H. Kreuzer and A. Massey,
“Biology and Biotechnology”,
American Society for Microbiology

“생명과학과 생명공학”, 라이프사이언스

Chapter 1

Science, Technology, and Society

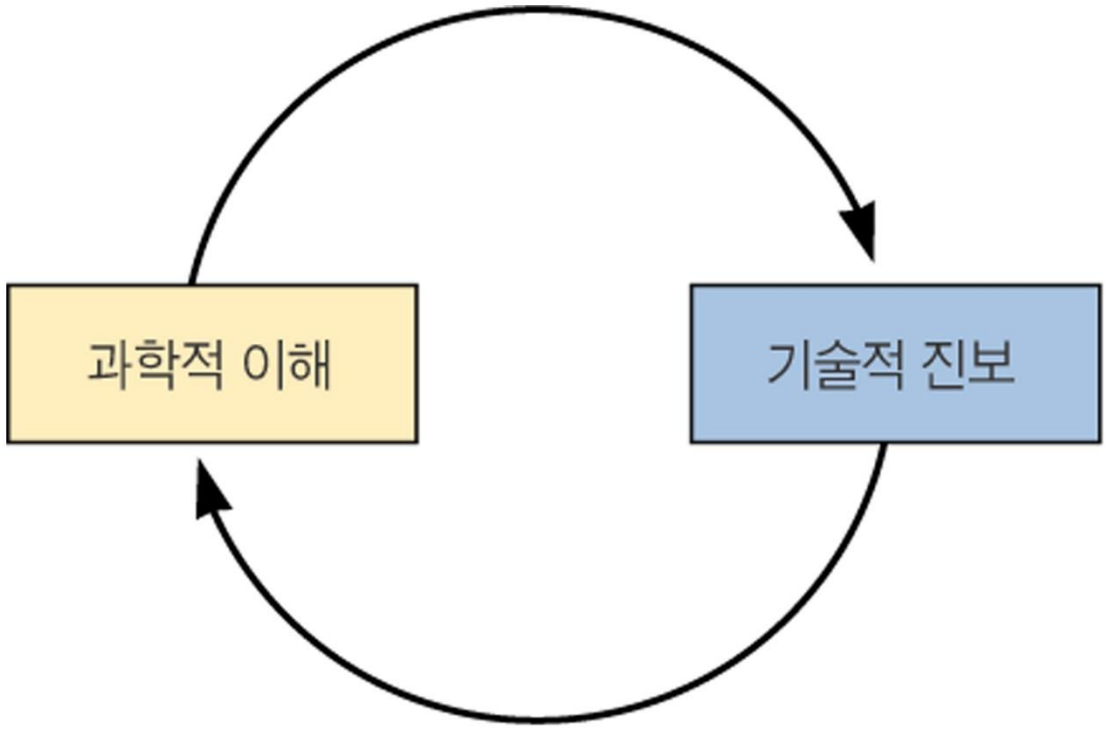
Contents

1. 과학과 기술

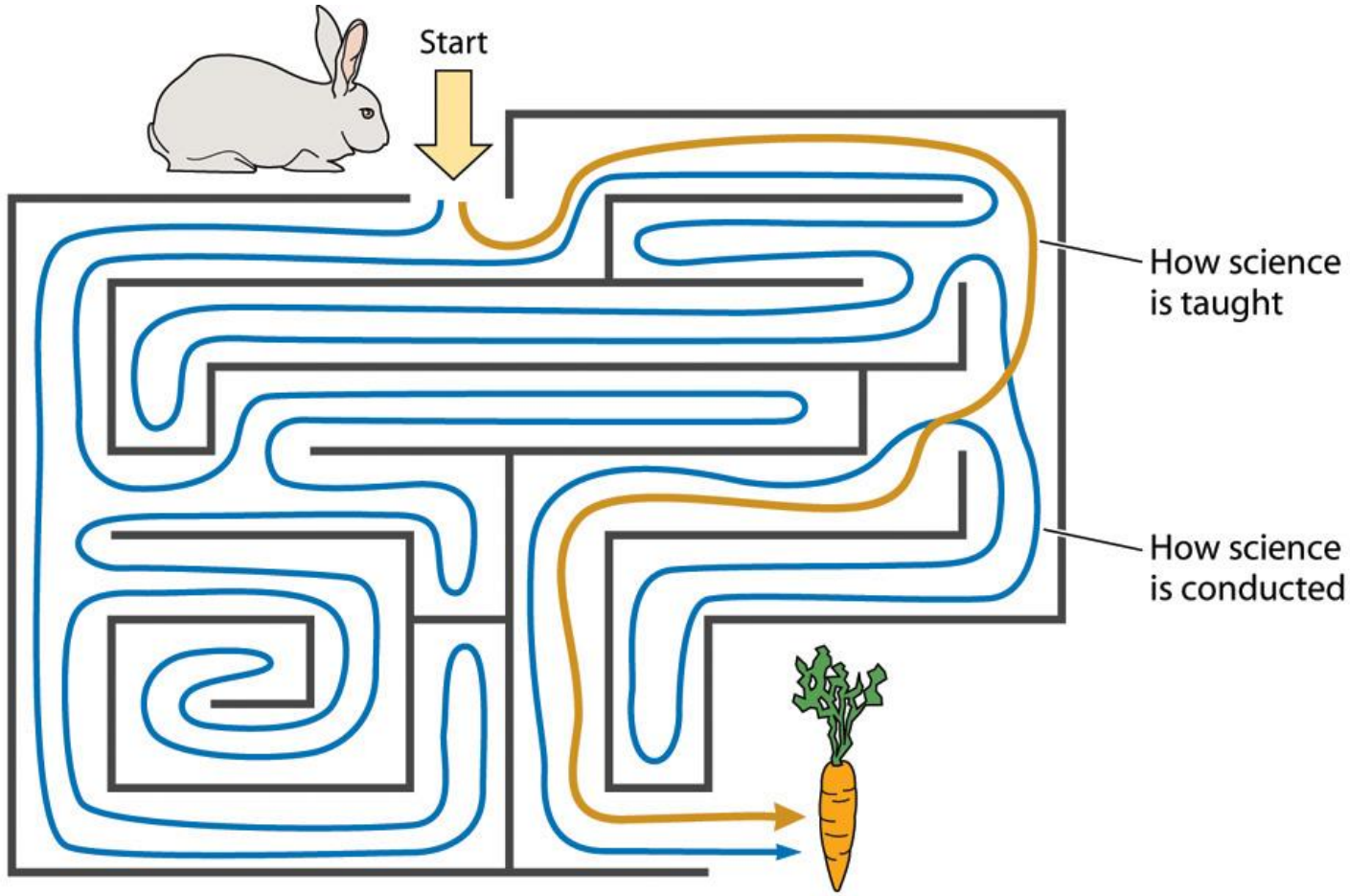
과학과 기술 (Science & Technology)

- **과학:**
  지식 창출

- **기술:**
  지식의 실용적 응용



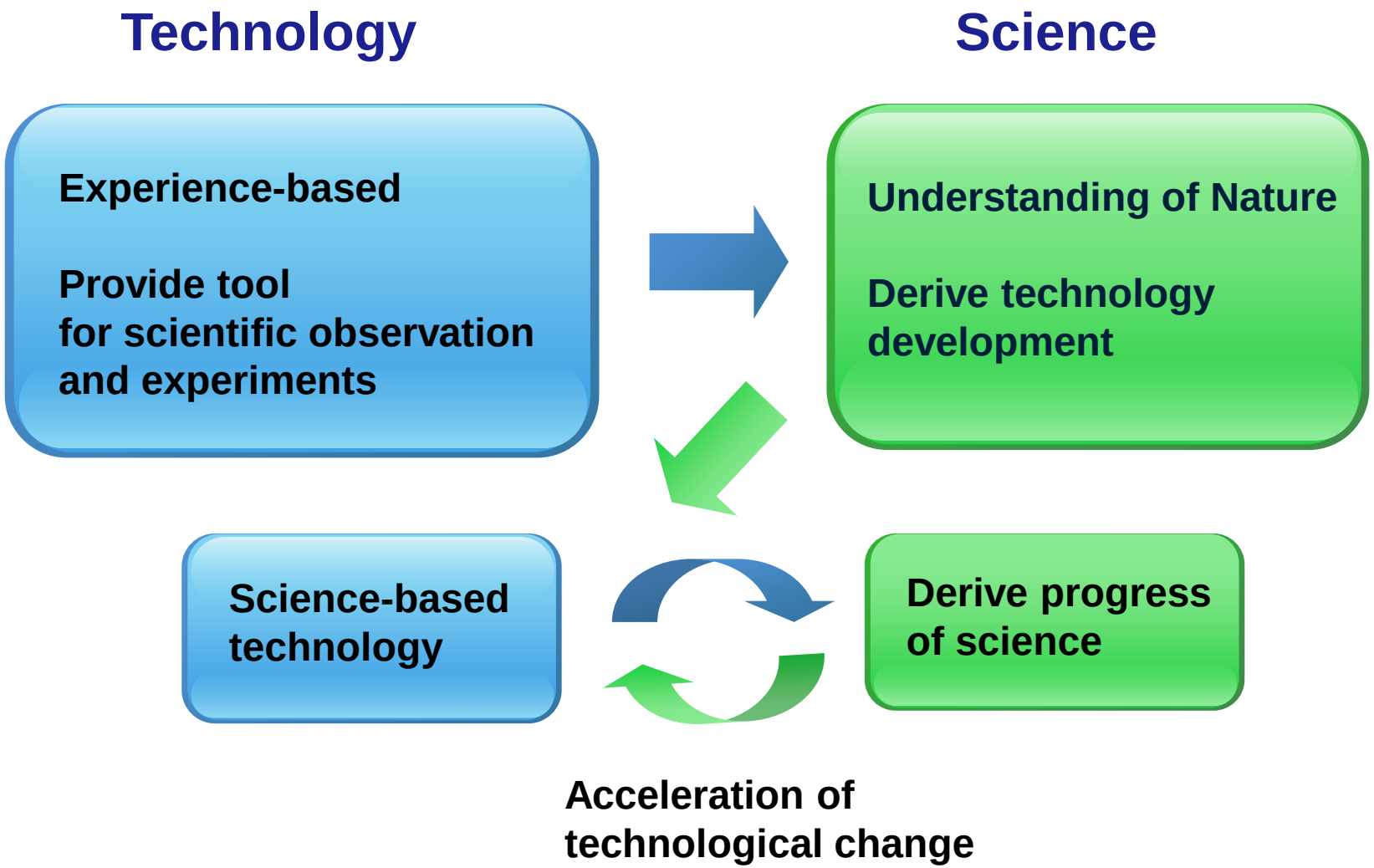
The Nature of Science



Technology

- Try to imagine a world without technology.
  - Computer
  - TV
  - Car
  - Heating (Energy)
  - Cooling
  - Clothes
  - Food
  - House
  - Lamp, paper, pen, chair, …..

The Relationship Between Science and Technology



Science and Technology

- Science
  - Search for knowledge
  - Way of understanding ourselves and the physical world
  - Process of asking questions and finding answers, then creating broad generalizations
  - Looks for order or patterns in the physical world
  - Evaluated by how well the facts support the conclusion or theory
  - Limited by the ability to collect relevant facts
  - Discoveries give rise to technological advances
- Technology
  - Practical application of knowledge
  - Way of adapting ourselves to the physical world
  - Process of finding solutions to human problems to make lives easier and better
  - Looks for ways to control the physical world
  - Evaluated by how well it works
  - Limited by financial costs and safety concerns
  - Advances give rise to scientific discoveries

2. 기술과 사회

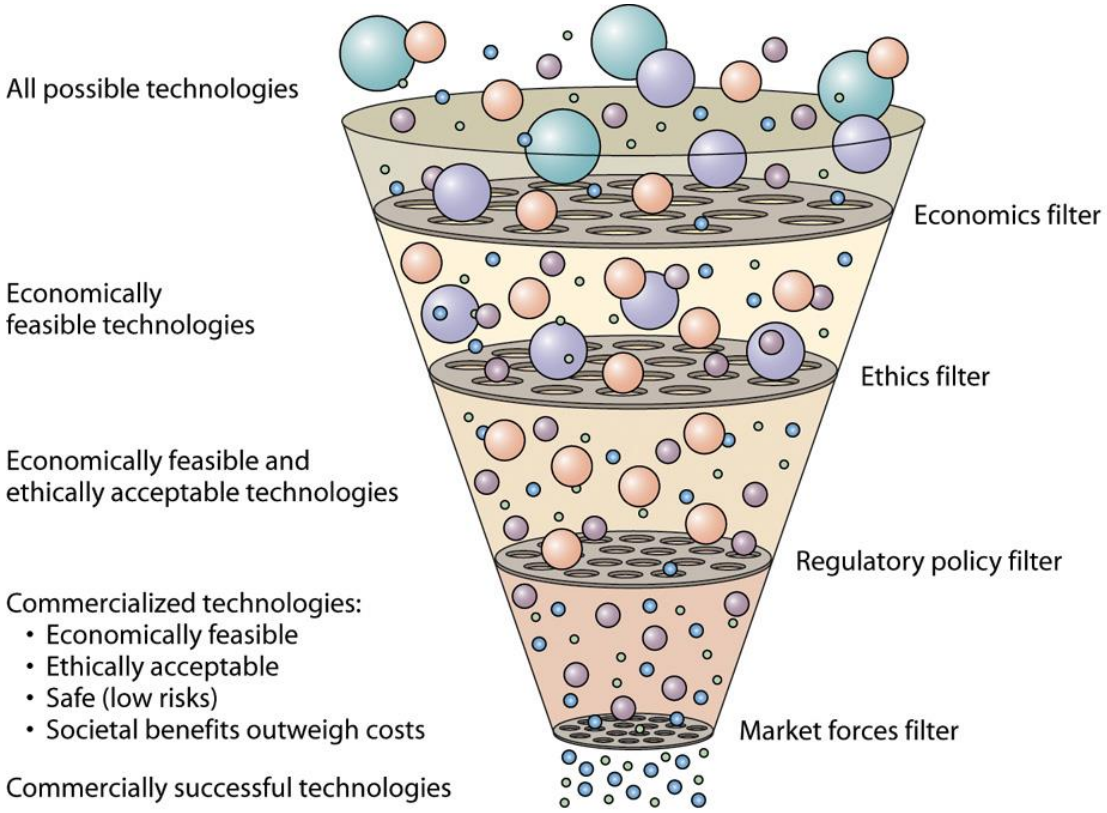
기술과 사회 (Technology and Society)

- 기술
  - 환경과 사회를 변화 시킴
  - Webster 사전의 정의:

"인간의 삶을 유지시켜 주고 안락하게 하는데 필요한 것들을 제공해 주는 수단이 되는 모든 것"

Technology and Society

- Society
  - Creates filters for technology



3. 바이오 시대

The Biology Century

- The past two centuries
  - Technology driven by physics and chemistry
  - Industrial Revolution, Information Age, Green Revolution
- The Biology Century will be fueled by biotechnology.

생명공학 (Biotechnology)

- 정의
  - 문제를 해결하기 위하여, 혹은 유용한 물품을 생산하기 위하여, 살아있는 생명체나 생명공정을 이용하는 기술
- 고대 생명공학
  - 시행착오에 기반
- 현대 생명공학
  - 문제를 해결하기 위하여, 혹은 유용한 물품을 생산하기 위하여, 세포, 생물분자, 생물분자 공정 등을 이용

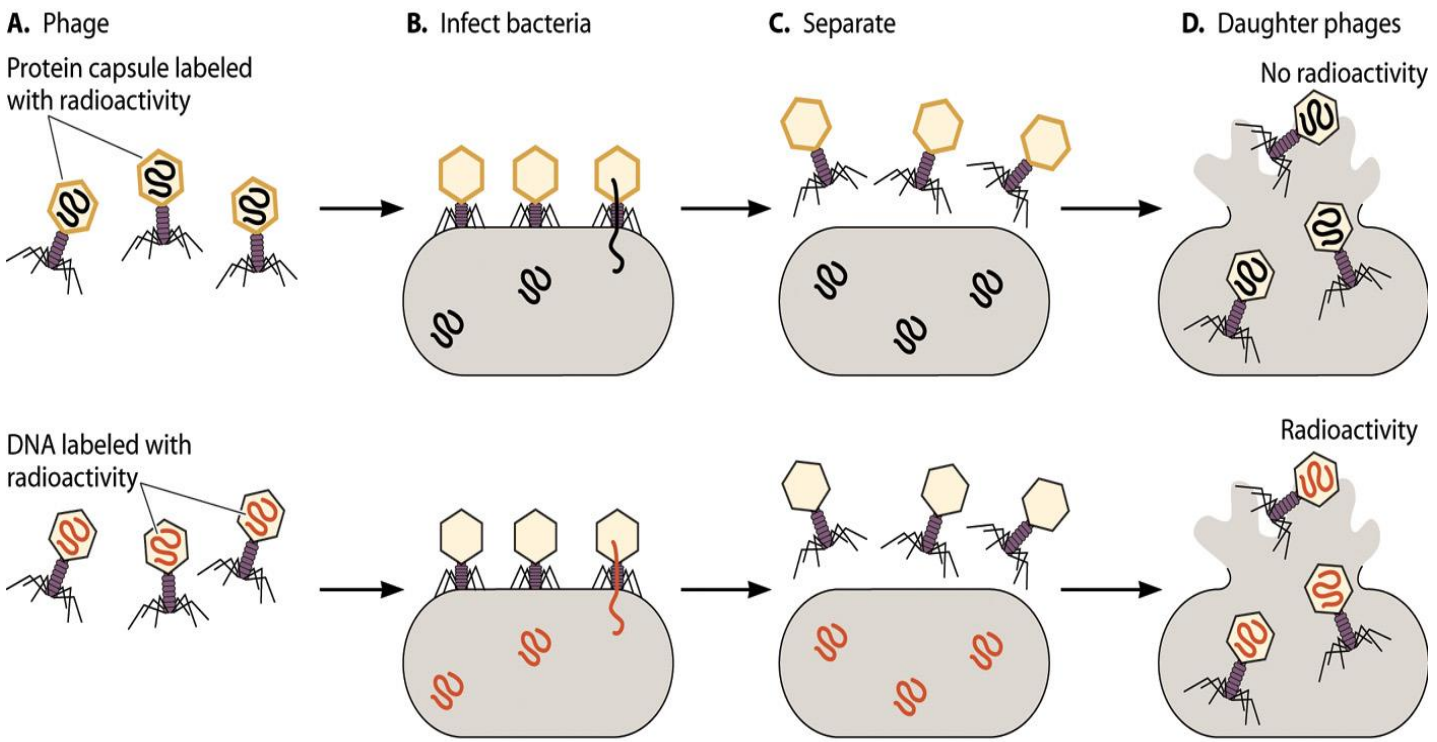
유전 물질 (Genetic Material)

- 콩 심은데 콩나고, 팥 심은데 팥난다.

- 엄마소도 얼룩소 엄마 닮았네.

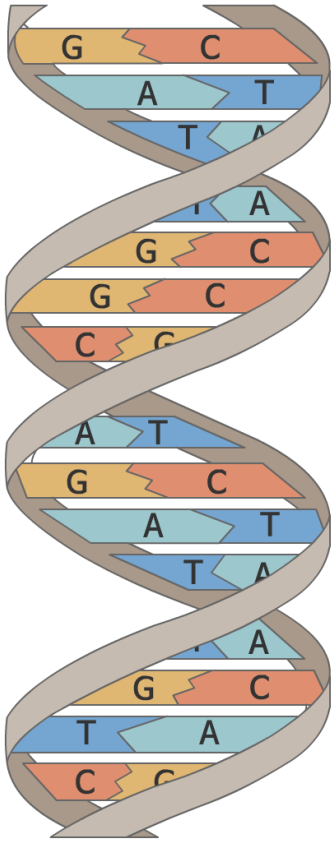
The Genetic Material
Protein or DNA?

- The DNA-vs.-protein debate was resolved.
  - Alfred Hershey and Martha Chase (1952)
    ----- Identification of DNA as genetic material



생체정보: DNA에 저장

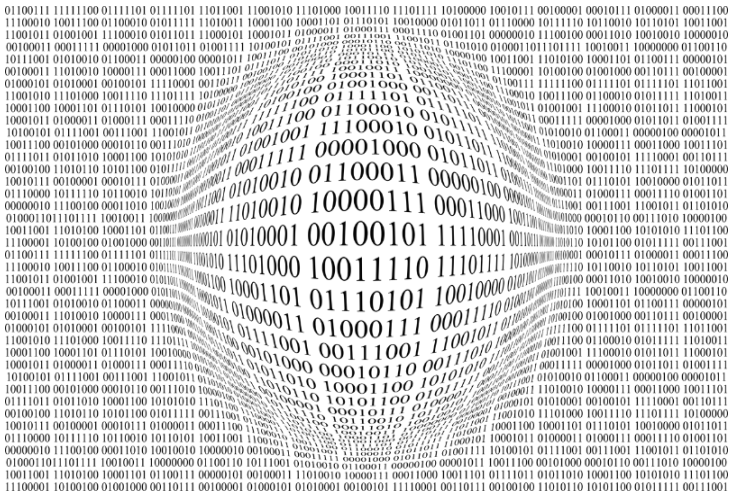
- 왓슨 & 크릭 (1953)
  - DNA 이중나선 구조 (Double Helix)



※ 출처 : Nobel Prize, wikimedia.org,

정보 저장

IT



BT

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AAAATCGATAAGGCTTATTCCGGGGAA
AATAGTGTTCTTGGAGATACAAAACTA
CGTCTACTACAAACAACTGTTGAACCG
GCCCTTTTGGAAATCTCAGATAGTGAT
CATGAAATTATACTTTCTTTCTTAGGG

컴퓨터: 2진법

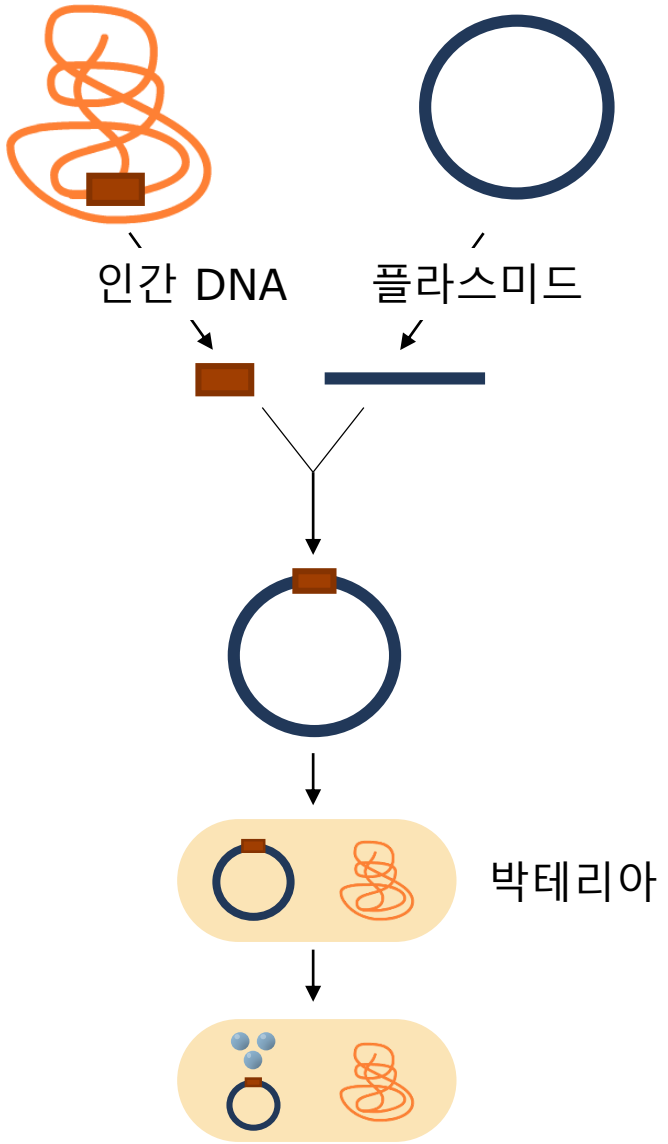
DNA: 4진법

DNA 재조합 기술

- **가위:**
  제한 효소
- **풀:**
  DNA 연결효소

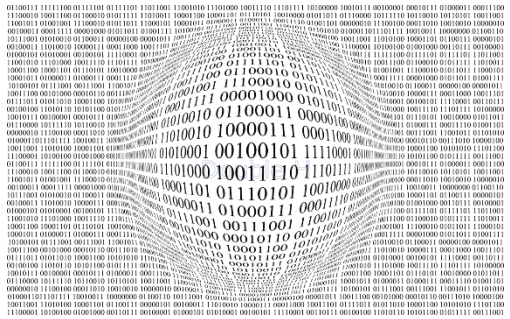
DNA 재조합 기술 (유전공학 기술)

- 하와이에서의 학회 (1972.11)
  - 보이어 (샌프란시스코 대)
    - 제한효소
  - 코헨 (스탠포드 대)
    - 플라스미드

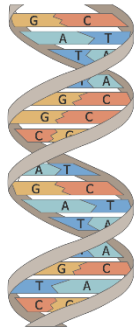


IT & BT (정보저장)

IT



BT



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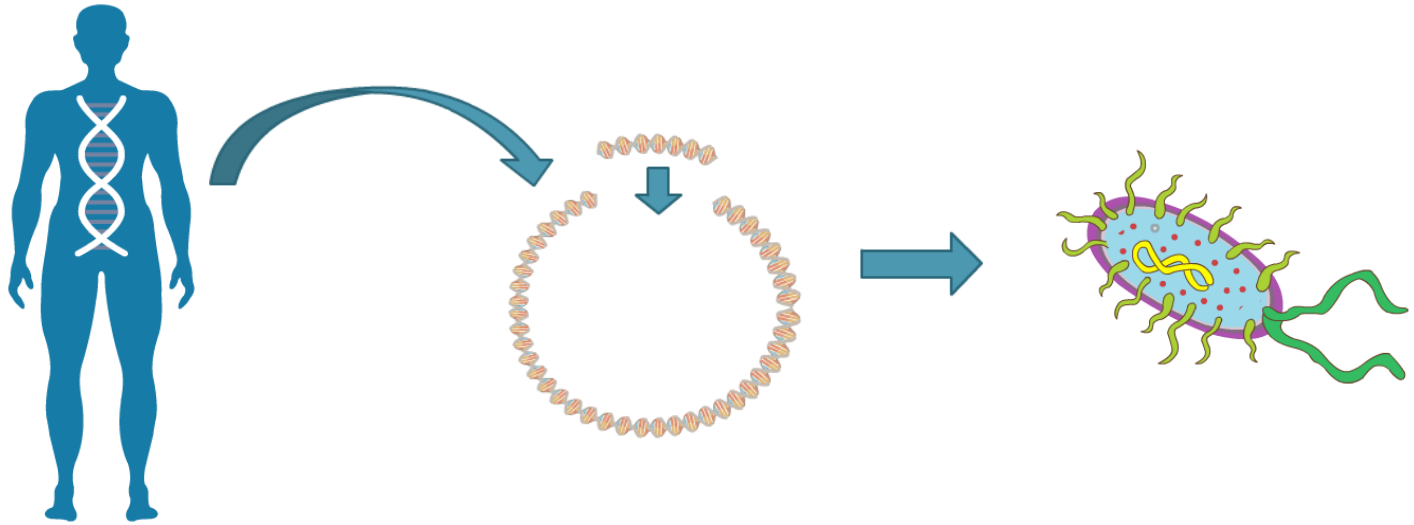
AAAATCGATAAGGCTTATTCCGGGGAA
AATAGTGTTCTTGGAGATACAAAACTA
CGTCTACTACAAACAACTGTTGAACCG
GCCCTTTTGGAAATCTCAGATAGTGAT
CATGAAATTATACTTTCTTTCTTAGGG

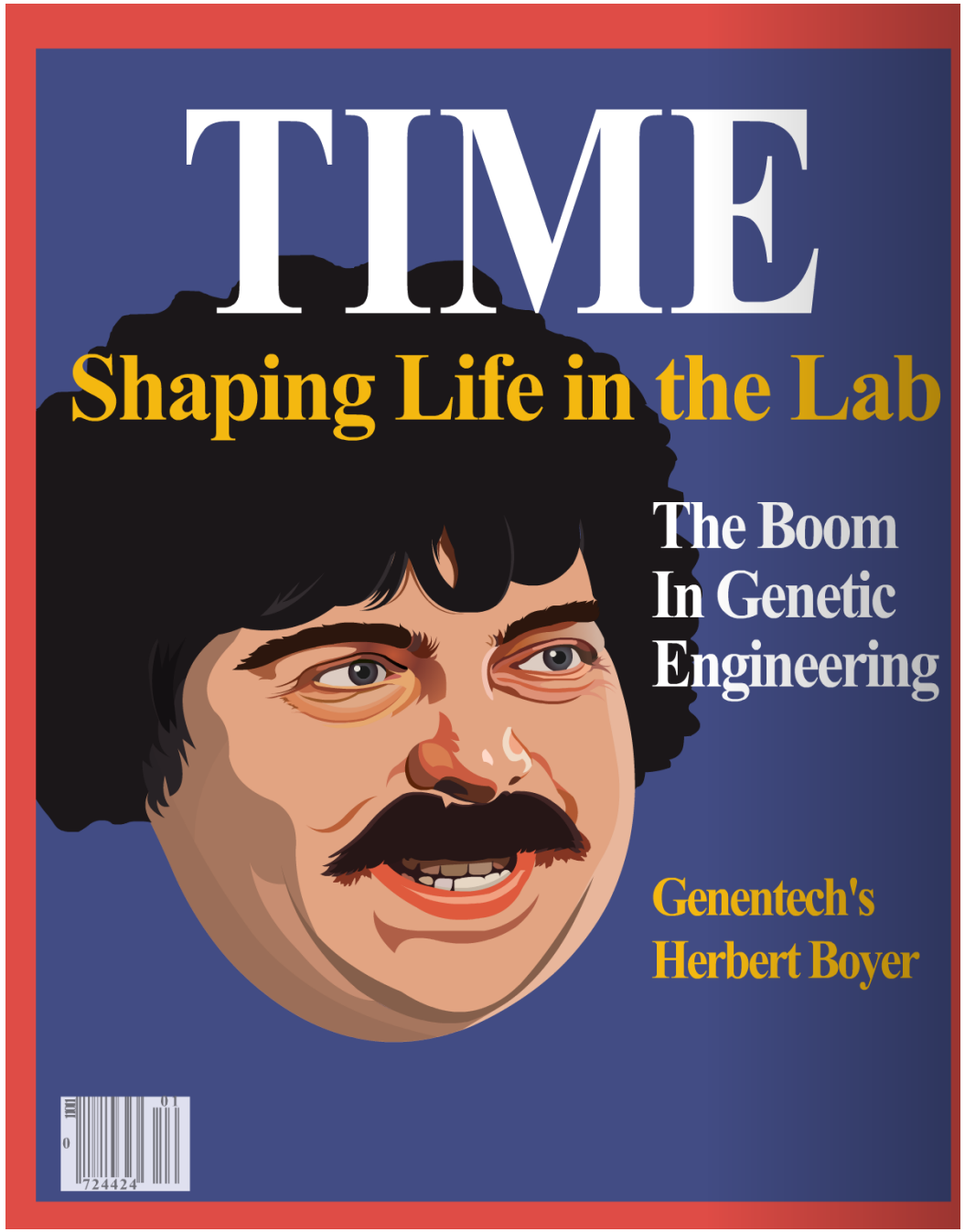


샌프란시스코, 1976

- 밥 스완슨
  - 벤처 투자가, 27세
- 허버트 보이어를 설득
- 1976.4, 제넨텍 설립
  - 인슐린

제넨텍

- 1980년 10월
  - 뉴욕 증권 거래소
  - 개장 20분 만에 $35 → $89
  - 월 스트리트 역사상 가장 급속한 증가

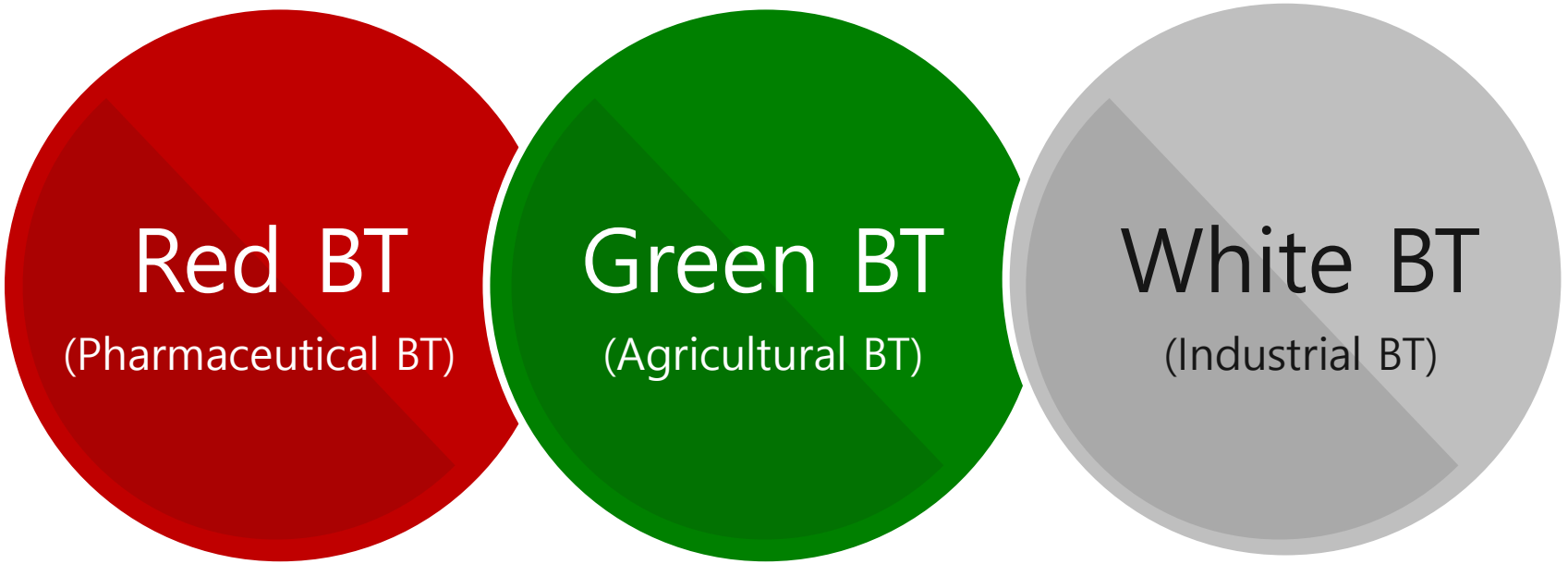


- 보이어 & 스완슨
  - 각각 6,600만 달러 재산의 부호가 됨

바이오 산업의 트렌드

부가가치가 높은 의약품 분야에서 가장 먼저 산업화 진행

다음으로 농산물 산업, 에너지/화학소재 산업 등으로 확산



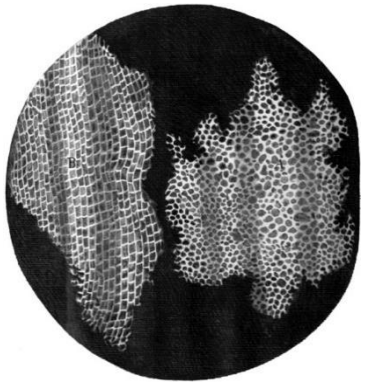
Chapter 2

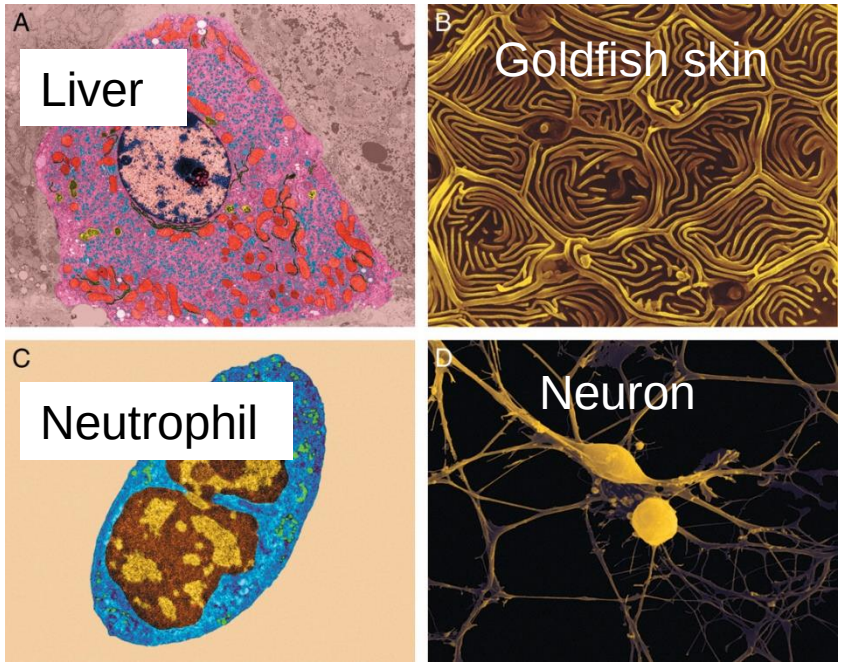
The Cell: the Basic Unit of Life

Contents

Cells

- Basic unit of living organism
- First named by Robert Hook in the 17th century
- Different types but the same essential properties
- Same building blocks: proteins, carbohydrates, fats, and nucleic acids



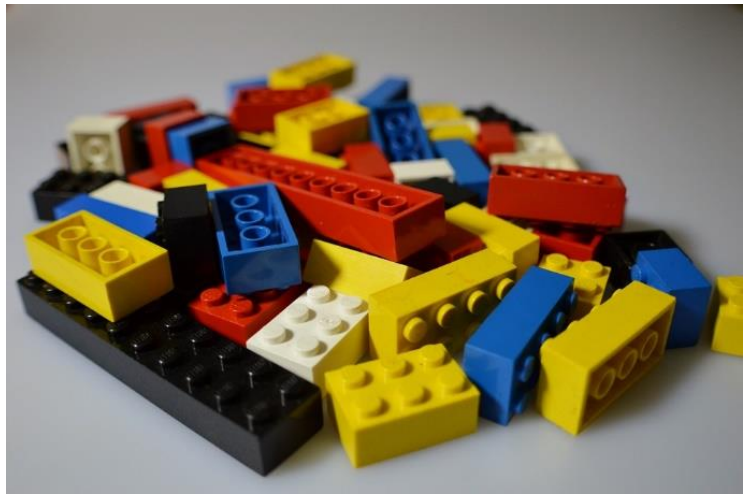


Essential Functions of Living Cells 1

- Growth
  - Metabolism
    - Catabolism: breaking down large molecules to generate building blocks and energy
    - Anabolism: Generation of large molecules using building blocks and energy

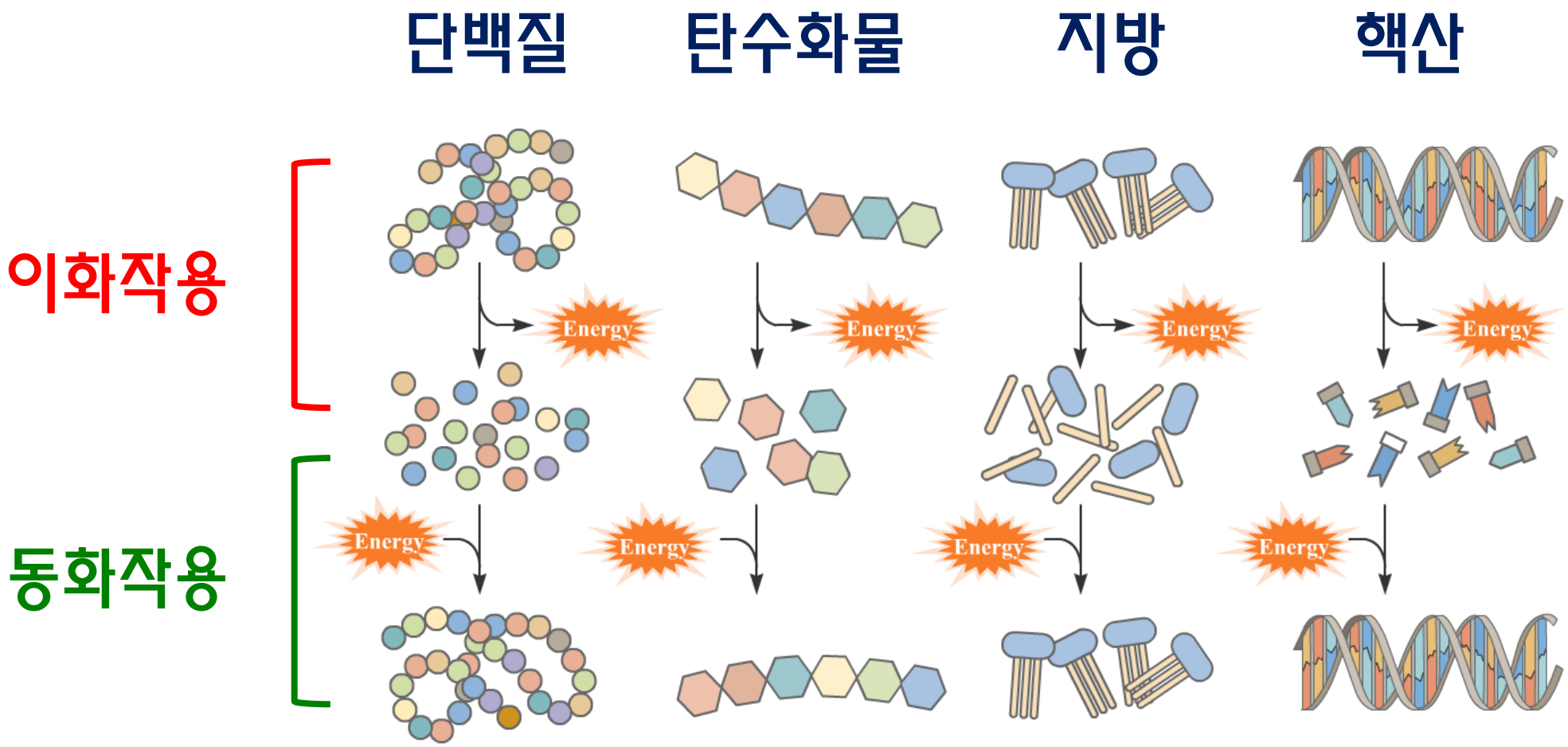
대사작용 (Metabolism)

분해



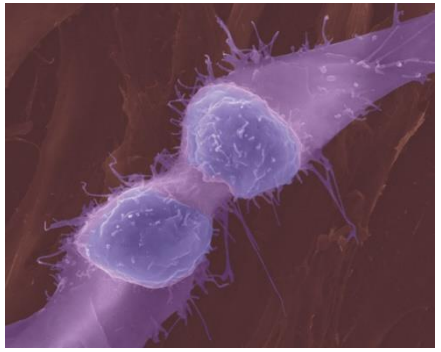
합성

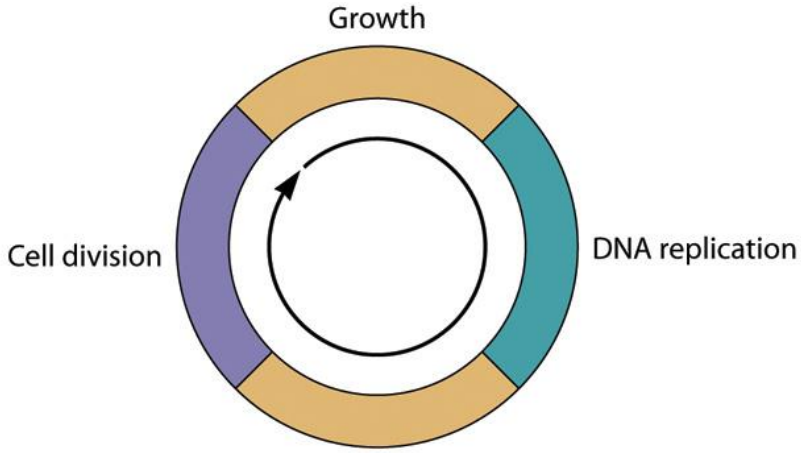
대사작용 (Metabolism)



Essential Functions of Living Cells 2

- Reproduction
  - Cell cycle
    - Cyclical process of cell growth and division
    - Daughter cell must receive a correct copy of genetic material
      →DNA replication before cell division





Cell cycle

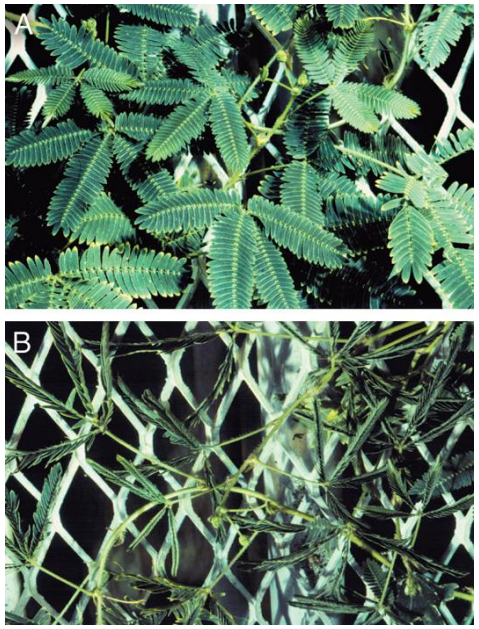
Essential Functions of Living Cells 3

- Maintenance of internal environments
  - Use energy to maintain the internal environments
    - Unique molecules
      - Specific proteins, DNA etc.
    - Some same molecules as outside but with different concentrations
      - Water, salts, sugar etc.

Amoeba

Essential Functions of Living Cells 4

- Response to external environments
  - Sense a change in their environment
  - Respond
    - Maintaining osmotic homeostasis
    - Bacterial chemotaxis
    - Release of digestive enzymes from stomach cells
    - …..

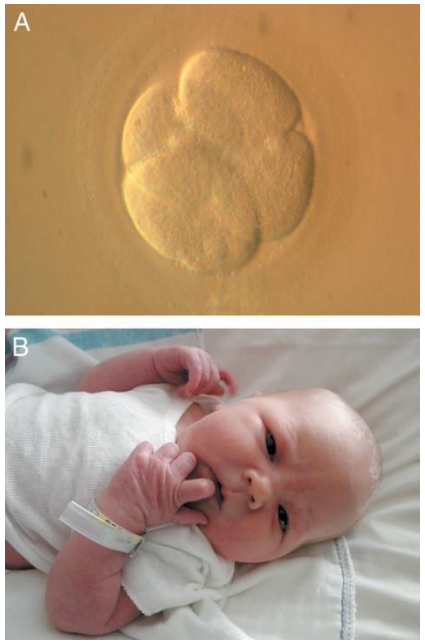


Essential Functions of Living Cells 5

- Communication with each other
  - Between cells in an organism
    - e.g. Nerve cell and muscle
  - Between single cell organisms
    - e.g. Mating of yeast cells, quorum sensing of bacteria

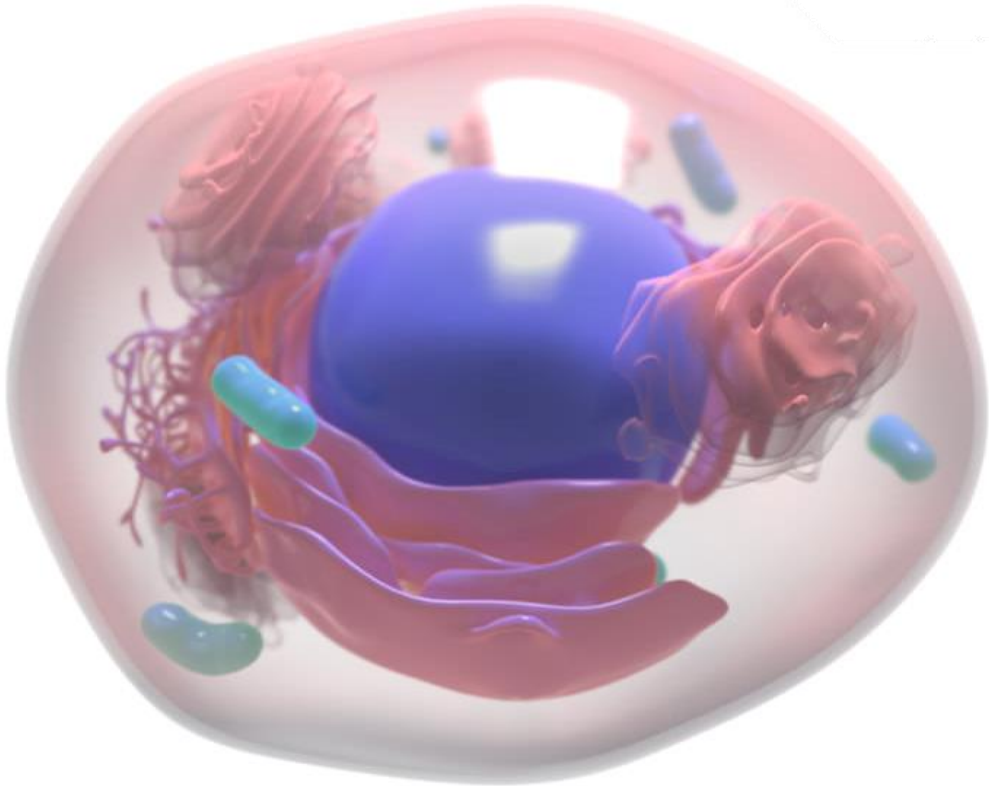
Essential Functions of Living Cells 6

- Differentiation in multicellular organisms
  - Cells differentiate to cells with specific functions
  - Specific cells organize into different tissues and organs



세포의 구조

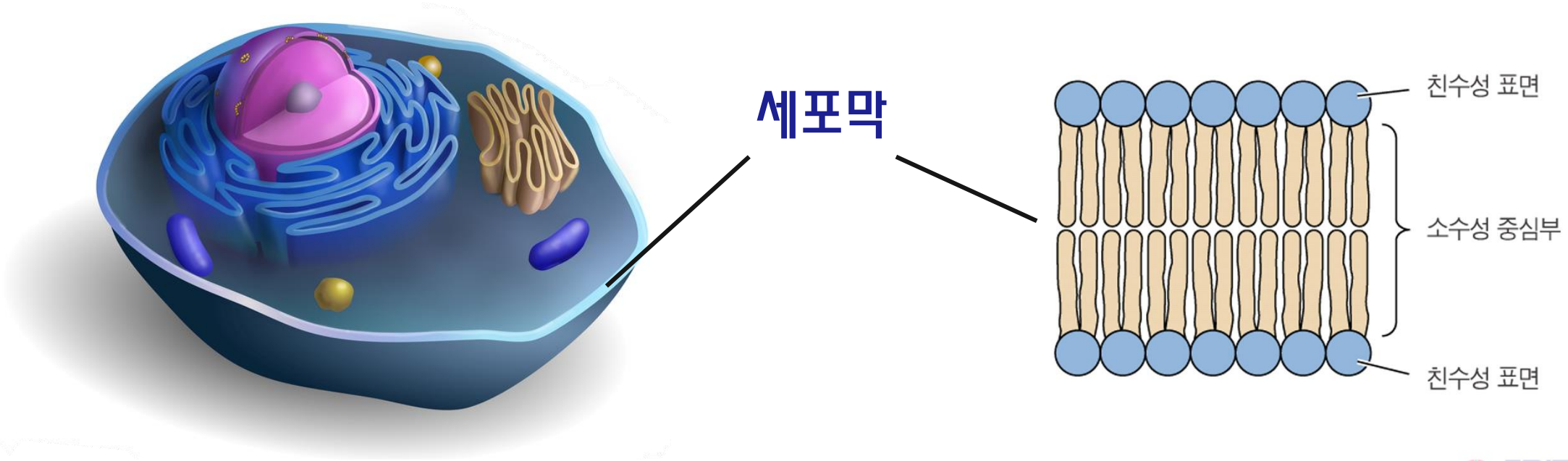
- 세포는 아주 작은 물 주머니



※ 출처 : www.medicalgraphics.de

세포 막 (Cellular Membrane)

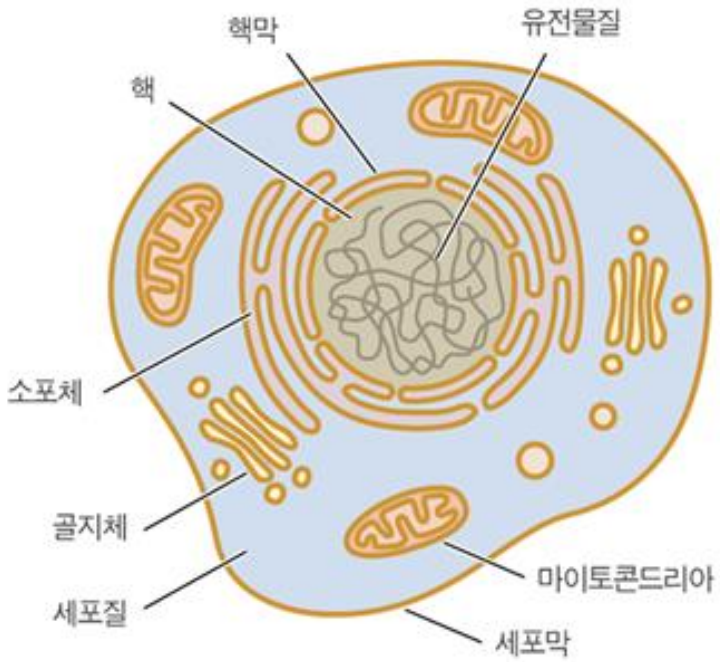
- 세포의 구조를 유지
  - 지질 이중 층(Lipid bilayer)

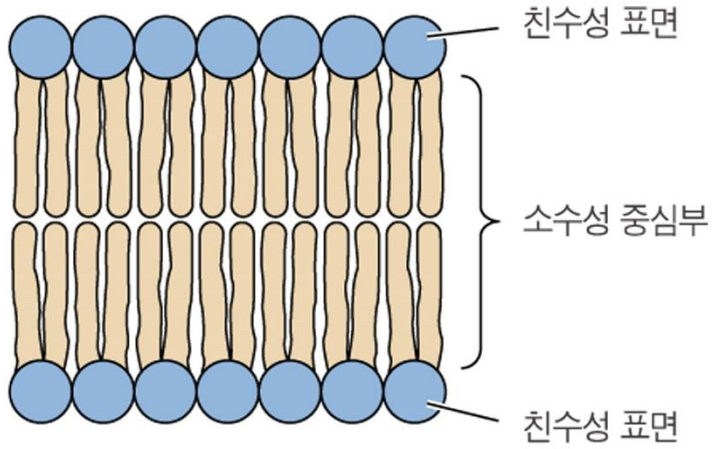


※ 출처 : www.medicalgraphics.de

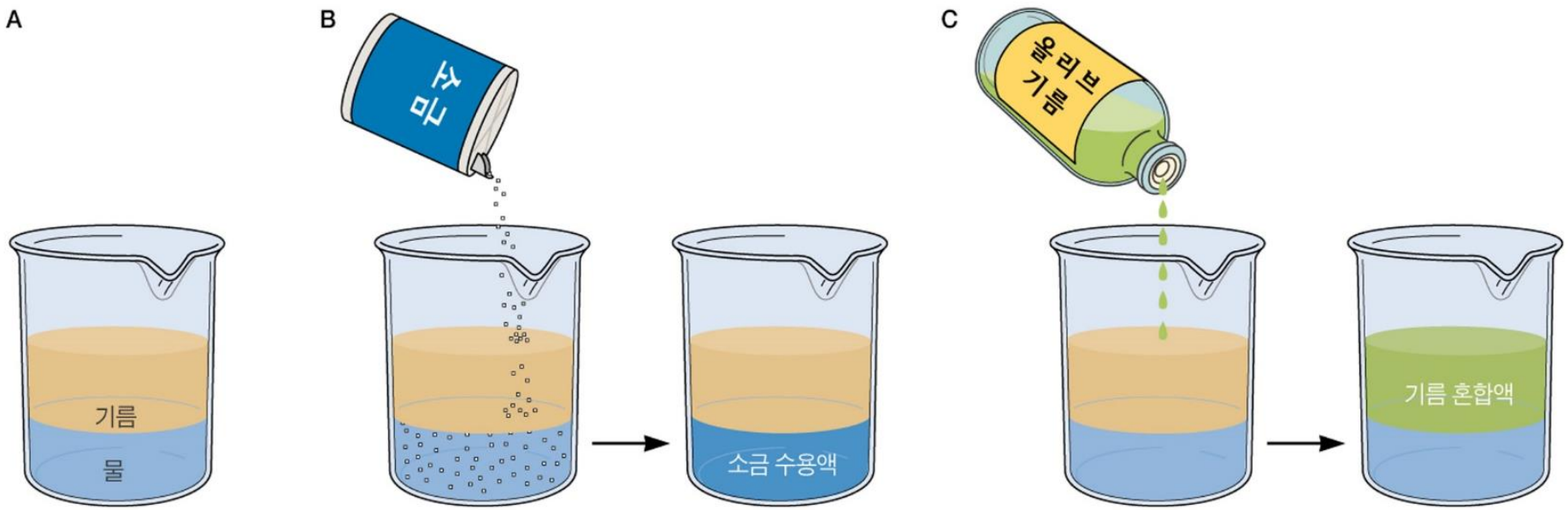
막 (Membrane)

- 세포 내부의 소기관 막
  - 지질 이중 층(Lipid bilayer)





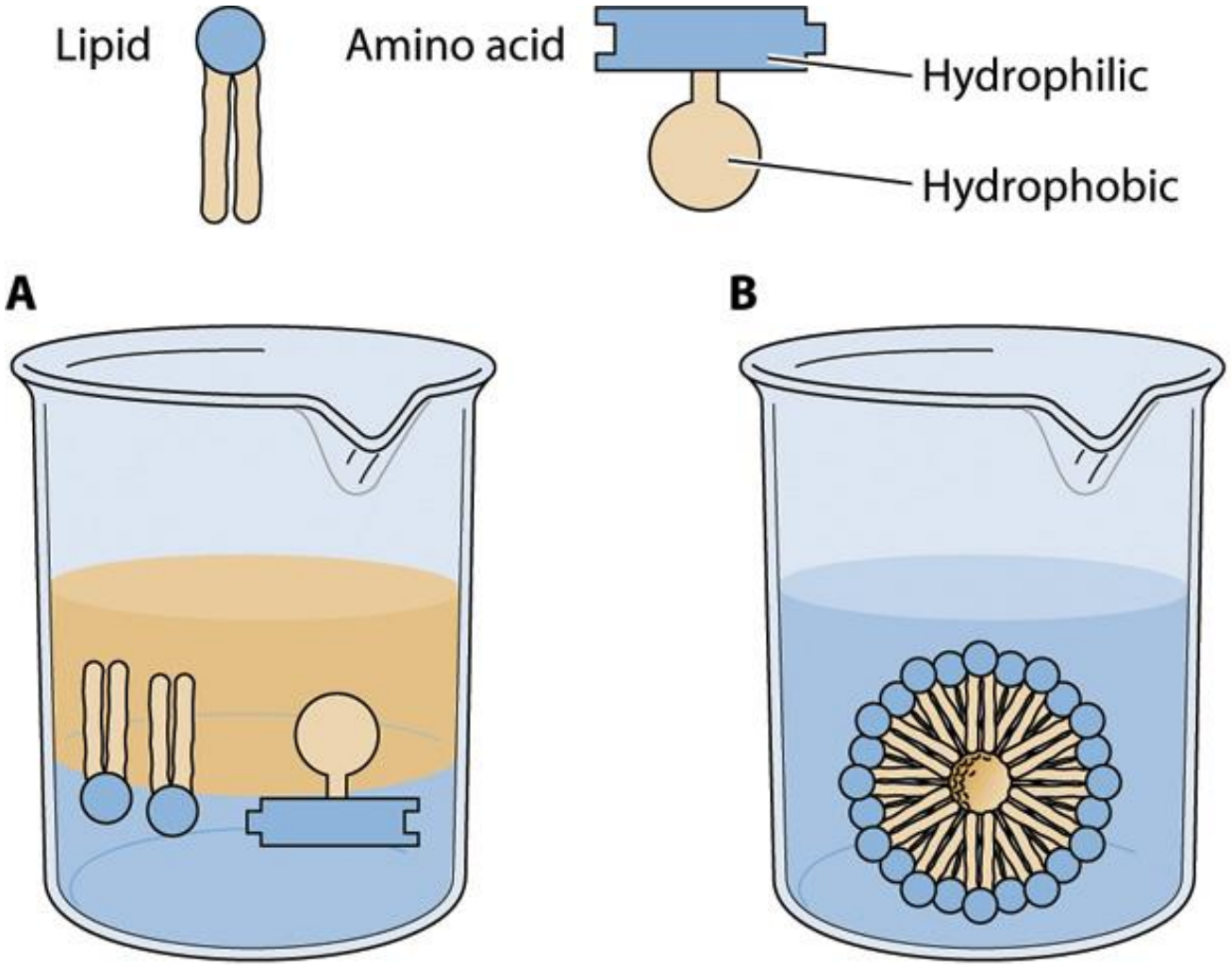
친수성과 소수성



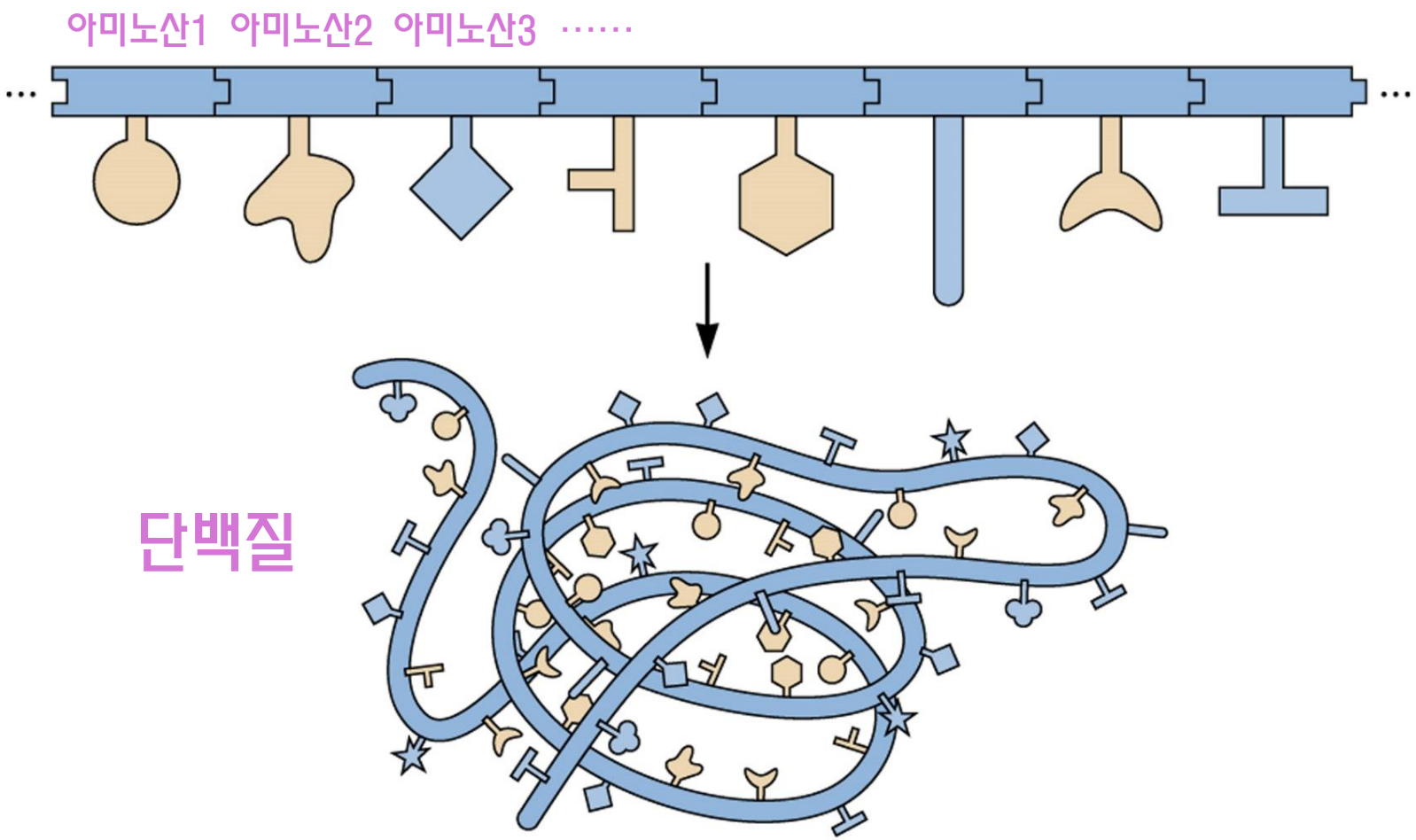
친수성과 소수성

- 세포 내 분자와 물과의 상호관계
  - 세포 내의 조직을 결정하는 중요 인자
  - 친수성(hydrophilic) 혹은 소수성(hydrophobic)
    - 친수성 부분은 친수성 부분과 뭉치고
    - 소수성 부분은 소수성 부분과 뭉친다

친수성과 소수성

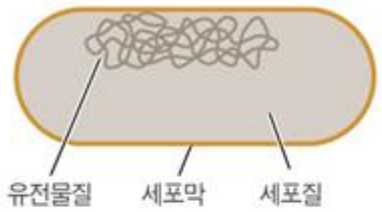


친수성과 소수성



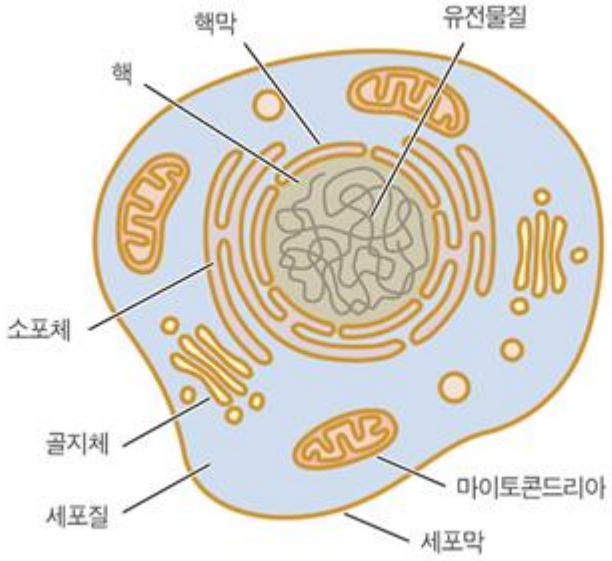
두 종류의 세포

원핵 세포 (Prokaryotic cell)

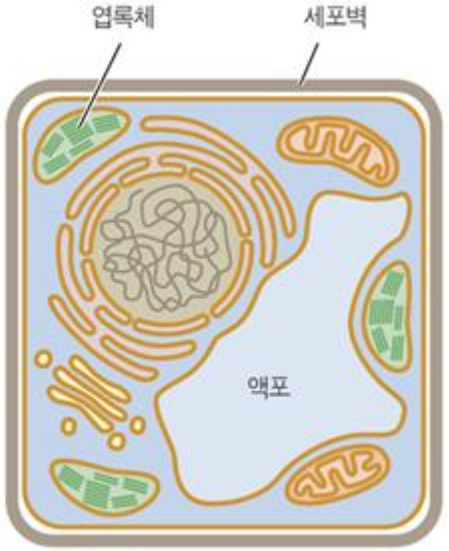


진핵 세포 (Eukaryotic cell)

동물 세포



식물 세포



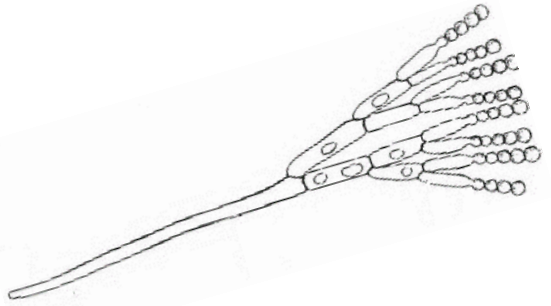
Two Fundamental Cell Types

- Prokaryotic cells
  - Prokaryote (pro; before, karyon: kernel or nucleus)
  - No nuclear membrane
  - Small (0.2-2 μm), mostly single-celled organisms
    - Eubacteria : common bacteria, e.g. *E. coli*, blue-green algae
    - Archaea (Archaebacteria)
- Eukaryotic cells
  - Eukaryote (well-formed nucleus)
  - Nuclear and internal membranes → organelles
  - Larger than prokaryotes (10-100 μm)
    - Single-celled: yeast, green algae, amoebae
    - Multicellular: fungi, plant, animal

다양한 종류의 세포

- **원핵 세포**
  - 진정세균(Eubacteria): 일반적인 박테리아 (예, 대장균)
  - 고세균(Archaea 혹은 Archaebacteria): 극한 환경에 서식 (온천, 심해)
- **진핵 세포**
  - 곰팡이(Fungi)
    - 효모(Yeasts) --- 단세포

    - 사상 곰팡이(Molds) --- 다세포 (예, 푸른 곰팡이)



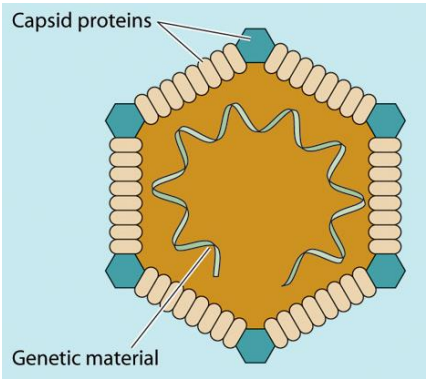
  - 조류(Algae)
    - 단세포 조류 혹은 미세조류 (예, 클로렐라)
    - 식물 형태의 다세포 조류 (예, 미역, 다시마)
  - 원생동물(Protozoa)
    - 단세포, 운동성 (예, 아메바)
  - 식물 세포(Plant cells)
  - 동물 세포(Animal cells)

각종 세포의 응용

- **원핵 세포**
  - 진정세균: 대장균 (유전공학 숙주세포)
  - 고세균: 호열균 (열저항성 단백질)
- **진핵 세포**
  - 곰팡이(Fungi)
    - 효모(Yeasts) --- 빵, 주류, 유전공학 숙주세포
    - 사상 곰팡이(Molds) --- 항생제
  - 조류(Algae)
    - 미세 조류 --- 바이오 디젤
    - 식물 형태의 다세포 조류 --- 식품
  - 원생동물(Protozoa)
    - 단세포, 운동성 (예, 아메바)
  - 식물 세포(Plant cells) --- 탁솔(항암제) 생산
  - 동물 세포(Animal cells) --- 바이오의약품 생산

바이러스 (Virus)

- Not cells
- No independent reproduction (not alive by itself)
  - Genetic material (DNA or RNA)
  - Proteins (Capsid)

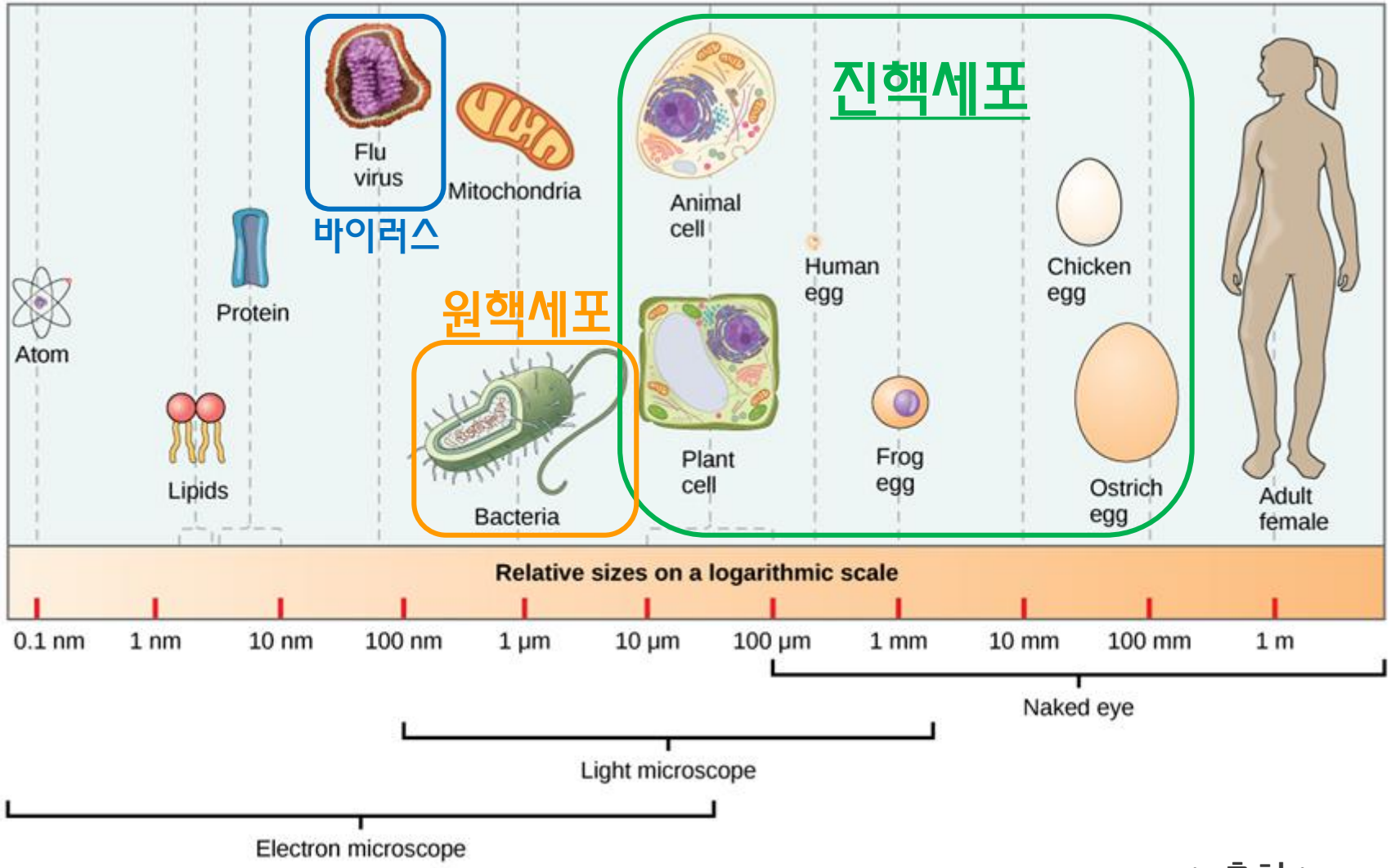


- "Viruses are in the semantic fog between life and non-life." (Campbell and Reece, *Biology*, 6e, p 339.)
- Are viruses living beings?

  "The answer to that question is 'no', inasmuch as viruses are incapable of independent life." (de Duve, *Life Evolving,* p.313)
- Conclusion:

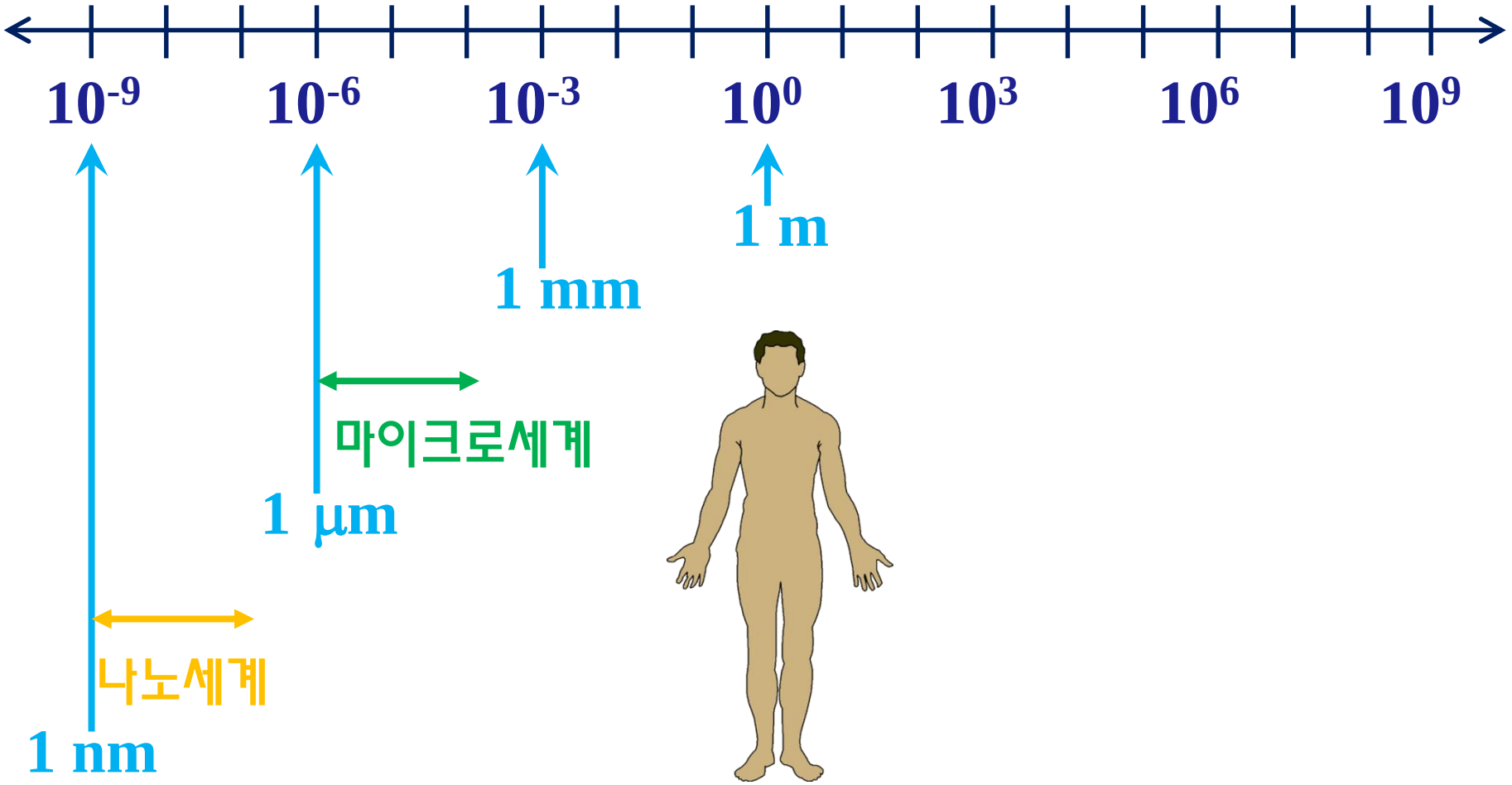
  Viruses do not fit the basic definition of cellular life.
  - Require host for all cellular activities
  - No metabolic capability of their own

세포의 크기

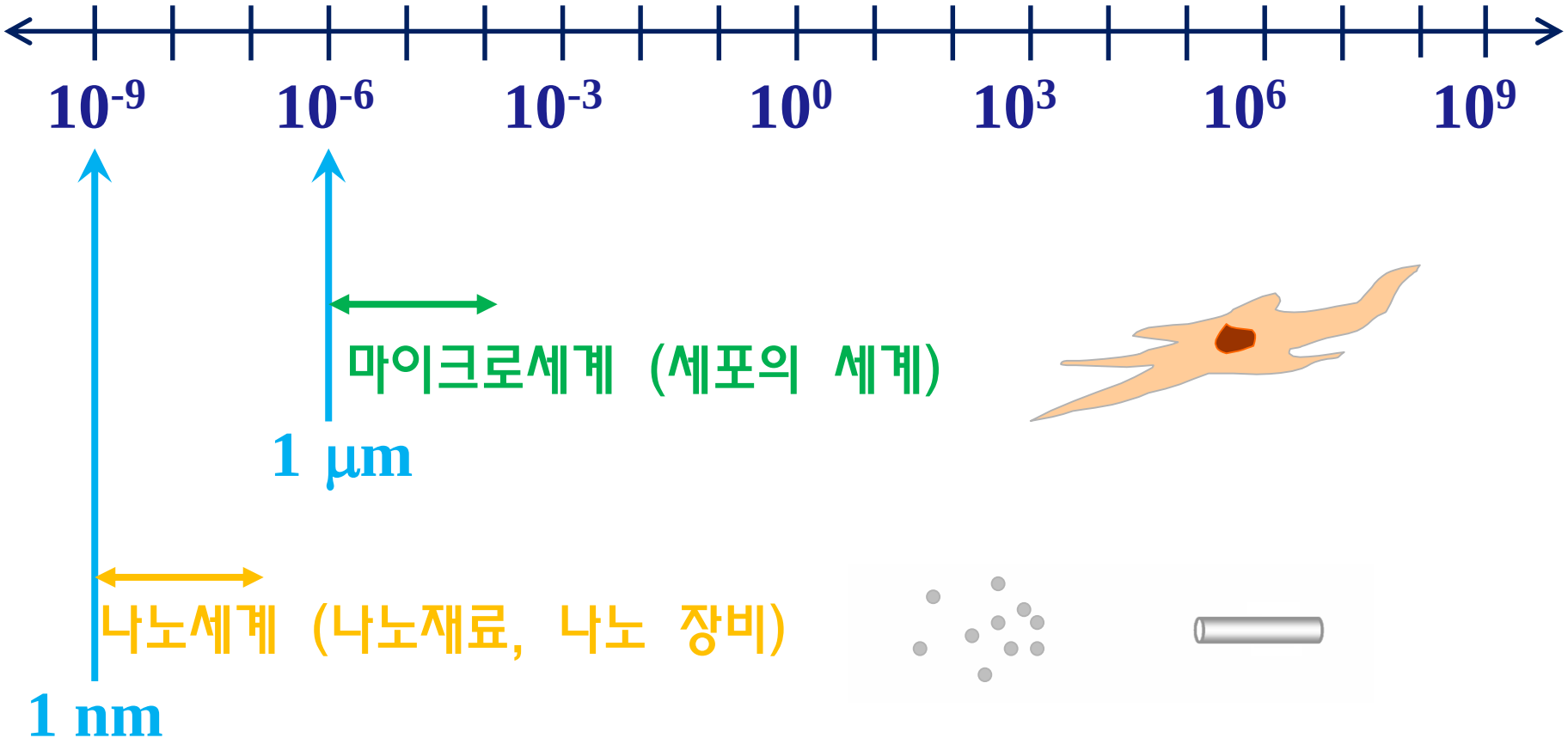


※ 출처 : commons.wikimedia.org

길이의 세계



길이의 세계


10^{-9}
10^{-6}
10^{-3}
10^{0}
10^{3}
10^{6}
10^{9}
마이크로세계 (세포의 세계)
1 μm
나노세계 (나노재료, 나노 장비)
1 nm