BIOL 200 (Section 921)
Lecture # 12
July 5, 2006

Unit 9: Cell Cycle, Cell division

Readings:

I. Cell cycle: ECB 2nd ed., Chapter 19, pp. 637-40. Overview of the cell cycle; Chapter 18, pp. 611-25. Good questions: 18-2, 18-3.

ECB 1st ed., Chapter 17, pp. 547-550. [Skim pp. 551-560] Overview of the cell cycle; Chapter 18, pp. 571-581.

II. DNA replication: ECB 2nd ed., Chapter 6, pp. 196-208 DNA Replication; Questions # 6-9, 6-10, 6-11 (very good).

ECB 1st ed., Chapter 6, pp. 189-197 DNA Replication; Questions # 6-14, 6-15, 6-16 (very good)

III. Chromosomes and Mitosis: ECB 2nd ed., Chapter 17 pp 639-55 for Mitosis; Good questions18-4; 18-7a, d, e, e; 18-10; 18-15; 18-16.

ECB 1st ed., Chapter 8, p 249-50 Telomeres: Specialized structures ensure that chromosomes replicate efficiently; Chapter 17 pp 551-562 for Mitosis

I. Introduction and Overview of Cell Cycle; Regulation of cell cycle by CDK-cyclin

Learning Objectives:

- Understand overall organization of the cell cycle and its relation to cell division (mitosis and cytokinesis):
- Be able to list cell cycle stages in order and indicate the location of the two major cell cycle control points.
- Give examples of discrete and continuous cell cycle processes.
- Understand the checkpoint concept and how this allows Integration of continuous and discrete cell cycle processes
- Understand the role of CDK-cyclin in regulation of cell cycle processes.
- Be able to explain how the CDK complex is regulated by protein phosphorylation, and by proteolysis.

Main Points:

- Four phases of the eukaryotic cell cycle (M, G1, S, and G2 phases)
- The cell cycle control system is based on cyclically activated protein kinases,
- MPF is the cyclin-CDK complex that controls entry to M-phase,
- Cyclin - dependent protein kinases are regulated by accumulation and destruction of cyclin.
- The activity of CDKs is further regulated by their phosphorylation. and dephosphorylation.
- Different Cyclin-CDK complexes trigger different steps in the cell cycle.

II. DNA Replication

Learning objectives

- Explain what is meant by semi-conservative replication of DNA.

- Explain how DNA replication occurs in eukaryotes through the independent operation of many replicons.
- Describe the roles of the following in DNA replication: Helicase, DNA polymerase, primer, Okazaki fragments, ligase.
- Explain the terms lagging and leading strand and the significance of these terms for DNA replication.
- Understand the relation between chromatids and chromosomes in both pre- and post-replication stages
- Explain and understand replicon and replication fork.

Main Points:

- DNA synthesis starts at replication origins
- New DNA is synthesized by DNA polymerase at replication forks (Y-shaped junctions in DNA)
- The DNA replication forks are asymmetric in nature
- DNA polymerase has self-correcting (proofreading) activity

III. Chromosomes and Mitosis

Learning objectives

- Understand why telomeres are important and how telomere extension occurs
- List the stages of mitosis in order and explain what is happening to the cytoskeleton, the mitotic spindle, the nuclear envelope and the chromosomes during this process.
- Explain how chromosomes are moved to the poles at mitosis.
- What are kinetochores and what are they good for.

Main points:

Prophase:

- centrosome has duplicated in S phase, and 2 centrosomes side by side near nucleus. Now in prophase they separate, move to opposite poles. These will be the spindle poles=MTOC for mitotic spindle
- MT extend from MTOC of spindle pole, exhibit dynamic instability, some are meet MT coming from opposite pole and are cross linked to their opposite to form "polar MTs".
- Chromosomes condense

Prometaphase

- NE breakdown due to lamin phosphorylation
- MTs bind chromosomes at kinetochore, a protein complex attached to the centromere
- chromosomes are yanked back and forth by kinetochore microtubules pulling on them until they align at the metaphase plate (metaphase plate=region equidistant between two spindle poles where all chromosomes line up)
- involves both MT polymerization/depolymerization and MT motors.

Metaphase: defined as when chromosomes are aligned at the equator of the spindle

Anaphase:

- connections between sister chromatids are cut by proteolytic enzymes, sisters move to poles
- segregates two identical sets of chromosomes to daughter cells

- Anaphase A-kinetochore MTs shorten, moving daughter chromosome to pole (combination of dynein motors and MT depolymerization)
- Anaphase B-polar microtubules push apart by motors, pulled apart by astral MT's

Telophase

- lamins dephosphorylated and NE reforms
- chromosomes decondense back to 30 nm interphase chromatin

Mitosis (nuclear division) followed by cytokinesis (cellular division)