

Illuminating Biology With Light

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Abstract: Light is one of the most natural, ubiquitous constituents of our environment and plays a central role throughout life's kingdoms. It is the ultimate source of fuel for our planet. Plants transform this source of energy into a form that can be used by biological systems for sustaining life as we know it. Even though light is one of the most common occurrences in our lives, describing the fundamental nature and physics of light, realizing its effect on our everyday life and culture, and understanding its effects on biological systems has been a major source of inquiry and wonder since the beginning of civilization. In the last century light also became an important tool for investigating many natural phenomena, and was the basic experimental basis of our modern view of the physical world. Recently light has also become a major tool for understanding many facets of biology. To understand how these applications are accomplished we first describe some basic, simple physical properties of light and its interaction with matter. Then we will give examples of modern uses of light for investigating biological systems, from the molecular and cellular scales, up to organisms and medical applications.

Organisms

AC excitation
DC excitation
phase difference
AC emission
DC emission
 $\tan(\phi_{ex} - \phi_{em}) = \omega\tau_{mean}$
time resolution at every pixel simultaneously
image focused on the pixel array
 $A_{ex}^0 + A_{ex} \sin(\omega t + \phi_{ex})$
 $A_{em}^0 + A_{em} \sin(\omega t + \phi_{em})$
object

Molecules

Cells

Photons
 $E = h\nu$

Medical Imaging

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