BIOL 200 (Section 921)
Lecture # 3
June 21, 2006

Reading for unit 3 on Interphase nucleus (Lecture 3): ECB 2nd edition, **Chap 5** pp. 177-191, **Chap 15** pp. 502-506, **Chap 17** p. 578, **Chap 19** pp 651-2.
Good questions: 5-1; 5-4 a, b, c; 5-5; 5-7; 5-10; 5-11; 5-12; 5-13; 5-17.

AMINO ACIDS AND PROTEINS [From last lecture]

UNIT 3: CHROMOSOMES, CHROMATIN; THE INTERPHASE NUCLEUS

I. CHROMATIN AND CHROMOSOMES

Learning Objectives

- Understand chromatin structure. Explain how proteins and DNA interact to form chromosomes, starting with the 2nm naked DNA molecule. Be able to explain the structure of nucleosomes and the forces stabilizing these structures, then proceed to the, 10 nm fibre, higher order structures, chromosomal loops, euchromatin and heterochromatin.
- Understand the organization of chromosomes; describe centromere and telomere.

Main Points

- Chromatin is a complex of DNA and protein (largely **histones**).
- Core Histones and DNA interact to form **nucleosomes**.
- Histone H1 interacts with nucleosomes and DNA to form a native chromatin fibre.
- This fibre is further folded to form the interphase chormosome.
- Specialized parts of chromosomes (centromeres, telomeres) are formed through the interaction of specific proteins with specific DNA sequences.

- In eukaryotes DNA occurs as a complex with proteins known as chromatin. Chromatin consists of DNA and two classes of proteins, histones and non-histone chromatin proteins.
- **Histones** are a set of basic proteins (have positive charges due to basic amino acid residue side chains) that interact strongly with DNA. There are five types of histones.
- Histones include four histone types (core histones) that interact strongly with each other and with DNA. These include the core histones H2A, H2B, H3 and H4. Histone H1 is a separate category and binds in a different manner to the outside of the DNA-core histone complex. Eight histones form the core of the nucleosome (two copies each of H2A, H2B, H3 and H4) around which the DNA is wrapped almost twice

Chromatin is divided into two different categories:
Euchromatin - relatively expanded chromatin, 30 nm fibre may be "loosened", transcriptionally active [active genes].
Heterochromatin - relatively condensed chromatin, 30 nm fibre packed tightly, transcriptionally inactive [mostly inactive genes].

-Constitutive heterochromatin – permanently condensed, usually lies adjacent to the centromere of chromosomes
-Facultative heterochromatin – specifically inactivated; Example: one of two X chromosomes of female mammals is genetically inactive, but it was inherited from ancestors in whose cells it was active – thus euchromatin was changed to heterochromatin to shut down transcription in a specific chromosome.

II. THE INTERPHASE NUCLEUS

Learning Objectives

Describe the organization of the interphase nucleus, and the transport of macromolecules into and out of the nucleus

Main Points

- Nuclear envelope controls transport in and out of the nucleus.
- Nuclear envelope is part of the endoplasmic reticulum system, and is supported by the nuclear lamina.
- **Nuclear lamina** supplies an internal structure for the nucleus. The lamina binds to interphase chromatin. During mitosis, when nuclear envelope vesiculates, lamins are phosphorylated. After mitosis, the dephosphorylated lamina proteins help the nuclear envelope organize.
- **Nucleoplasm** is made up of solutes, extended chormatin (DNA and protein complexes) and non-histone proteins
- Transport is actively regulated by **nuclear pore complexes**. Nuclear pores are protein complexes that span both of the nuclear membranes. The pore itself is ~70-90nm diameter and the opening is thought to be ~9nm in diameter. They regulate passage of material between the cytoplasm and the nucleoplasm
- **Active Nuclear import** of proteins requires a certain amino acid signal sequence, "nuclear localization signal" NLS, consisting of positively charged amino acids, eg R-Lys-Lys-Lys-Arg-Lys-R, then it is recognized by a soluble receptor (called Importin) and imported through the nuclear pore. Receptors recycle to cytoplasm
- **Nucleolus** is a specialized chromosomal region for synthesis and processing of ribosomal RNAs and assembly of ribosomal units.