Epigenetics

• The study of inheritance of factors above or beyond DNA sequences that make up genes

• Factors affecting the “on-off” switching of gene expression

• Inheritance of modifications of chromatin structure not DNA sequence
  – Chemical modification of DNA (methylation) and histone modifications
Important facts

• Individuals vary in absolute level of gene expression
• Gene expression changes over the lifetime of individuals
• Environmental factors can impact gene expression by modifying the chromatin structure
Epigenetics

• Genetics (nature)-inheritance of genes
• Epigenetics (nurture)-inheritance of changes in gene expression caused by mechanisms other than changes in the DNA sequence
Important concepts about Epigenetics

– On-off switches of gene expression
– Imprinting
– Role of environmental factors including toxins and treatment
– Sensitive periods and trans-generational effects
Review of Chromatin Remodeling

- Nucleosomal beads of chromatin: DNA and histones “Beads on a string”
- Chromatin packing is the degree of nucleosome coiling
- Histones play major role in gene expression

Expose DNA when it is to be transcribed shield it when it is to be silenced
Biochemical mechanisms for Chromatin Remodeling

Specific Chemical modifications through functional groups that bind to histones and DNA are:

- Acetyl group- histones
- Methyl groups- histones and DNA
- Phosphate groups- histones
Genetic Imprinting

- An inheritance process of gene expression
- Only one allele of imprinted genes is expressed: mono-allelic expression (either paternal or maternal allele)
- < 1% of the human genes are imprinted
- Found in mammals
Genetic Imprinting

• Dynamic process: erase and re-established between generations

• Imprint is erased in germline cells and re-established.
  – In testes, parental imprint is reset
  – In ovaries, maternal imprint is reset

• Passed on to next generation
Role of Epigenetics in Disease

• Within the life time of the individual
• Trans-generational effect