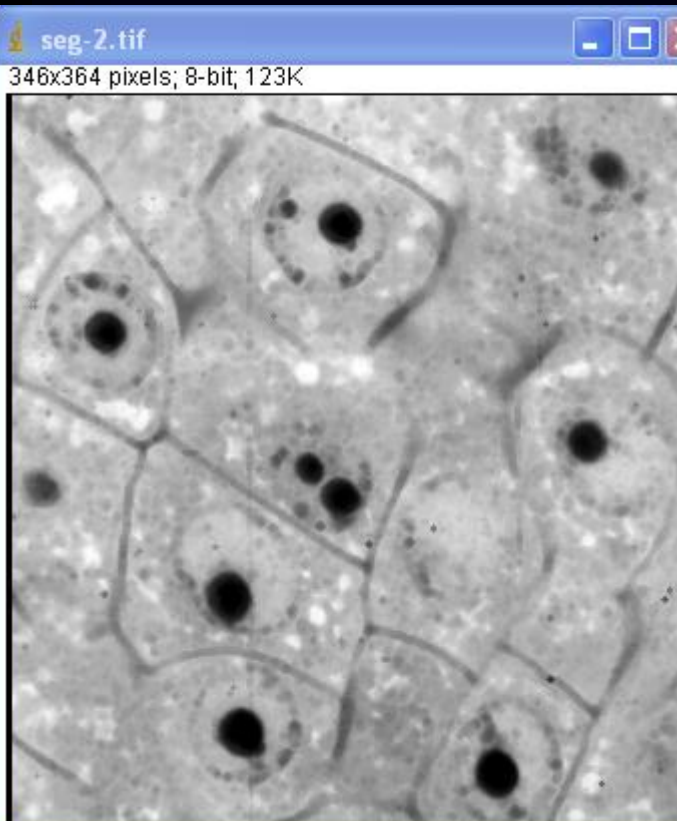


**Dilatation
agrandit les zones
claires**

Plugins → Morphology → Gray Morphology



Morpho_math en niveaux de gris



Ouverture
Erosion puis
Dilatation
supprime les petites
zones claires

Fermeture
Dilatation puis
Erosion
supprime les petites
zones sombres

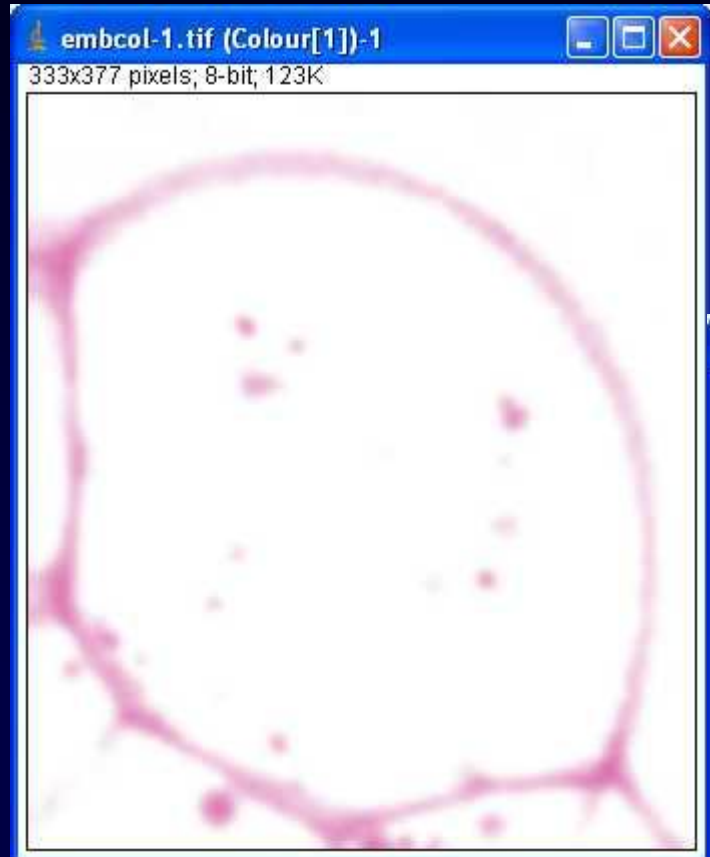
Plugins → Morphology → Gray Morphology



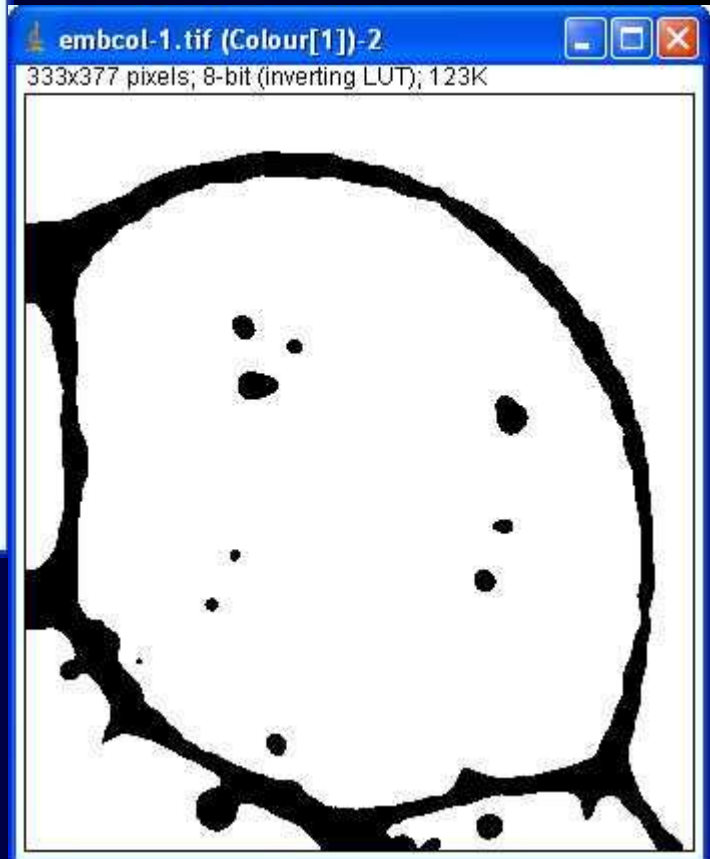
Exemple



Colour Deconvolution



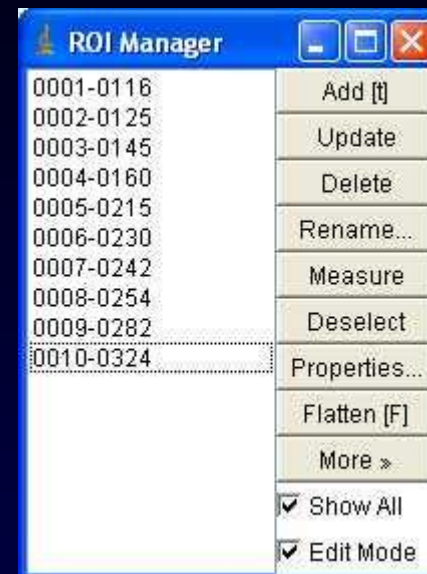
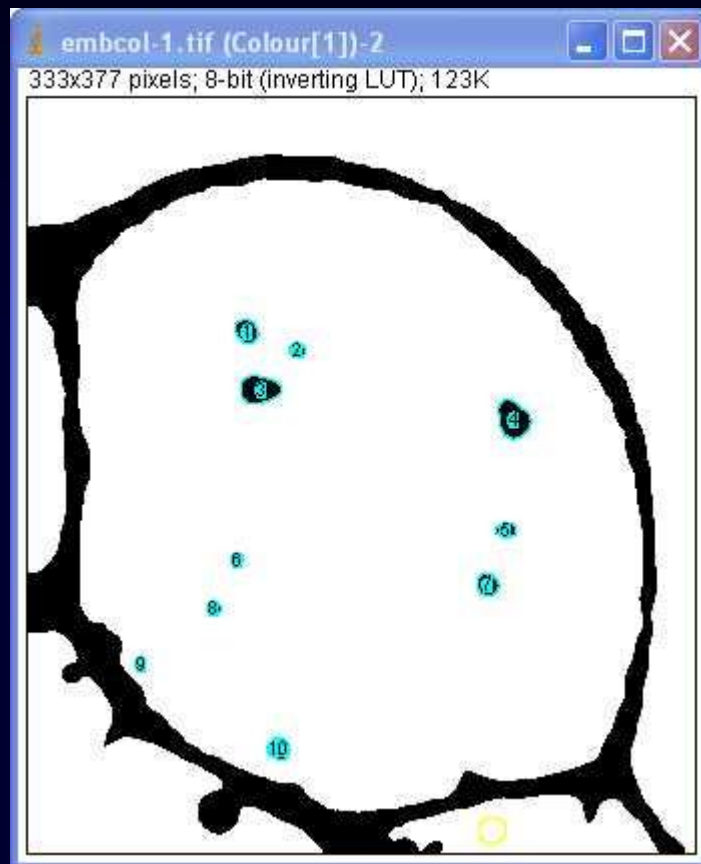
Seuillage





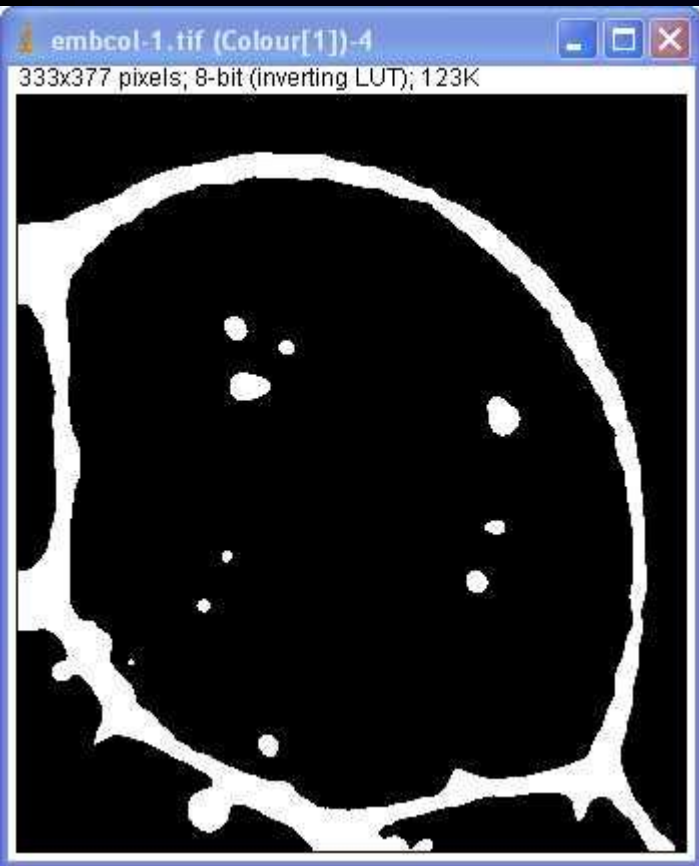
Exemple

Analyse particules → ROI Manager

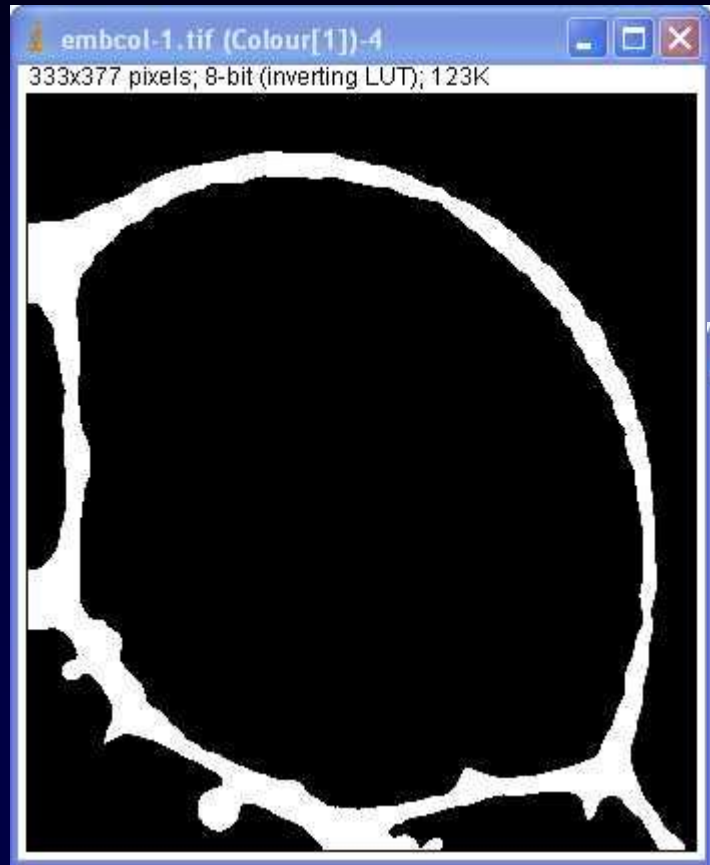


Exemple

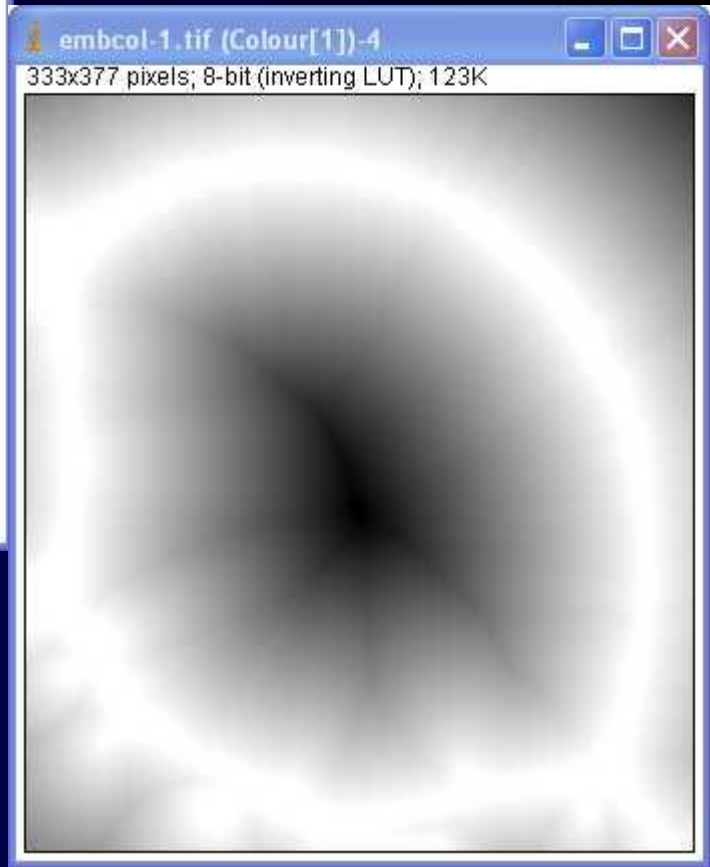
Inversion



Boucher les trous



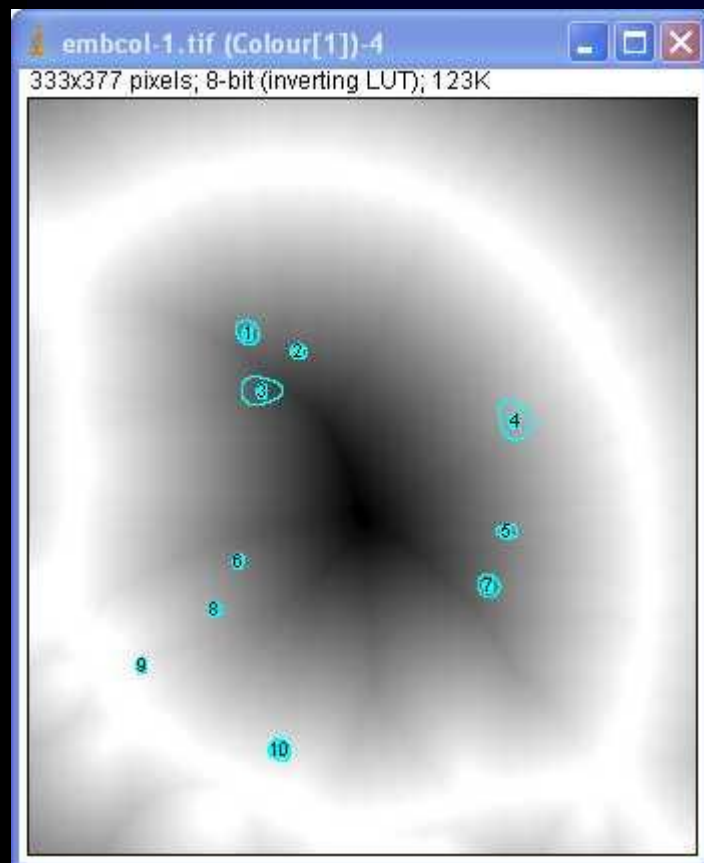
Carte des distances





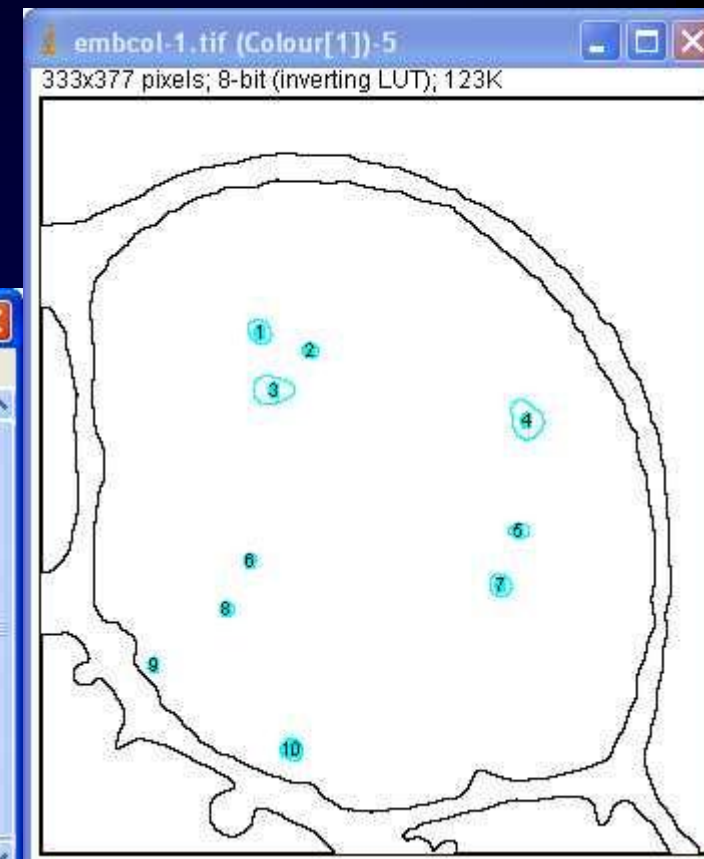
Exemple

Mesures des moyennes de niveaux de gris
sur la carte des distances →
Estimation de la position des grains d'amidon
dans la cellule



ROI ID	Bounding Box
0001	0116
0002	0125
0003	0145
0004	0160
0005	0215
0006	0230
0007	0242
0008	0254
0009	0282
0010	0324

ROI ID	Area	Mean
1	107	72.196
2	46	84.174
3	220	89.295
4	235	46.170
5	57	67.368
6	24	71
7	95	76.737
8	33	49.273
9	7	8.143
10	88	16.625





Topic 09 – Mathematical Morphology



L'image numérique

Les Prétraitements

La Segmentation

Les Post-traitements

La Quantification



Mesures

ImageJ

File Edit Image Process **Analyze** Plugins Window Help

Segmented line selections

- Measure Ctrl+M
- Analyze Particles...
- Summarize
- Distribution...
- Label
- Clear Results
- Set Measurements...

- Set Scale...
- Calibrate...
- Histogram Ctrl+H
- Plot Profile Ctrl+K
- Surface Plot...
- Gels
- Tools

Analyze Particles

Size (pixel²):

Circularity:

Show:

Display results Exclude on edges
 Clear results Include holes
 Summarize Record starts
 Add to Manager In situ Show

OK Cancel Help

Set Measurements

Area Mean gray value
 Standard deviation Modal gray value
 Min & max gray value Centroid
 Center of mass Perimeter
 Bounding rectangle Fit ellipse
 Shape descriptors Feret's diameter
 Integrated density Median
 Skewness Kurtosis
 Area fraction Stack position

Limit to threshold Display label
 Invert Y coordinates Scientific notation

Redirect to:

Decimal places (0-9):

OK Cancel Help

Histogram of Cellules

300x240 pixels; 8-bit; 70K

Count: 1655680 Min: 0
 Mean: 177.263 Max: 255
 StdDev: 54.860 Mode: 248 (64439)

List Copy Log Value: 238
 Count: 10284

Set Scale

Distance in Pixels:

Known Distance:

Pixel Aspect Ratio:

Unit of Length:

Scale: 1200 pixels/inch

Global

OK Cancel

Plot of Cellules

520x250 pixels; 8-bit; 126K

Gray Value

Distance (inches)

List Save... Copy... X=0.43, Y=244.3



Mesures

- Longueur
- Surface
- Périmètre
- Moyenne des valeurs de niveaux de gris
- Niveau de gris le plus fréquent (sommet de l'histogramme)
- Min et Max des niveaux de gris
- Centroid : moyenne des x,y
- Center off mass : moyenne des x,y pondérée par les intensités de niveaux de gris
- Circularité : $4\pi(\text{surface} / \text{périmètre}^2) = 1$ pour un cercle
- Etc ...



Topic 10 – Quantification