Physiology of Animal Cells

Department of Animal Science
National Chung-Hsing University
Pin-Chi Tang
Reference Textbooks

**Cell Biology 2002**
by Thomas D. Pollard and William C. Earnshaw

**Molecular Biology of The Cell 4th Ed. 2002**
by Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, James D. Watson

**Molecular Cell Biology 5th Ed. 2004**
by Harvey Lodish, Arnikd Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Lawrence Zipursky, James Darnell

**Biology 6th Ed. 2002**
by George B. Johnson and Peter H. Raven
Overview of Cell Biology
Origin and evolution of life on earth

**Historical event**
Chance
Cells come in an astounding assortment of shapes and sizes.

(a) Eubacteria, Lactococcus lactis; (b) Archaebacteria, Methanosarcina.
Cells come in an astounding assortment of shapes and sizes.

(c) Blood cells; (d) Fossilized dinosaur eggs.

Molecular Cell Biology, Ch 1, 2004
Cells come in an astounding assortment of shapes and sizes.

(e) A colonial single-celled green alga, *Volvox aureus*; (f) A single Purkinje neuron of the cerebellum.
Cells come in an astounding assortment of shapes and sizes.

(g) Cells can form an epithelial sheet; (h) Plant cells are fixed firmly in place in vascular Plants.

Molecular Cell Biology, Ch 1, 2004
A single cell, the human egg (~200 \( \mu \text{m} \)), with sperm, which are also single cells. From the union of an egg and sperm will arise the 10 trillion cells of a human body.
All cells are thought to have evolved from a *common progenitor*, because the structures and molecules in all cells have so many similarities.
The tree of life. Universal tree based on comparisons of ribosomal RNA sequences
The tree of life. Time line for the divergence of animals, plants, and fungi.

Cell Biology, Ch 1, by Pollard and Earnshaw, 2002
All organisms from simple bacteria to complex mammals probably evolved from a common, single-celled progenitor.
The biological universe consists of two types of cells:

- **prokaryotic cells**
- **eukaryotic cells**
(a) Prokaryotic cell

- Periplasmic space and cell wall
- Outer membrane
- Inner (plasma) membrane
- Nucleoid

0.5 μm
many proteins are precisely localized in their aqueous interior, or cytosol, indicating the presence of internal organization.
(b) Eukaryotic cell

- Nucleus
- Golgi vesicles
- Lysosome
- Mitochondrion
- Endoplasmic reticulum

1 μm
cytoplasm, comprising the cytosol (aqueous phase) and the organelles.
Prokaryotic cells consist of a single closed compartment that is surrounded by the plasma membrane, lacks a defined nucleus, and has a relatively simple internal organization.

Eukaryotic cells contain a defined membrane-bound nucleus and extensive internal membranes that enclose other compartments, the organelles.

Prokaryotic cells have a simpler internal organization than eukaryotic cells.
## Cell

<table>
<thead>
<tr>
<th></th>
<th>Eukaryotic cells</th>
<th>Prokaryotic cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compartamentalized</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Cytoskeleton</td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>
Mammalian Oocyte Architecture
Cell Cycle

- **Interphase**: 2n, 4C
- **M phase**: 2n, 2C
- **Cytokinesis**: 2n, 2C

**Cell Cycle Phases**
- **G_1**
- **S** (DNA replication)
- **G_2**
- **M phase**
  - Prophase
  - Metaphase
  - Anaphase
  - Telophase
Mitosis
Germinal vesicle (GV) stage

Meiosis I

First polar body
Meiosis II

Metaphase II (MII) stage
Morphology of the chromatin and the cytoskeleton of germinal vesicle stage porcine oocytes

(A) The chromatin structure (arrow) of the GV stage oocyte.

(B) The microtubular structure (arrow heads) of a normal GV oocyte. Note that the intensive periooplasmic microtubules are clearly visible.

Bars: 5 mm (A) and 20 mm (B).
Microfilament characteristics of pig oocytes during in vitro maturation.

(A) Long microfilaments are distributed in the periooplasm of a small proportion of the GV oocytes.

(B) The majority of GV oocytes possess a short form or punctates of microfilaments and the proportion of oocytes with this type of microfilaments increase with maturation.
Microfilament characteristics of pig oocytes during *in vitro* maturation.

(C) Some small proportions of oocytes have a disorganized or irregular morphology of microfilament pattern.

(D) The vitelline ring of an oocyte is distinguishable from the periloooplastic actin (white arrows). Outside the vitelline ring, some transzonal processes (TZP) are still visible in a MII oocyte (Left, yellow arrow), in which the amount or intensity of TZP is much less than a GV stage oocytes (inset, yellow arrows).

Location of mitochondria in mouse MII oocytes. The circles indicate the MII chromosomes.

Location of cortical granule (green) and microfilament (red) in mouse MII oocytes.

Arrow head: polar body
Chromotin: blue.