林盈廷

高雄醫學大學
生命科學院
生物科技學系 助理教授

第一教學大樓 N1038 室
校內分機：2792
ytlin@kmu.edu.tw

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Biophysical Chemistry

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Reference Books

- Physical Chemistry for the Life Sciences
  (Engel, Drobny and Reid)
- Physical Chemistry for the Life Sciences
  (Atkins and de Paula)
- Biophysical Chemistry
  (James P. Allen)
- Biochemistry
  (Berg, Tymoczko and Stryer)

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Lecture

Pattern (模式)

New and also old scientific way to explore

科學探索的新方式

THE SCIENTIFIC METHOD

- **The scientific method -** a systematic approach to the discovery of new information

Characteristics of the scientific process

1. Observation
2. Formulation of a question
3. Pattern recognition
4. Developing theories
5. Experimentation
6. Summarizing information

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Pattern

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模式

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百合

http://nature.cs.nthu.edu.tw/image/pic/cat_115/763/763_1024x768.jpg

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毛茛

http://xyzw.plantlib.net/plant/Fam_Pic/%E6%AF%9B%E8%8C%9B%E7%A7%91.jpg

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飛燕草

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萬壽菊

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紫荛

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雛菊

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向日葵

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雛菊

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鳳梨

八列左斜，十三列右斜

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花瓣的數目

- 3, 5, 8, 13, 21, 34, 55, 89, 144, …

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苜蓿

http://www.cepolina.com/photo/2670.1108/b/b_416.2456.jpg

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苜蓿

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Leonardo Fibonacci, 1202

- rabbit growth
- 0,1,1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, …

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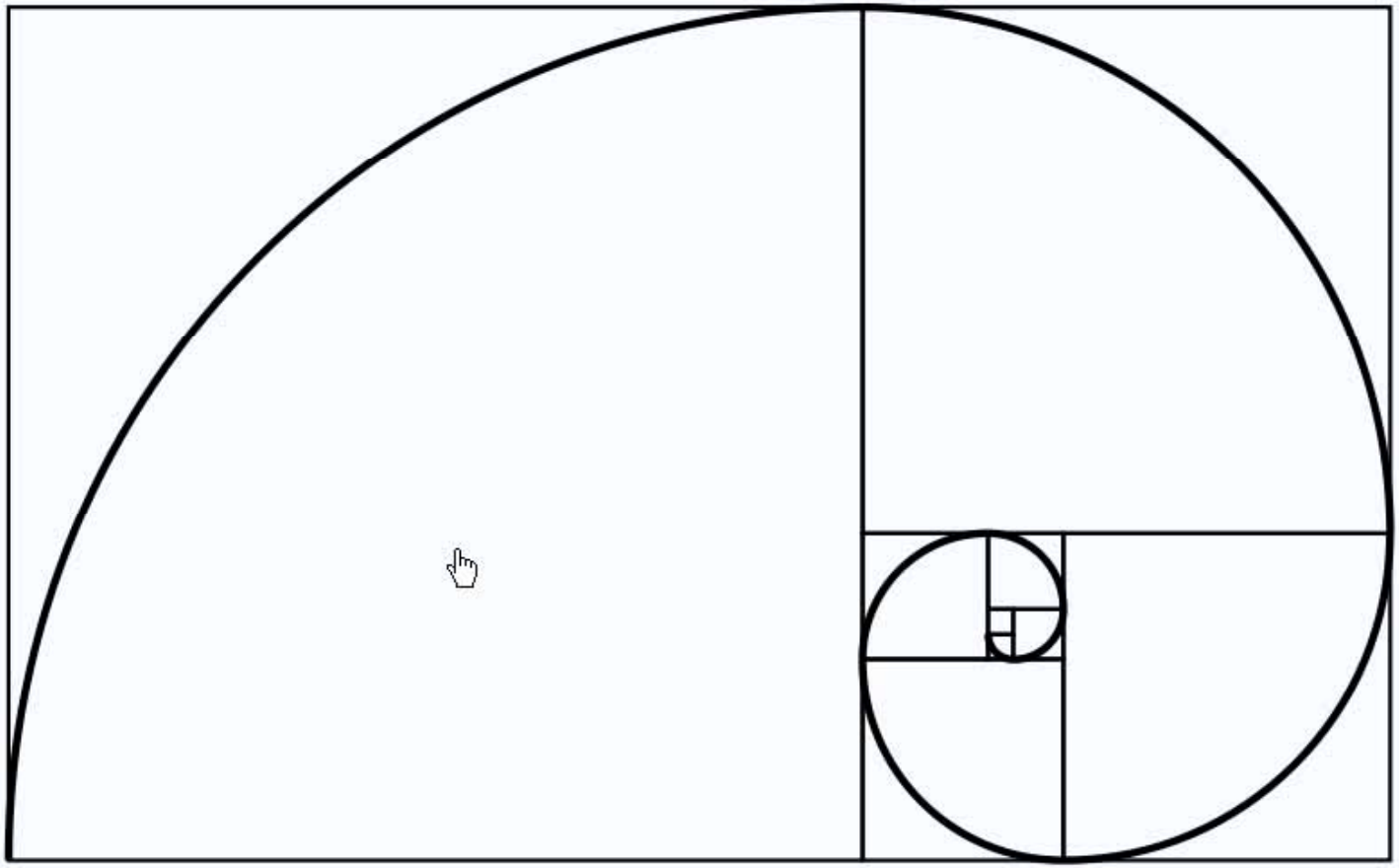
Fibonacci spiral



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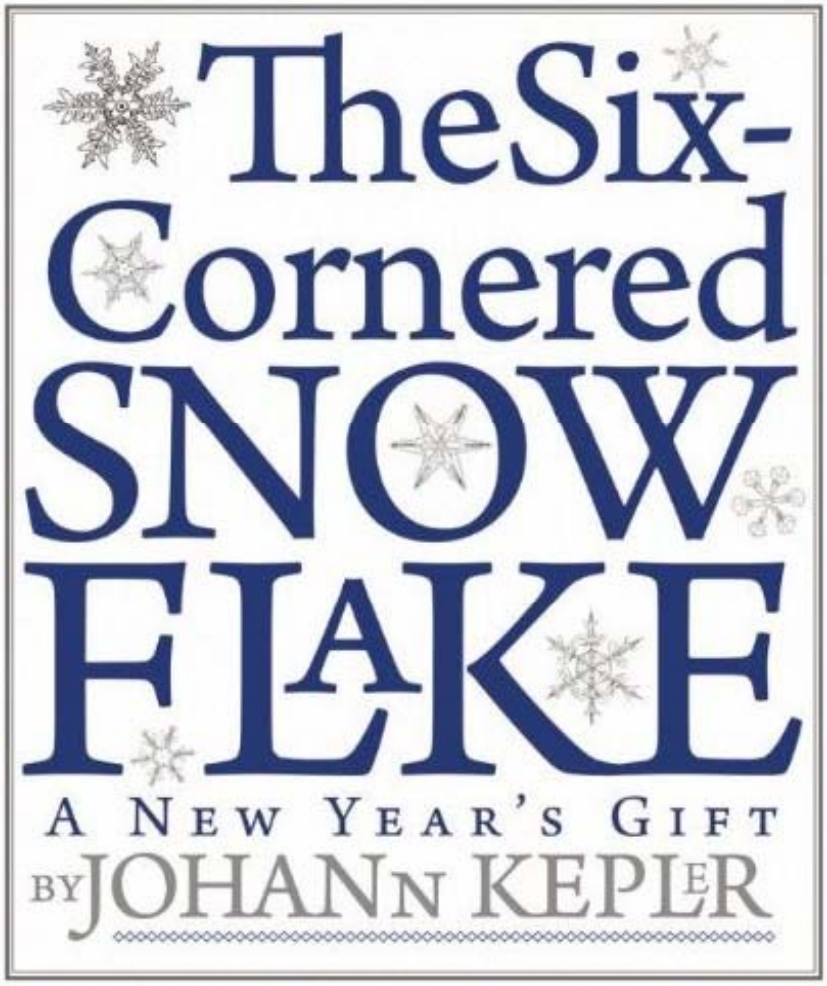
Johannes Kepler, 1571-1630



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Atomic Theory, 1803

- John Dalton

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某些模式一樣代表什麼？

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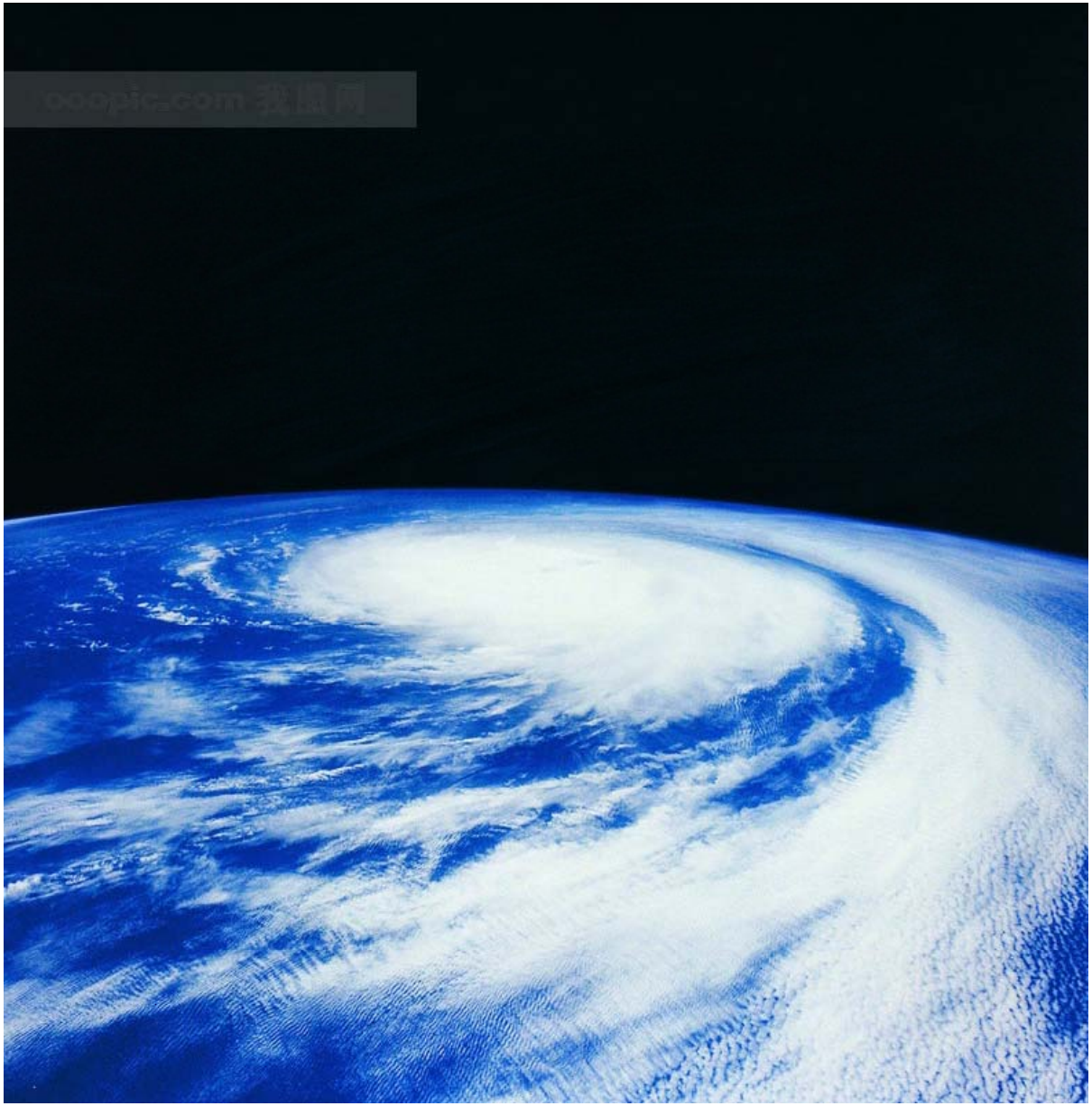

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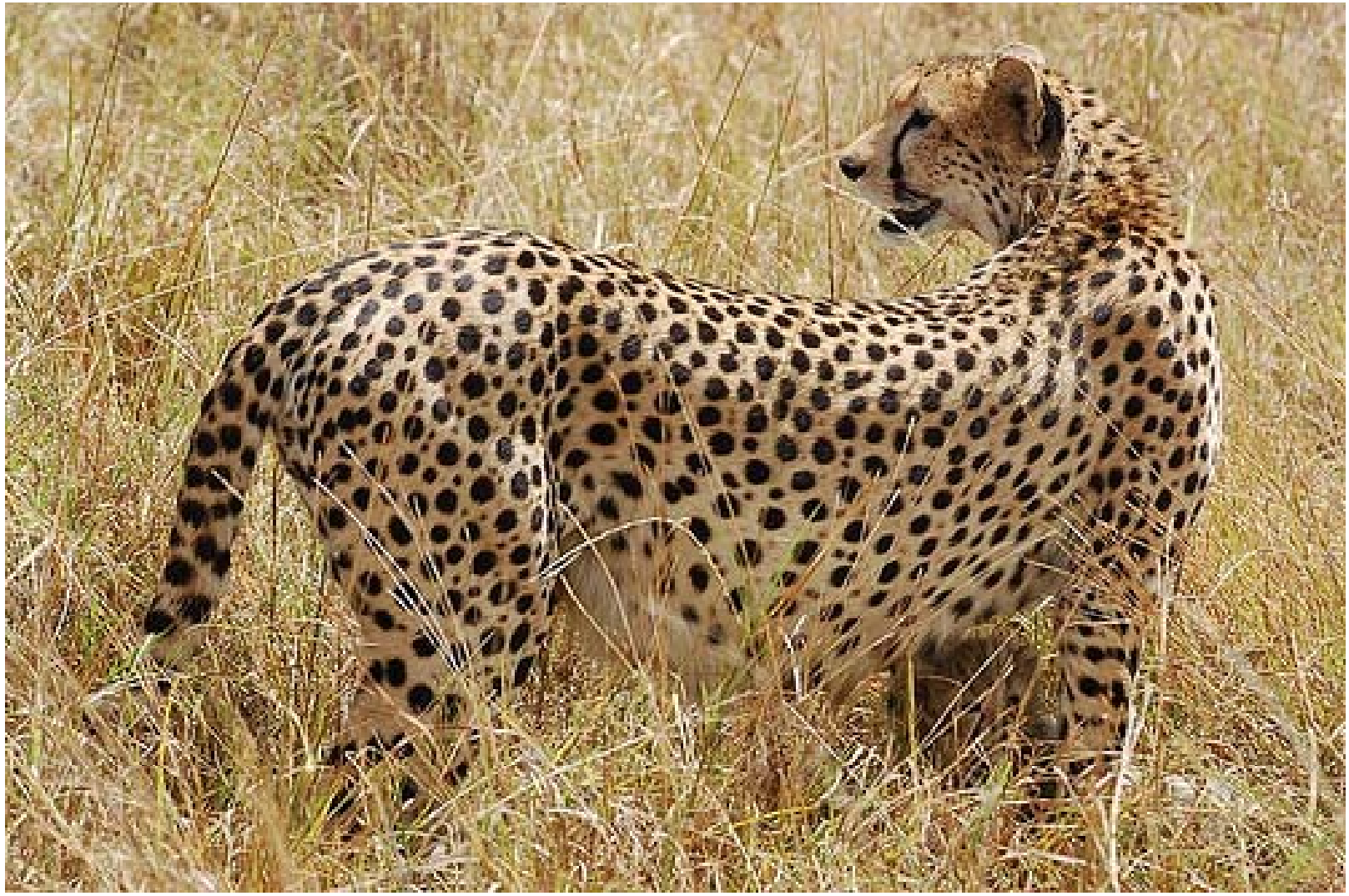

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模式

- 數字模式
- 幾何模式
- …

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某些模式一樣代表什麼？

代表背後有某種共通法則

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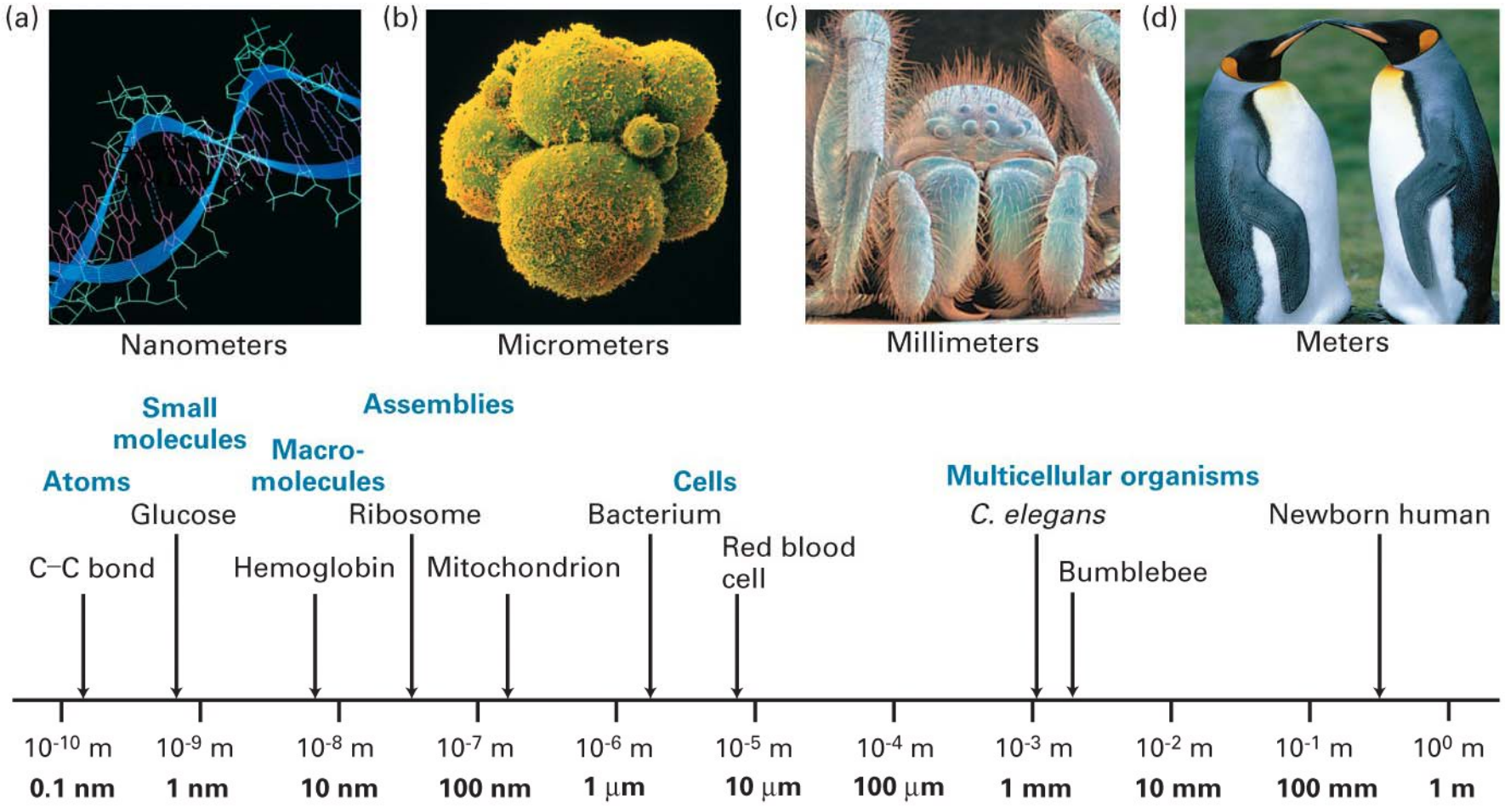

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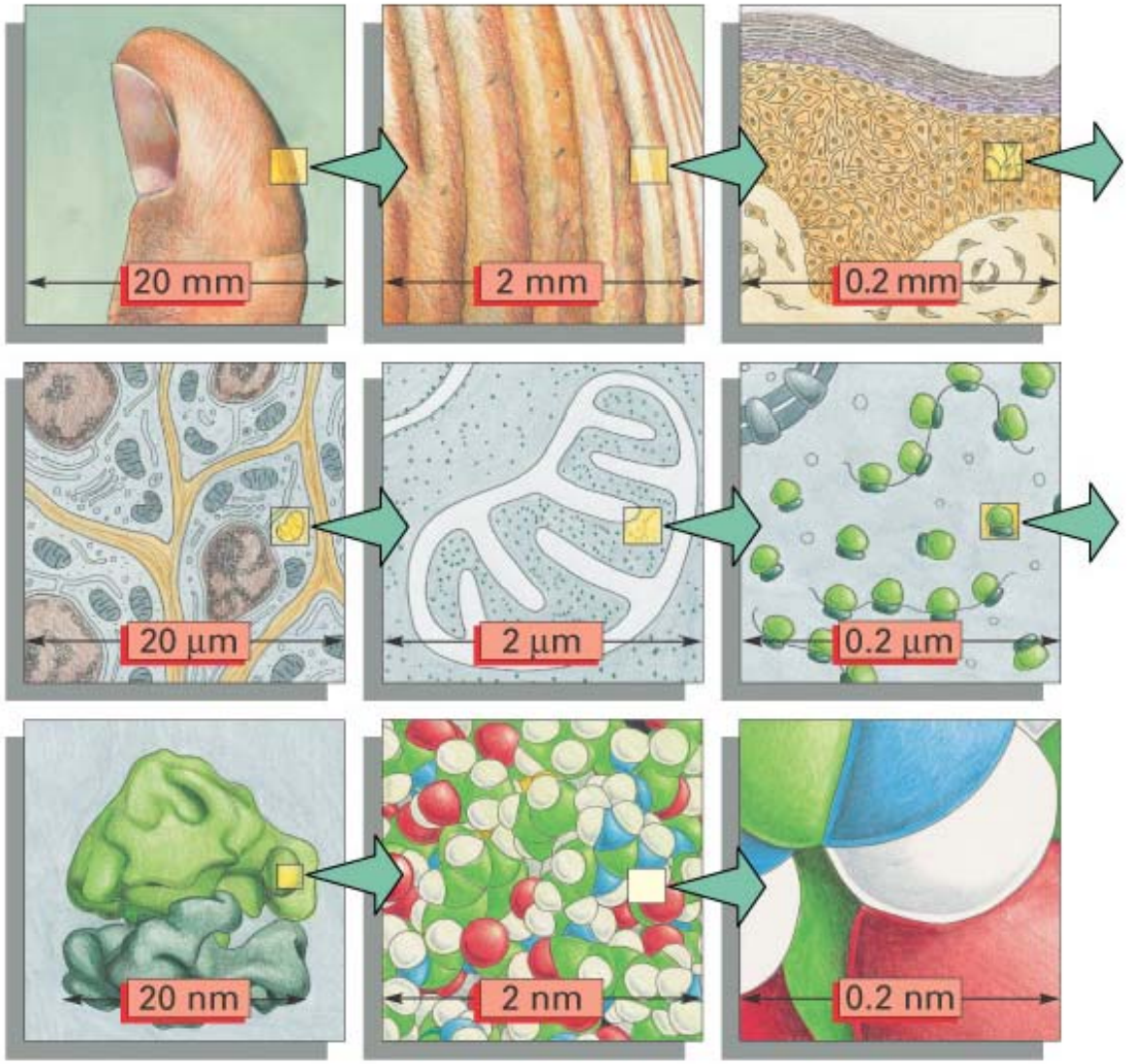

Figure 1-9 Essential Cell Biology, 2/e. (© 2004 Garland Science)

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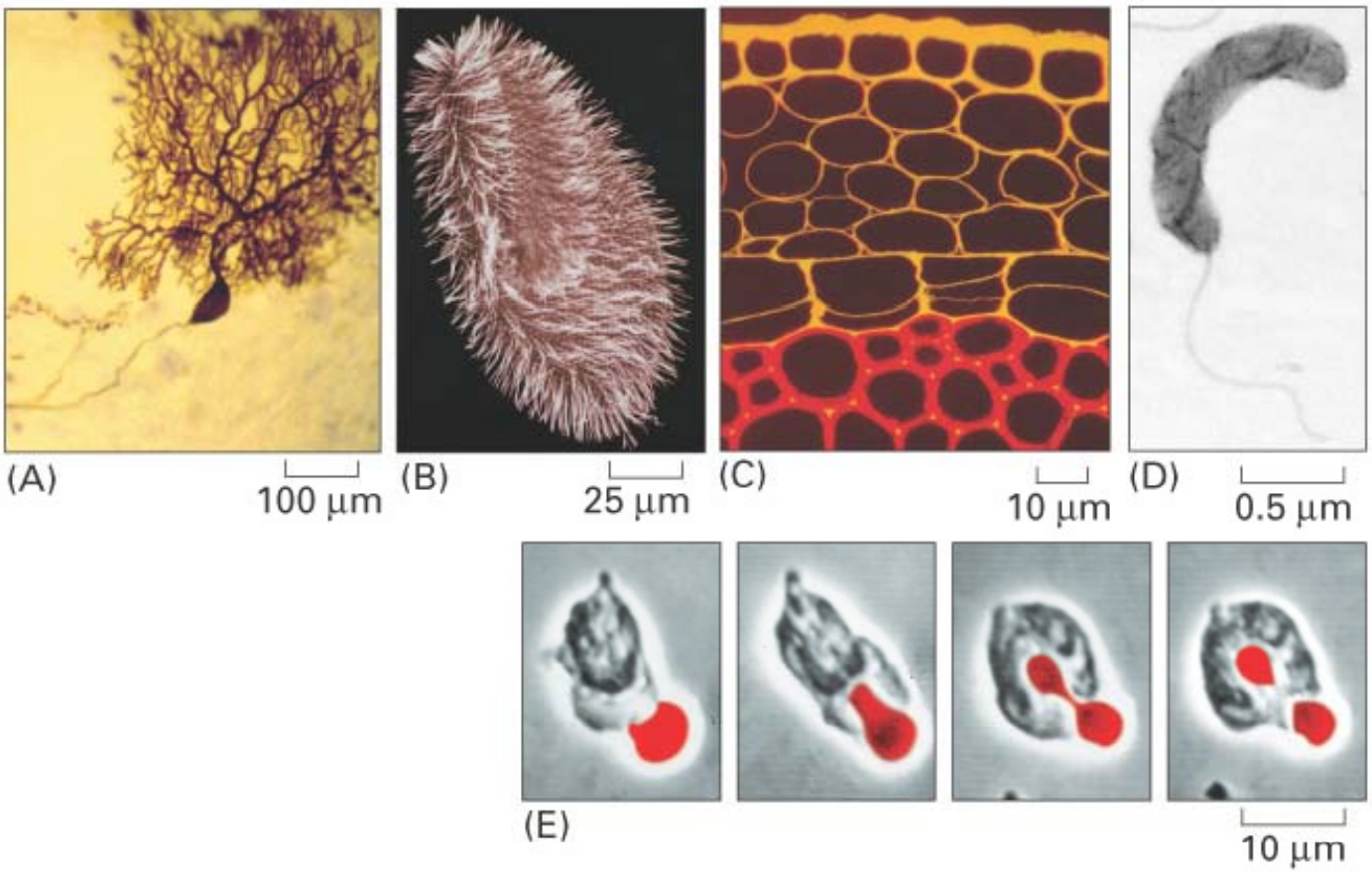

Figure 1-1 **Essential Cell Biology, 2/e. (© 2004 Garland Science)**

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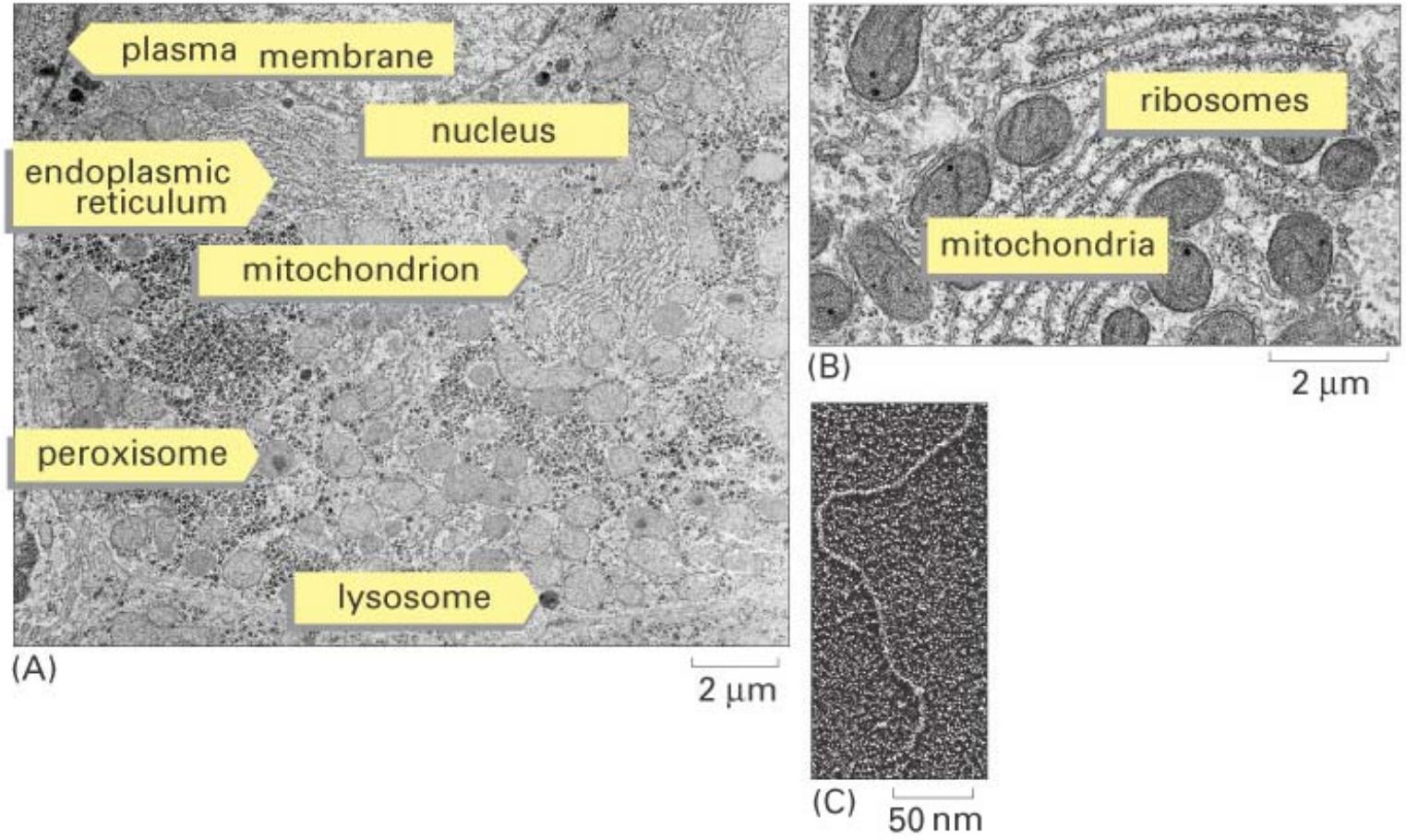

Figure 1-8 Essential Cell Biology, 2/e. (© 2004 Garland Science)

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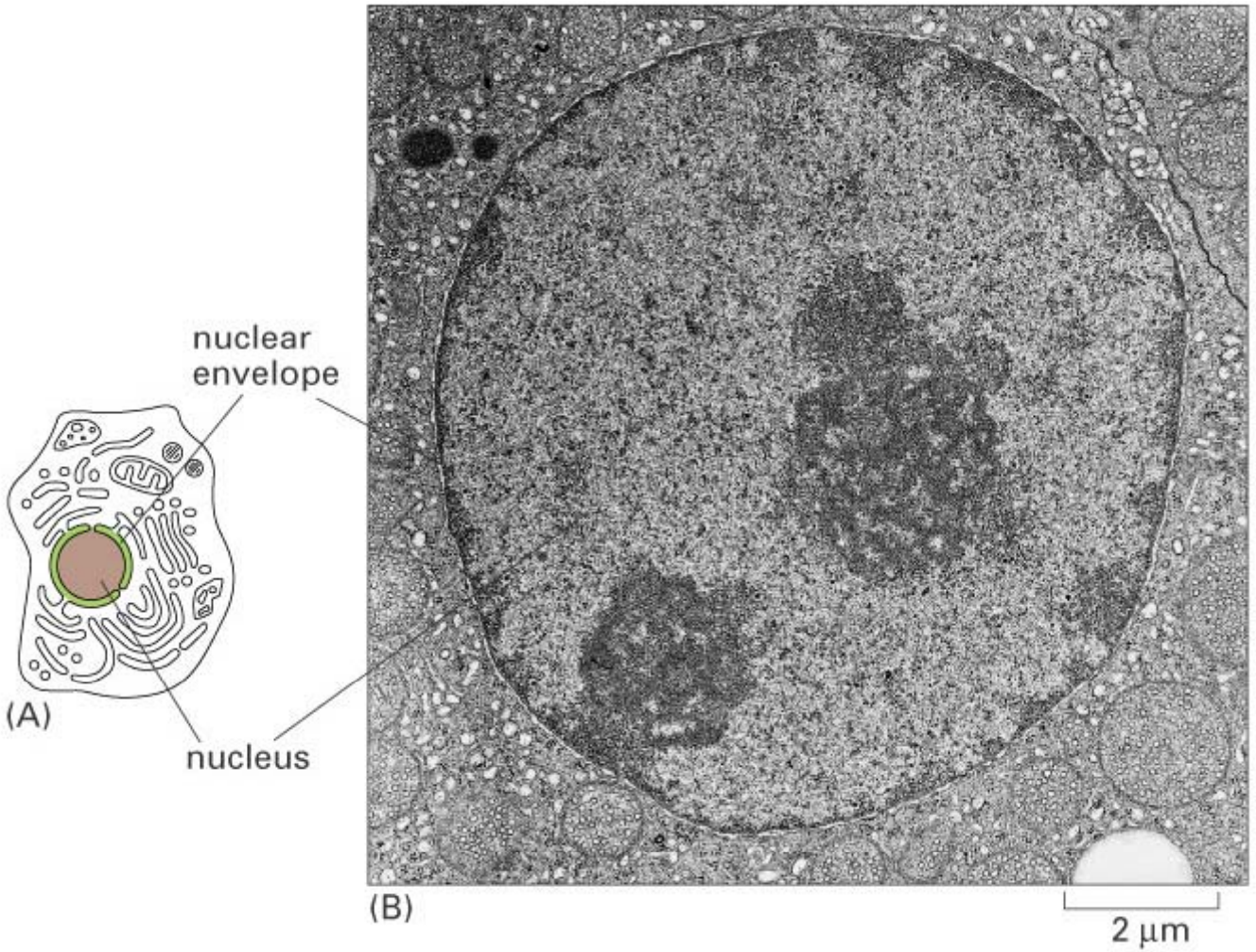

Figure 1-15 Essential Cell Biology, 2/e. (© 2004 Garland Science)

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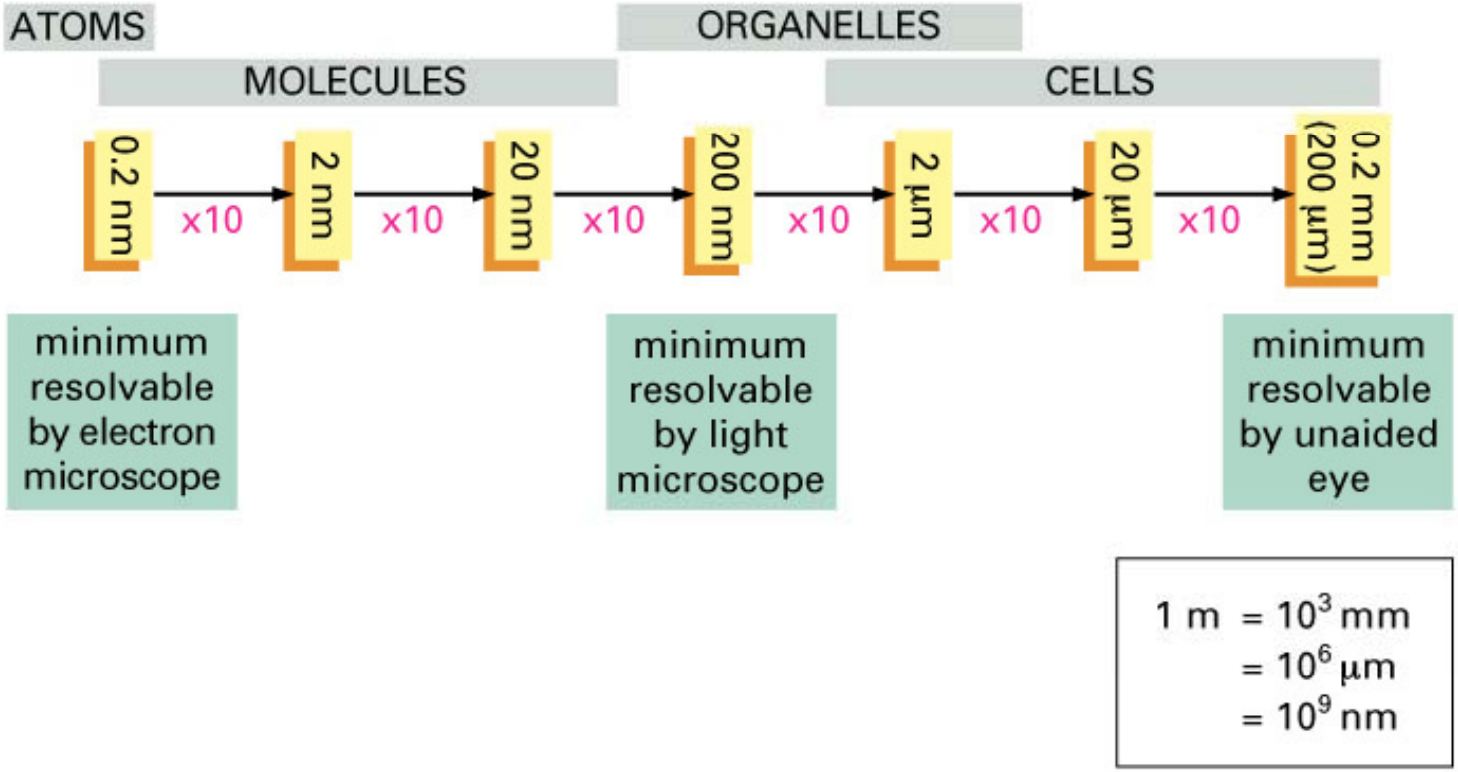

Figure 1-6 Essential Cell Biology, 2/e. (© 2004 Garland Science)

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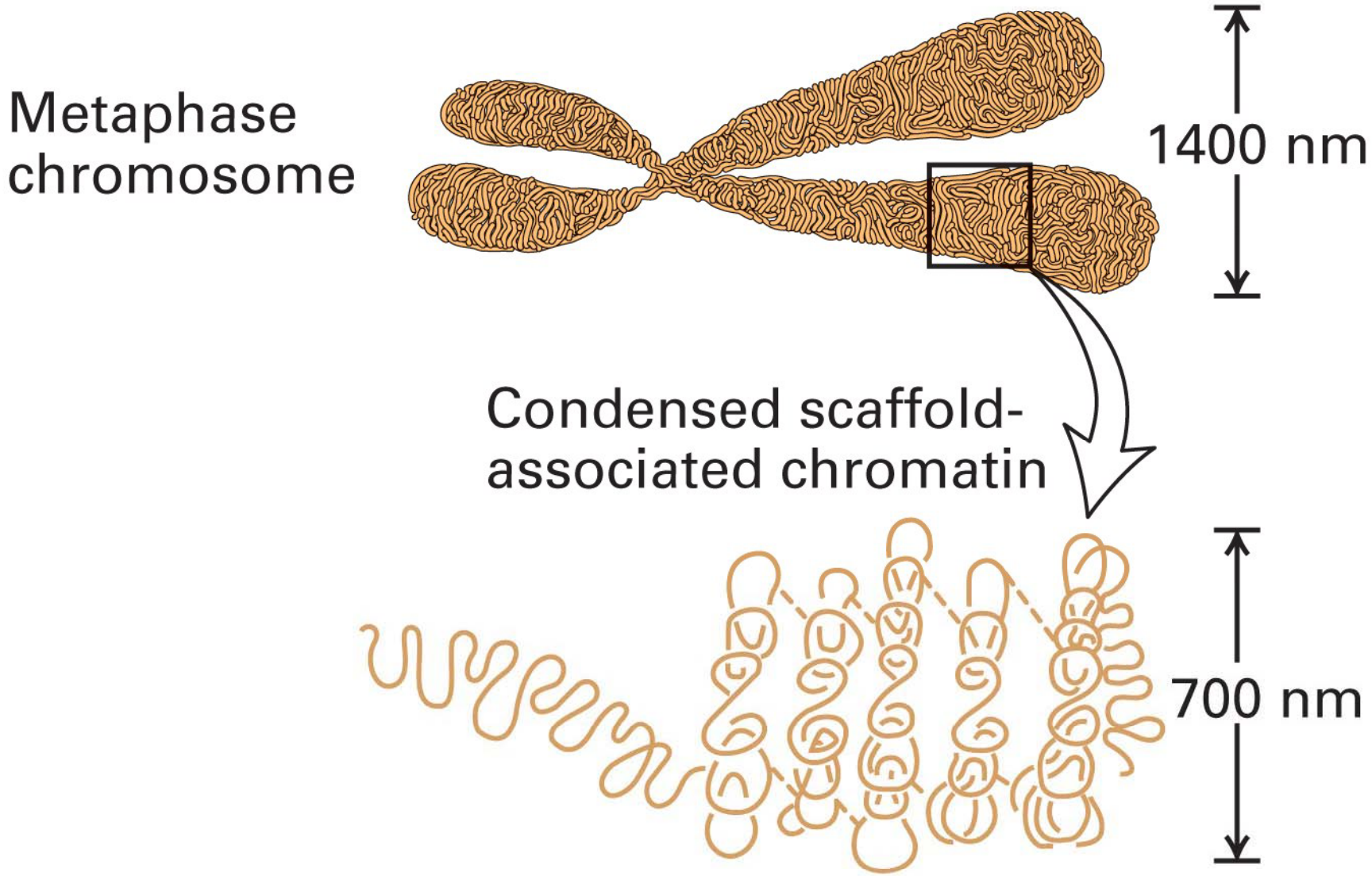

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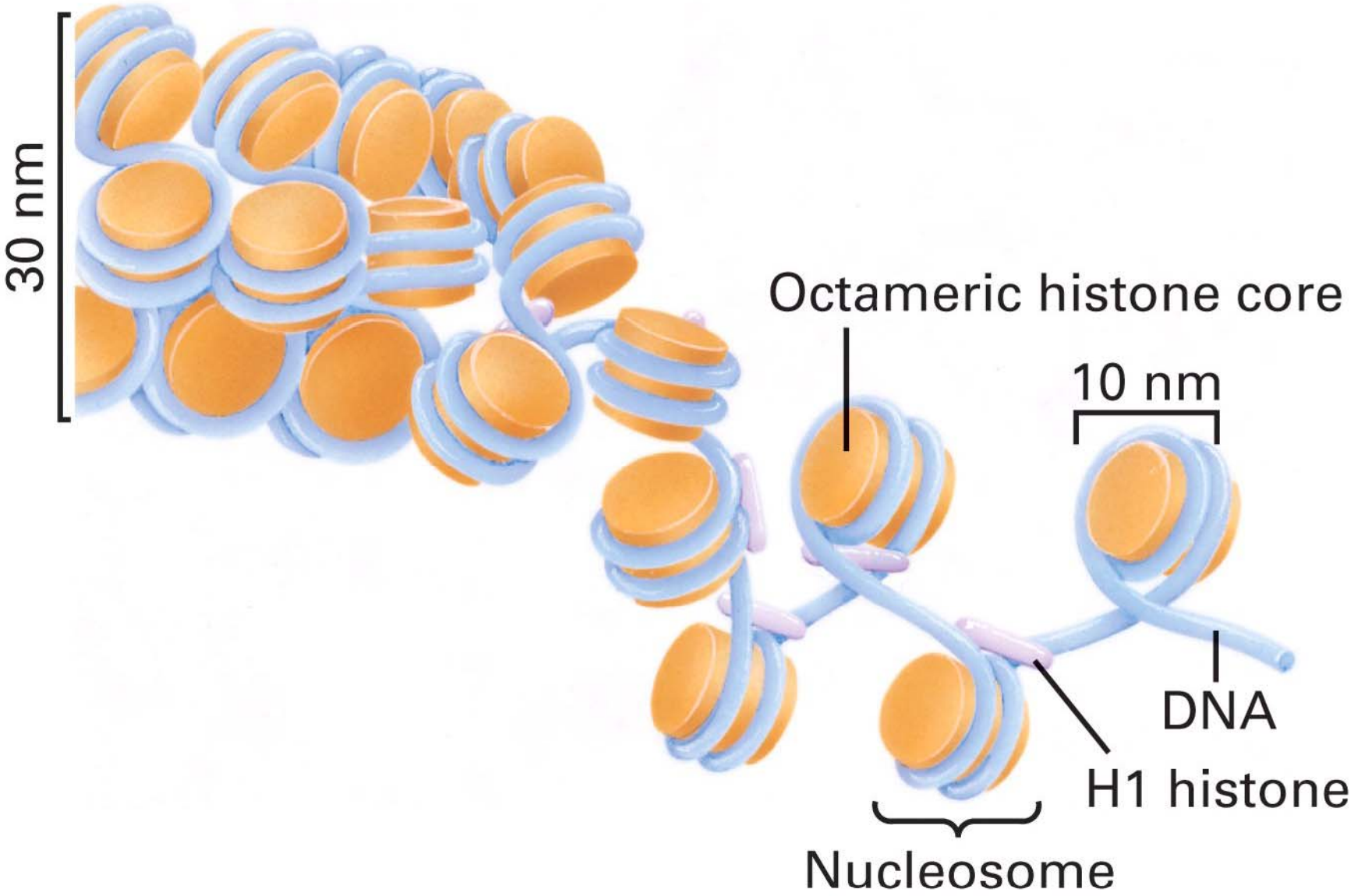

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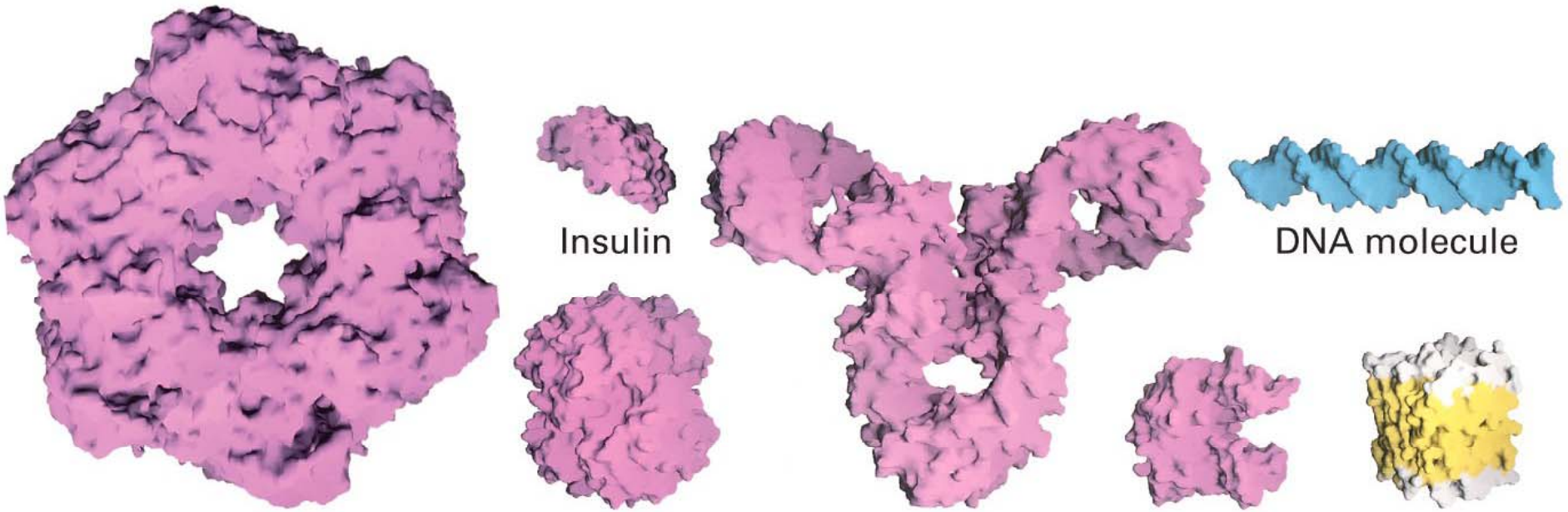

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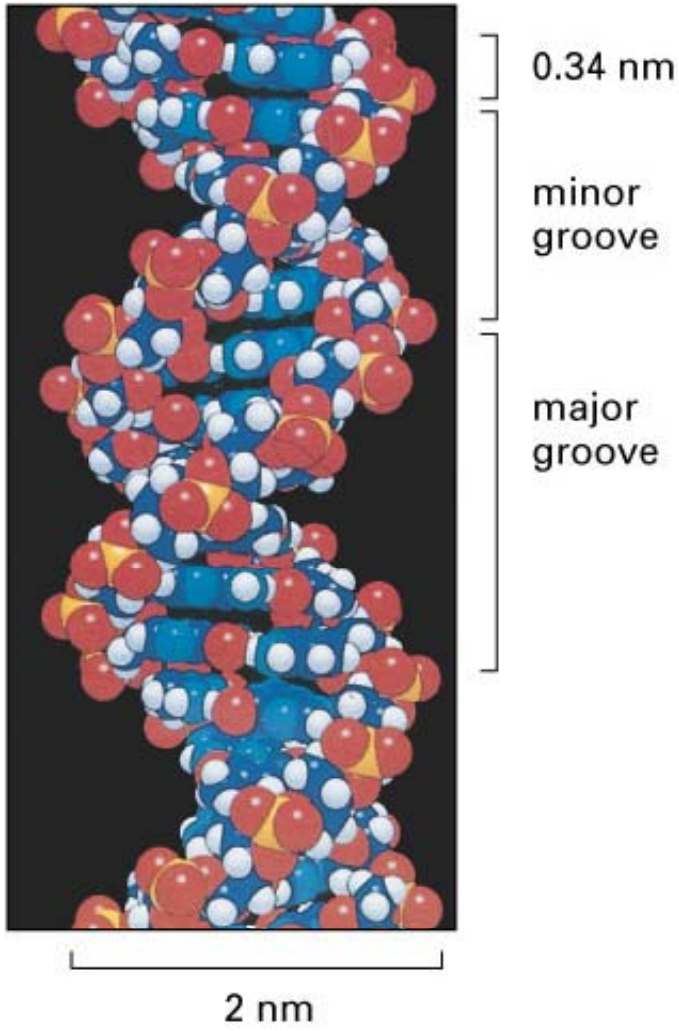

Figure 5-8 **Essential Cell Biology, 2/e. (© 2004 Garland Science)**

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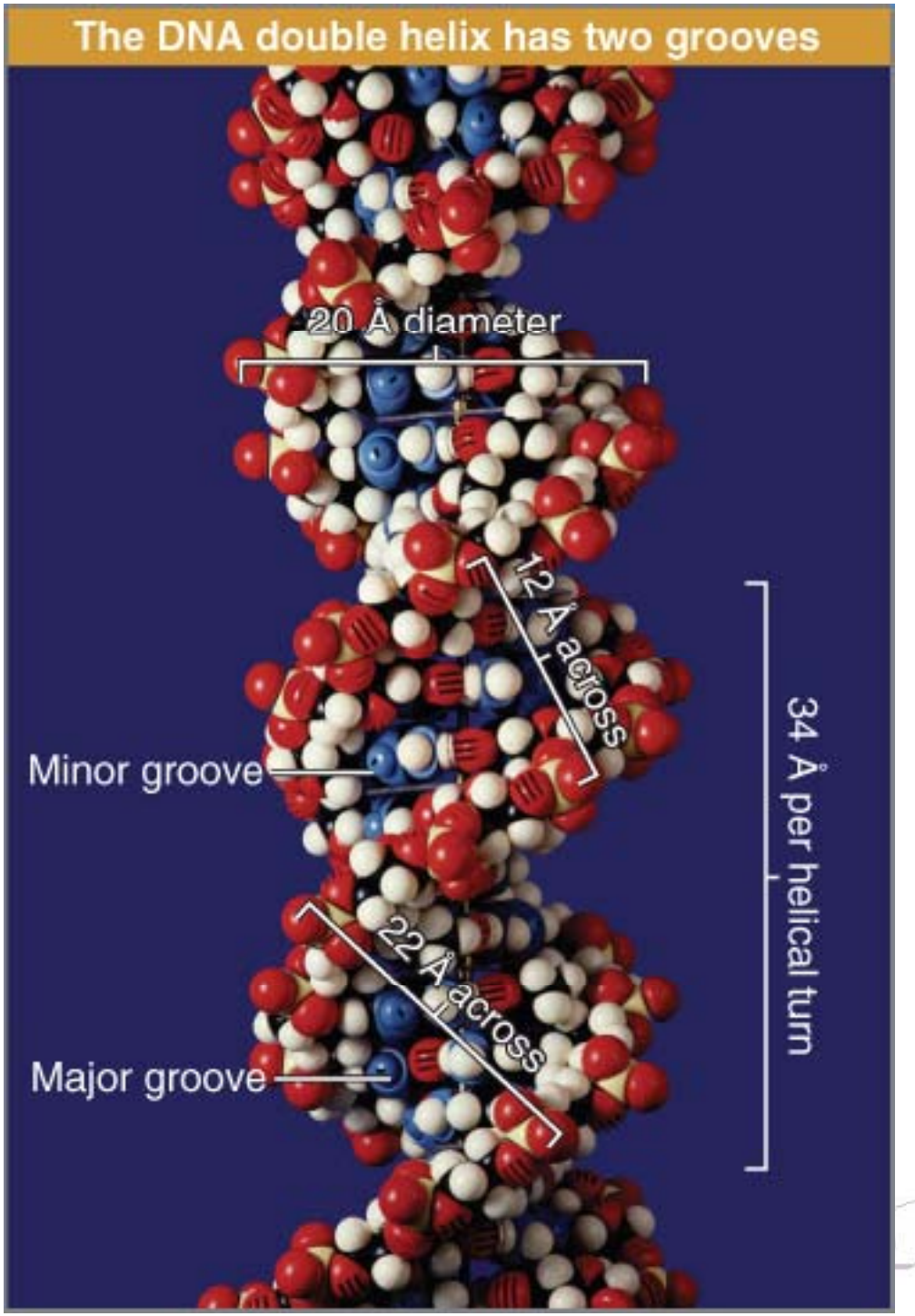

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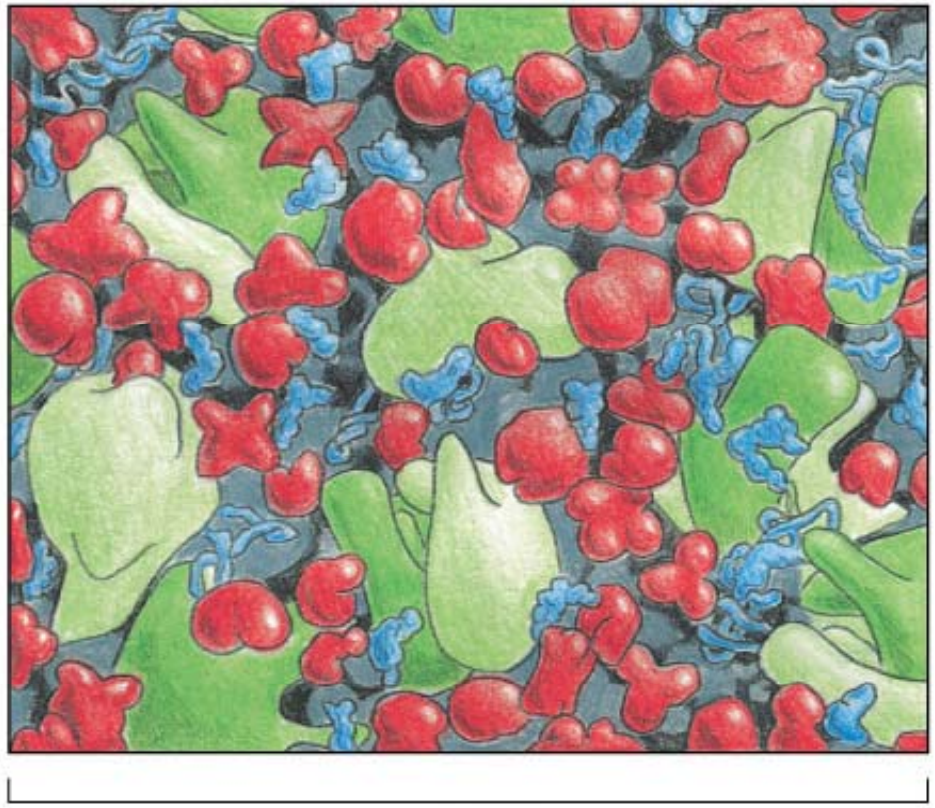

Figure 3-24 Essential Cell Biology, 2/e. (© 2004 Garland Science)

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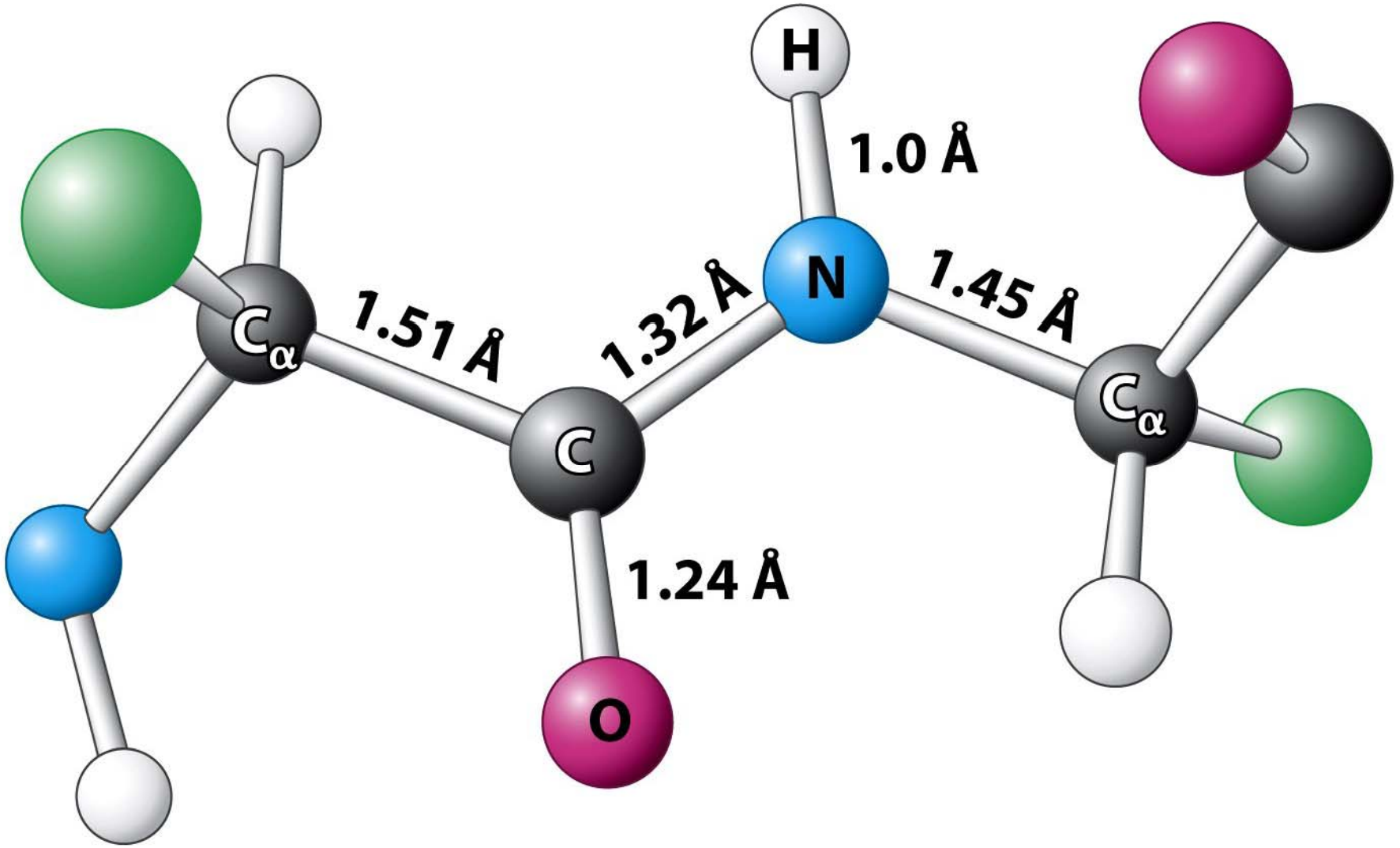

Figure 2-24
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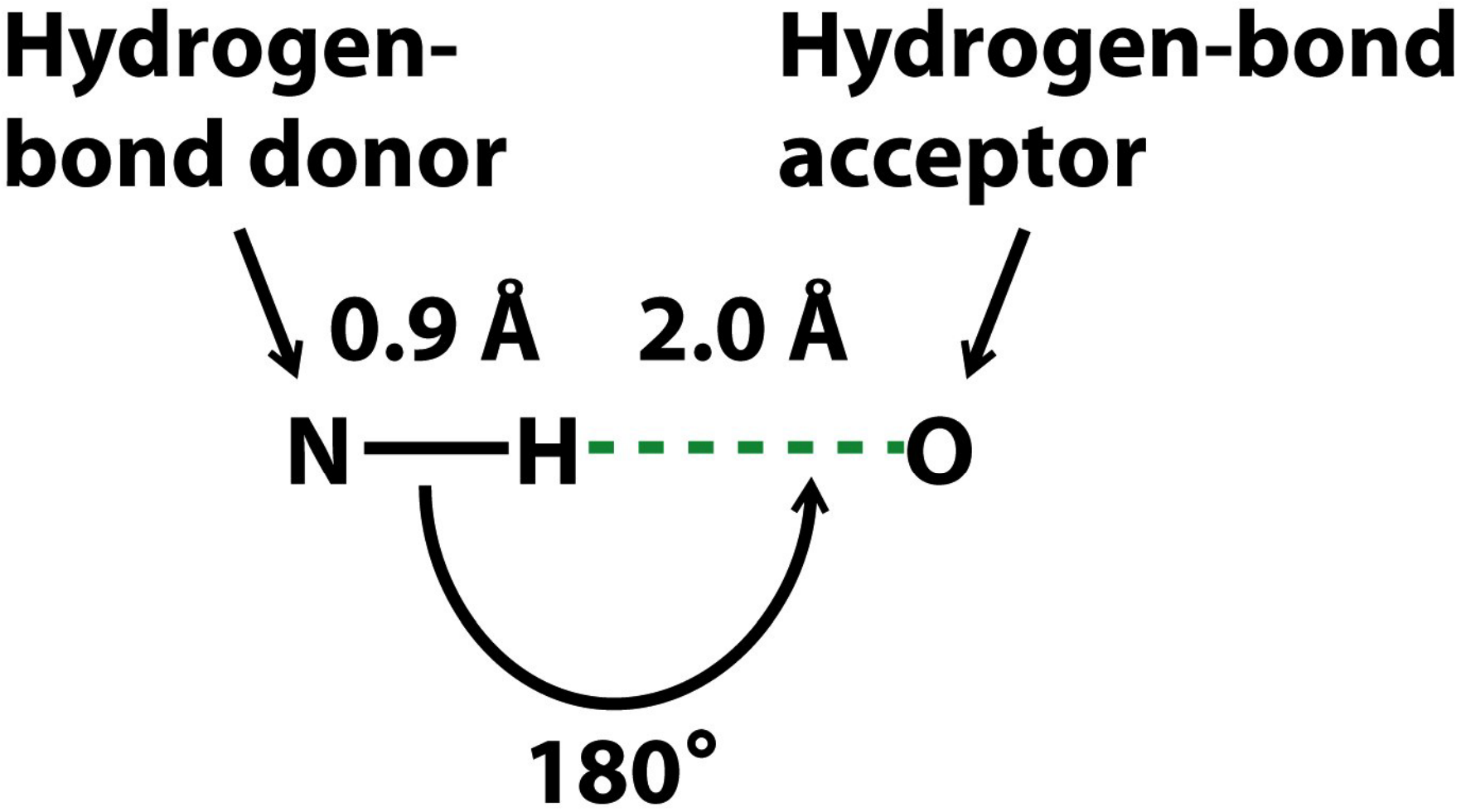

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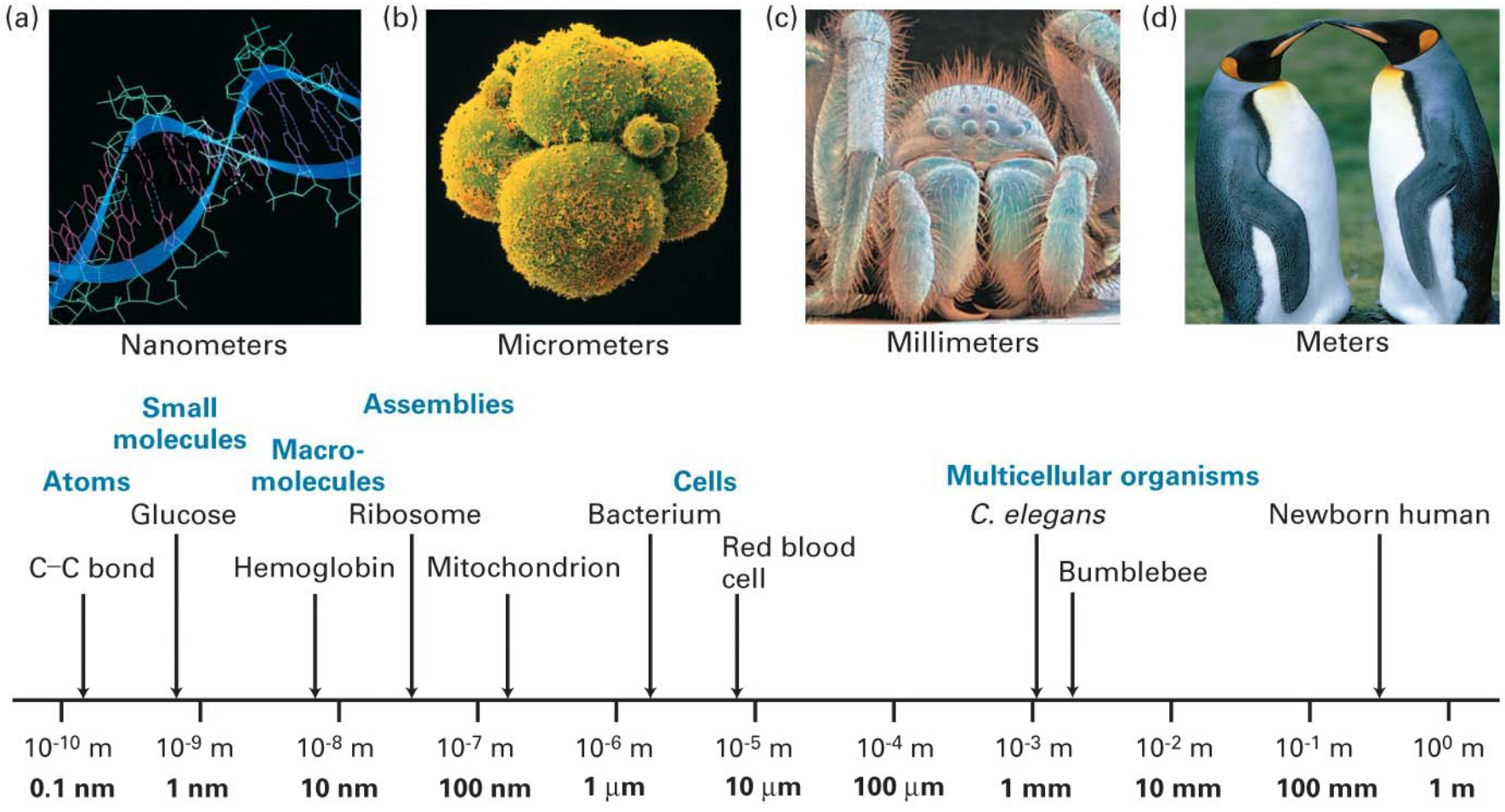

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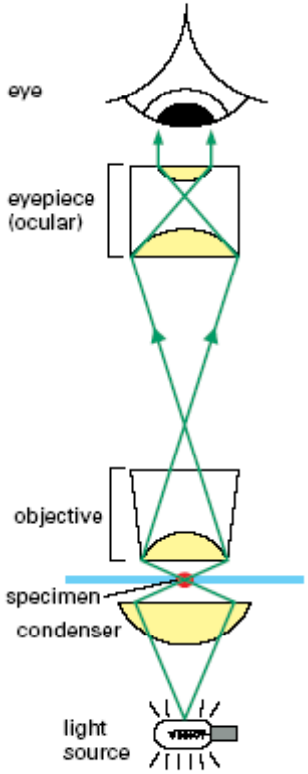
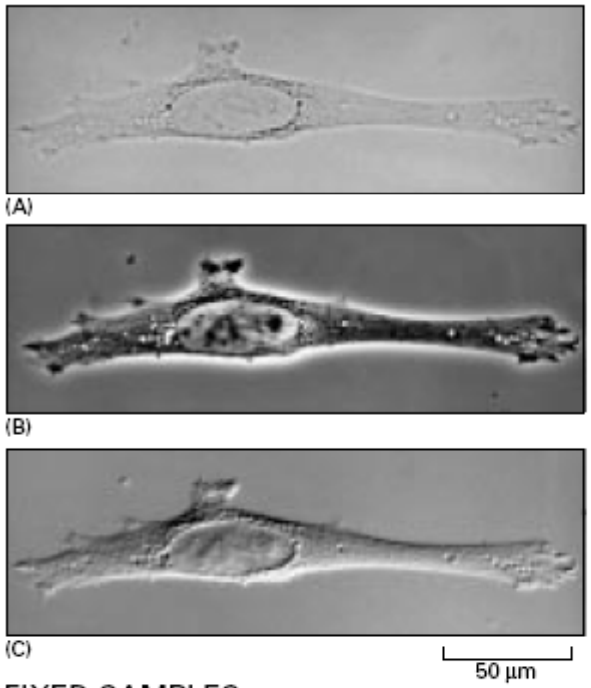
THE LIGHT MICROSCOPE



the light path in a light microscope

The light microscope allows us to magnify cells up to a thousand times, and to resolve details as small as 0.2 µm (a limitation imposed by the wavelike nature of light, not by the quality of the lenses). Three things are required for viewing cells in a light microscope. First, a bright light must be focused onto the specimen by lenses in the condenser. Second, the specimen must be carefully prepared to allow light to pass through it. Third, an appropriate set of lenses (objective and eyepiece) must be arranged to focus an image of the specimen in the eye.

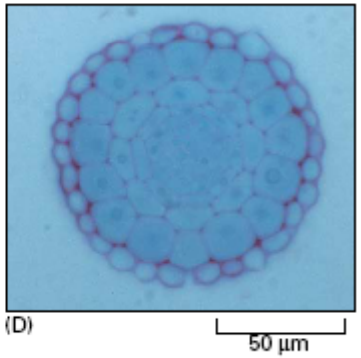


LOOKING AT LIVING CELLS

The same unstained, living animal cell (fibroblast) in culture viewed with (A) straightforward (bright-field) optics; (B) phase-contrast optics; (C) interference-contrast optics. These latter systems exploit differences in the way light travels through regions of the cell with differing refractive indexes. All three images can be obtained on the same microscope simply by interchanging optical components.

FIXED SAMPLES

Most tissues are neither small enough nor transparent enough to examine directly in the microscope. Typically, therefore, they are chemically fixed and cut into very thin slices, or *sections*, that can be mounted on a glass microscope slide and subsequently stained to reveal different components of the cells. A stained section of a plant root tip is shown here (D). (Courtesy of Catherine Kidner)



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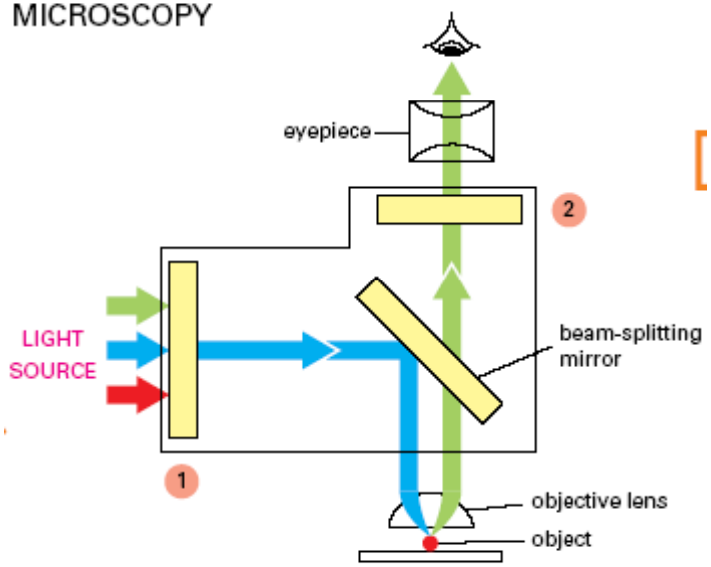
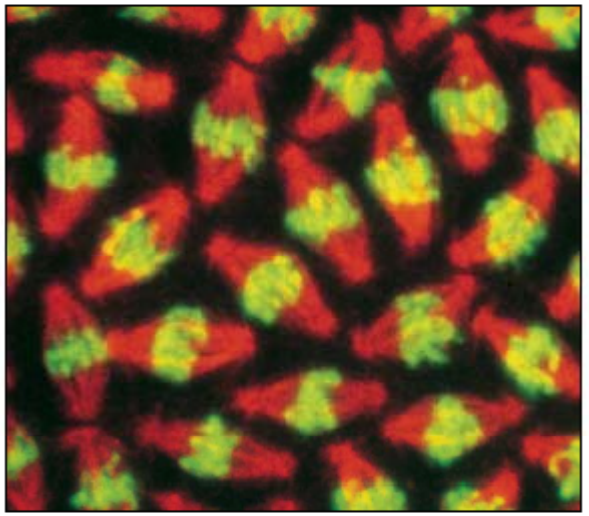
FLUORESCENCE MICROSCOPY



Fluorescent dyes used for staining cells are detected with the aid of a *fluorescence microscope*. This is similar to an ordinary light microscope except that the illuminating light is passed through two sets of filters. The first (1) filters the light before it reaches the specimen, passing only those wavelengths that excite the particular fluorescent dye. The second (2) blocks out this light and passes only those wavelengths emitted when the dye fluoresces. Dyed objects show up in bright color on a dark background.

FLUORESCENT PROBES

Dividing cells seen with a fluorescence microscope after staining with specific fluorescent dyes.



Fluorescent dyes absorb light at one wavelength and emit it at another, longer wavelength. Some such dyes bind specifically to particular molecules in cells and can reveal their location when examined with a fluorescence microscope. An example is the stain for DNA shown here (*green*). Other dyes can be coupled to antibody molecules, which then serve as highly specific and versatile staining reagents that bind selectively to particular macromolecules, allowing us to see their distribution in the cell. In the example shown, a microtubule protein in the mitotic spindle is stained *red* with a fluorescent antibody. (Courtesy of William Sullivan.)

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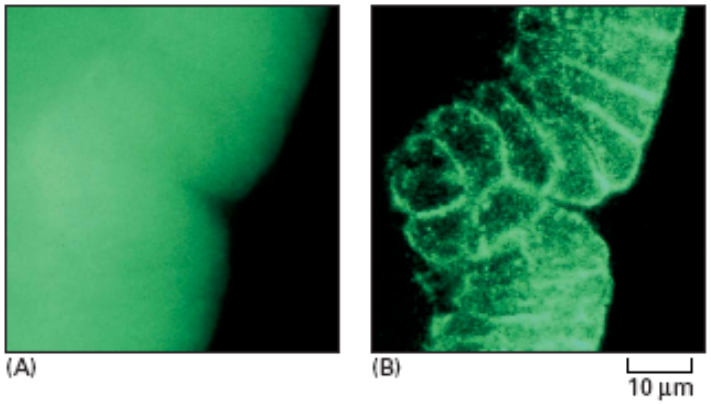
CONFOCAL MICROSCOPY

A confocal microscope is a fluorescence microscope with a laser as its source of illumination. This is focused onto a single point at a specific depth in the specimen, and a pinhole aperture in the detector allows only fluorescence emitted from the exact point of focus to be included in the image. Scanning the laser beam across the specimen generates a sharp two-dimensional image of the plane of focus. A series of optical sections at different depths allows a three-dimensional image to be constructed. An intact insect embryo is shown here stained with a fluorescent probe for actin (a type of protein). (A) Conventional fluorescence microscopy generates a blurry image due to the presence of fluorescent structures above and below the plane of focus. (B) Confocal microscopy provides a crisp optical section of the cells in the embryo. (A, courtesy of Richard Warn; B, courtesy of Peter Shaw.)



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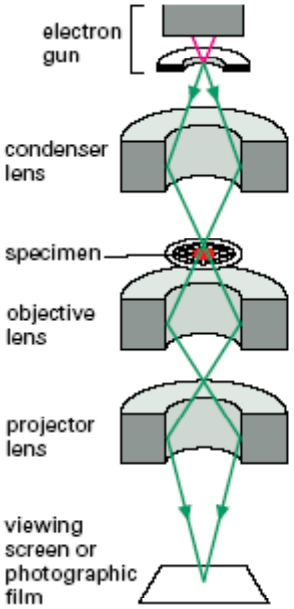
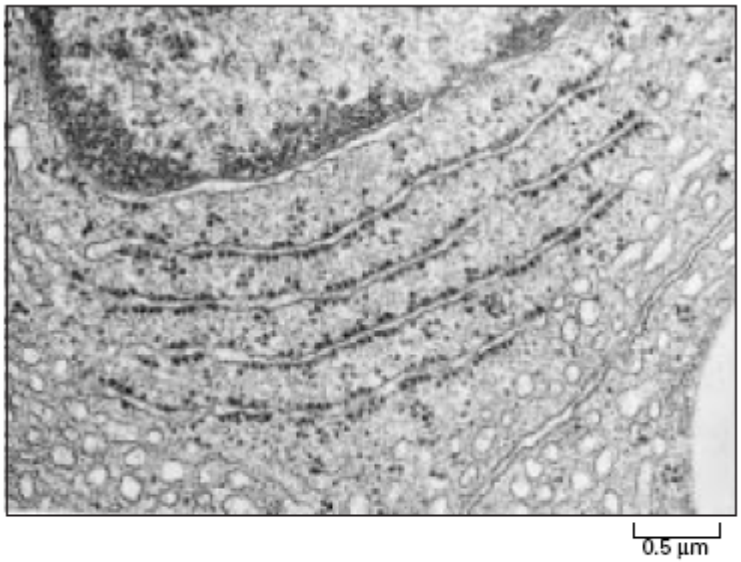
TRANSMISSION ELECTRON MICROSCOPY



Courtesy of Philips Electron Optics

The electron micrograph below shows a small region of a cell in a piece of testis. The tissue has been chemically fixed, embedded in plastic, and cut into very thin sections that have then been stained with salts of uranium and lead. (Courtesy of Daniel S. Friend.)



The transmission electron microscope (TEM) is in principle similar to an inverted light microscope, but it uses a beam of electrons instead of a beam of light, and magnetic coils to focus the beam instead of glass lenses. The specimen, which is placed in a vacuum, must be very thin. Contrast is usually introduced by electron-dense heavy-metal stains that locally absorb or scatter electrons, removing them from the beam as it passes through the specimen. The TEM has a useful magnification of up to a million-fold and with biological specimens can resolve details as small as about 2 nm.

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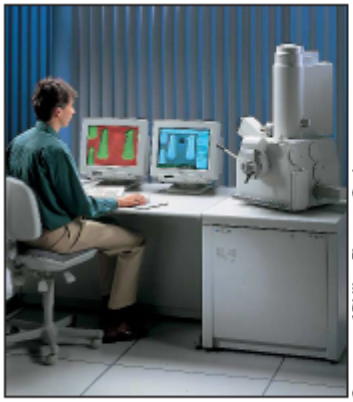
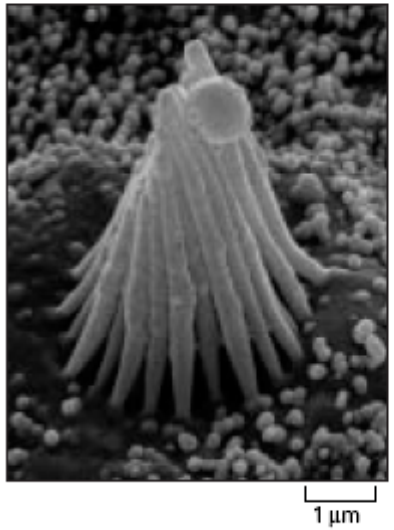
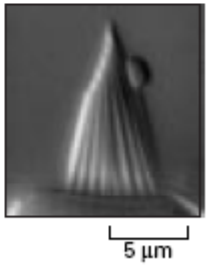


SCANNING ELECTRON MICROSCOPY

In the scanning electron microscope (SEM) the specimen, which has been coated with a very thin film of a heavy metal, is scanned by a beam of electrons brought to a focus on the specimen by the electromagnetic coils that, in electron microscopes, act as lenses. The quantity of electrons scattered or emitted as the beam bombards each successive point on the surface of the specimen is measured by the detector, and is used to control the intensity of successive points in an image built up on a video screen. The microscope creates striking images of three-dimensional objects with great depth of focus and can resolve details down to somewhere between 3 nm and 20 nm, depending on the instrument.





Scanning electron micrograph of the stereocilia projecting from a hair cell in the inner ear (*left*). For comparison, the same structure is shown by light microscopy, at the limit of its resolution (*above*). (Courtesy of Richard Jacobs and James Hudspeth.)

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- 碎形
- 混沌

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- 星辰
- 颱風
- 季節
- 雪花
- 蜂巢
- 硬幣堆積
- 老虎
- 斑馬
- 豹子

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- 波浪
- 沙丘
- 彩虹
- 霓虹
- 月暈
- 球狀的水滴

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End of Lecture

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