1. Describe the steps of image formation (on the observer's retina or on a CCD camera sensor) in a transmission optical microscope.
2. Describe what is meant by numerical aperture, its range of values, and how it is related to the image formation.
3. Describe what is the size and shape of the image (on the image plane of a microscope) of a point-like source of light.
4. Describe what are the connections, if any, between magnification, resolution and pixel size.
5. Describe what is the "point spread function" and how it is related to the property of the microscope.
6. Describe what it is meant by Fourier component of an image, and what are the parameters that describe each Fourier component of a 2D image.
7. Describe the relationship between the Fourier component of an image and the resolution of the microscope used to acquire it.
8. Discuss the pros and cons of confocal microscopy over conventional fluorescence microscopy. Is there a gain in resolution?
9. Describe how a moonbeam confocal microscopy obtains three-dimensional images.
10. Describe how a multibeam confocal microscopy obtains three-dimensional images.
11. Describe the resolution of a confocal microscope.
12. Describe the difference in the structure of monobeam vs. multibeam confocal microscopes.
13. Describe the working principle of light sheet microscopy.
14. Describe what is commonly done, in terms of analysis, when a sample is marked by two or three different fluorophores which have some degree of overlap in the emission spectra.
15. Describe the principles of SNOM microscopy.
16. Describe the concept and the main features of two-photon microscopy.
17. Describe how is it possible to obtain 3D images in two-photon microscopy.
18. What are the pros and cons of two-photon microscopy with respect to linear fluorescence microscopy, either traditional or confocal?
19. Describe what type of illumination of the sample (wavelength, shape, timing) is used in STED microscopy.
20. Why does STED microscopy enable super-resolved images?
21. Describe the working principle of STED microscopy.
22. Describe the interplay of image (fluorescence) intensity and resolution in STED microscopy.
23. Describe the working principle of TIRF microscopy.
24. Describe how samples are illuminated in TIRF microscopy.
25. Describe an example of use of TIRF microscopy and discuss why this technology has offered an advantage.
26. Describe the working principle of PALM microscopy.
27. Describe which factors control the resolution in PALM microscopy.
28. What are photoactivable fluorophores? How are they used in microscopy?
29. List in which way the various super-resolved microscopies presented in the class do not form linear images of the samples.
30. Discuss why mixing can be a problem in microfluidic devices and its solutions.
31. Describe the main features of the two families of microfluidic devices
32. Describe an example of use of a microfluidic device.
33. Describe what is measured in depolarized fluorescence.
34. Describe what information is carried by depolarized fluorescence and how it can be of use.
35. What are "quantum dot" particles? What could they be used for?
36. Why are magnetic nanoparticles used in magnetic resonance imaging?

37. How can the aggregation of gold nanoparticles be measured and exploited for molecular detection?
38. Describe how the optical properties of nanometallic particles and quantum dots depend on their size.
39. What is it meant with bioconjugation of nanoparticles? Make a list of molecules used to bioconjugate nanoparticles and their goal.
40. How can magnetic nanoparticles be used to control the local temperature of the tissue hosting them?
41. Describe a bioconjugation strategy for the internalization of nanoparticle in cells.
42. Describe the principle of laser tweezing.
43. Describe how laser tweezers can be used to measure biomolecular properties and which quantities can be determined.
44. Describe what it is meant by label-free biosensors and how they differ from ELISA essays.
45. Describe the working principle of Surface Plasmon Resonance biosensors.
46. Describe how Surface Plasmon Resonance biosensing are generally used: which quantities can be measured or deduced?
47. How do “contact mode” and “tapping mode” AFM procedures differ from each other?
48. Describe the working principle of AFM and what does its resolution depends on.
49. Describe how the kinetic parameters k_{on} and k_{off} can be determined using a label-free biosensor.
50. Describe RGB coding and its relationship with human vision.
51. Describe main features that define an electronic image.
52. If one would need to capture an electronic image with a microscope to observe tiny features and tiny changes of luminosity, what are the crucial requirements for the electronic image?
53. Describe what it is image depth. How is it determined in an image? Is it the same for all electronic images?
54. An 8-bit image taken with a microscope have many pixels whose value is saturated, what does it mean? Could that be an issue? Would be the same if they were 0?
55. Give a quantitative estimate of the size (in bits and in bytes) of a false color image 1000x600px with 6 (8-bit) color channels. Would it be a realistic situation?
56. Describe the main difference between GIF/PNG formats and TIFF
57. Describe what lossy o lossless compressions are. Why lossy compressions are used?
58. Describe the relationship between JPEG compression and FFT (Fast Fourier Transform).
59. Why stacks of images are useful in confocal microscopy? How many dimensions does an image stack have?
60. Define what is an image stack. Describe at least two situations in which stacks are useful.
61. A 16-bit monochromatic image is visualized with a color LUT. Is that a color image? How many color planes does the image have? Discuss the answer
62. Define what is a LUT (Look Up Table). Give an estimate for the number of lines of a lookup table used in an 16-bit image. And in an RGB image?
63. Why LUT are used in electronic imaging? If I change LUT, am I changing image information?
64. Define what does it mean to change brightness and contrast of an image. Are both reversible processes? Discuss the answer.
65. Describe the steps that one must do to binarize an image. Why binarization is used? Is it a technique free from subjective interpretations?
66. What process can I perform if I want to extract topological information from an image (area, perimeter, distances…)? Do I need to have a calibrated image?
67. Describe how can FFT (Fast Fourier Transform) be used to assess the background of an image.
68. Why time-lapse and slow-motion videos are used in scientific measurements? If one wants to obtain a 100x slow-motion, what is the framerate that need to be set on the camera? How much longer will be the slow-motion video to have a fluid visualization?
69. What happens if I subtract two images? What is a situation in which image subtraction could help?