

The diagram illustrates the relationship between DNA and a nucleosome. On the left, a blue double helix represents DNA, with green circles labeled 'Me' (methyl groups) attached to the cytosine ('C') base pairs. A nucleosome, shown as a purple sphere wrapped by DNA, is on the right. Various epigenetic marks are depicted as small colored shapes: a green triangle labeled 'Ac' (acetyl group), a red circle labeled 'K' (lysine), a blue circle labeled 'Me' (methyl group), a yellow circle labeled 'R' (arginine), a green square labeled 'P' (phosphate group), and a green hexagon labeled 'Ub' (ubiquitin).

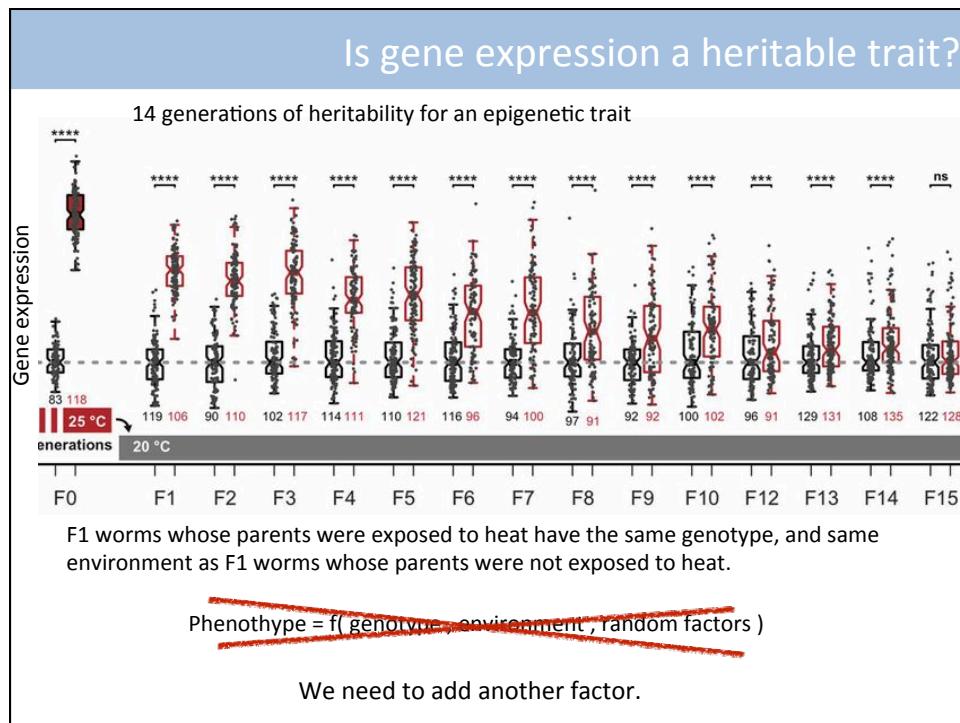
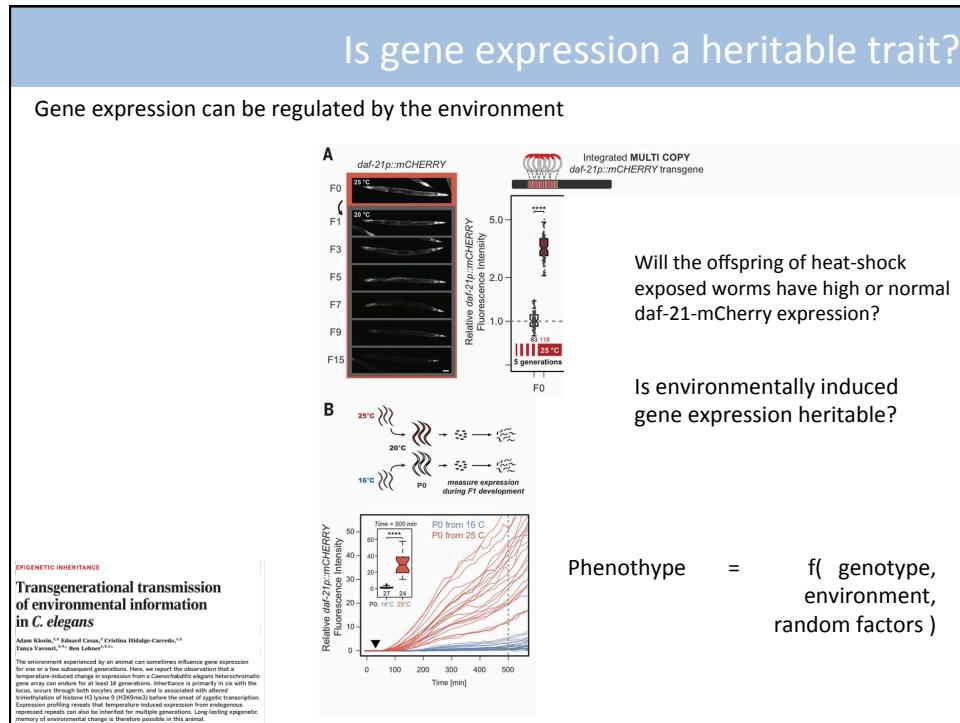
EPIGENOMICS  
Omics Techniques  
Bàrbara Negre, UAB

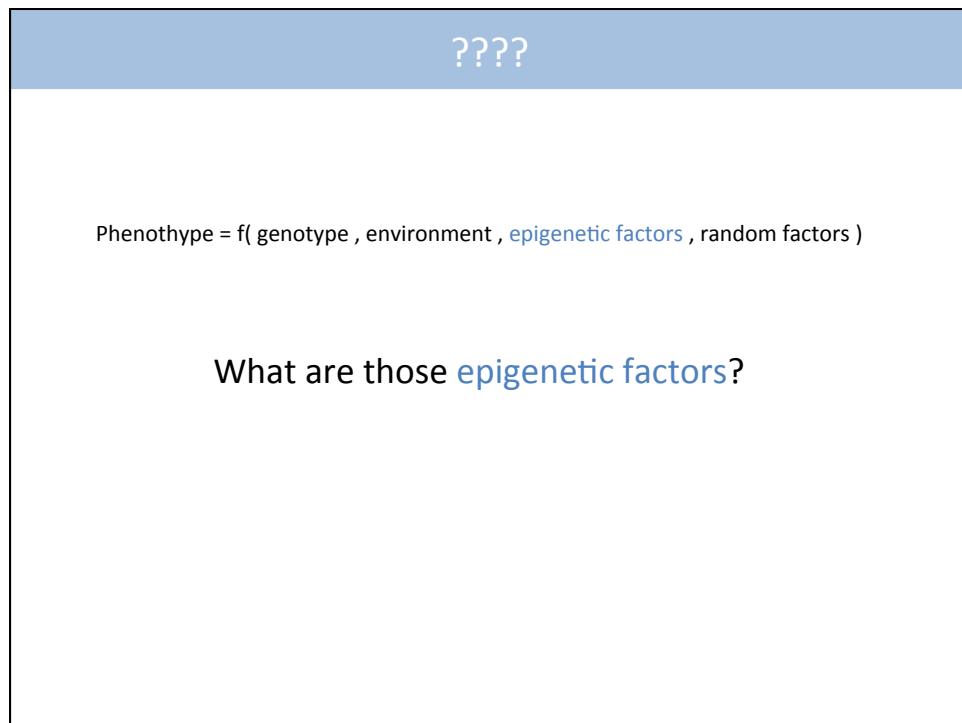
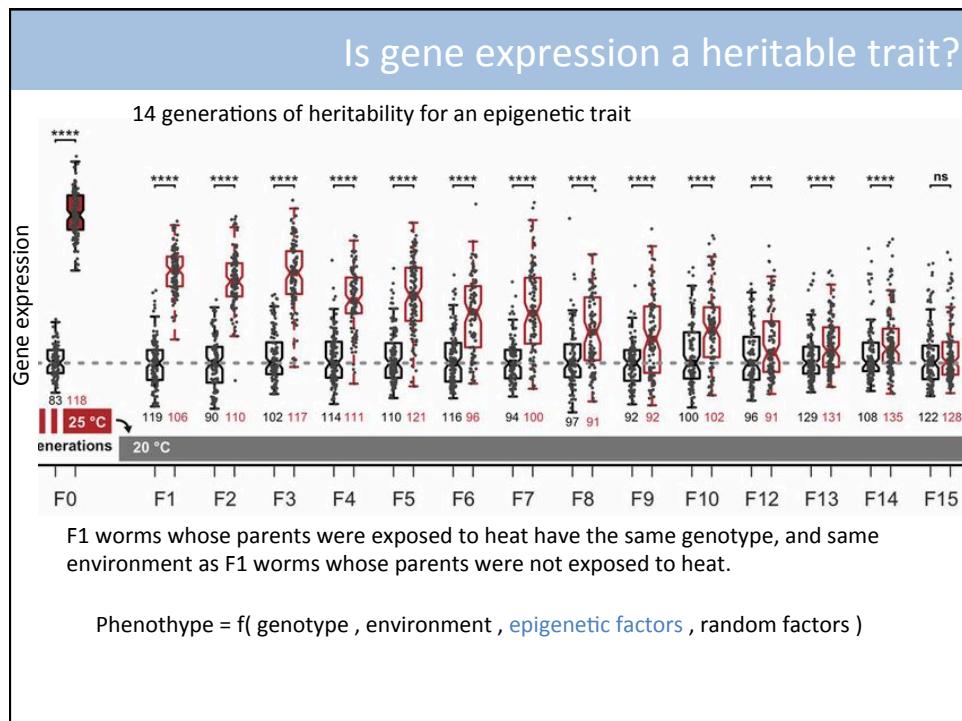
## Epigenetics

$\epsilon\pi\acute{}$  : over, outside of, around

**epigenetic trait:** "stably heritable phenotype resulting from changes in a chromosome without alterations in the DNA sequence". PMID: 19339683

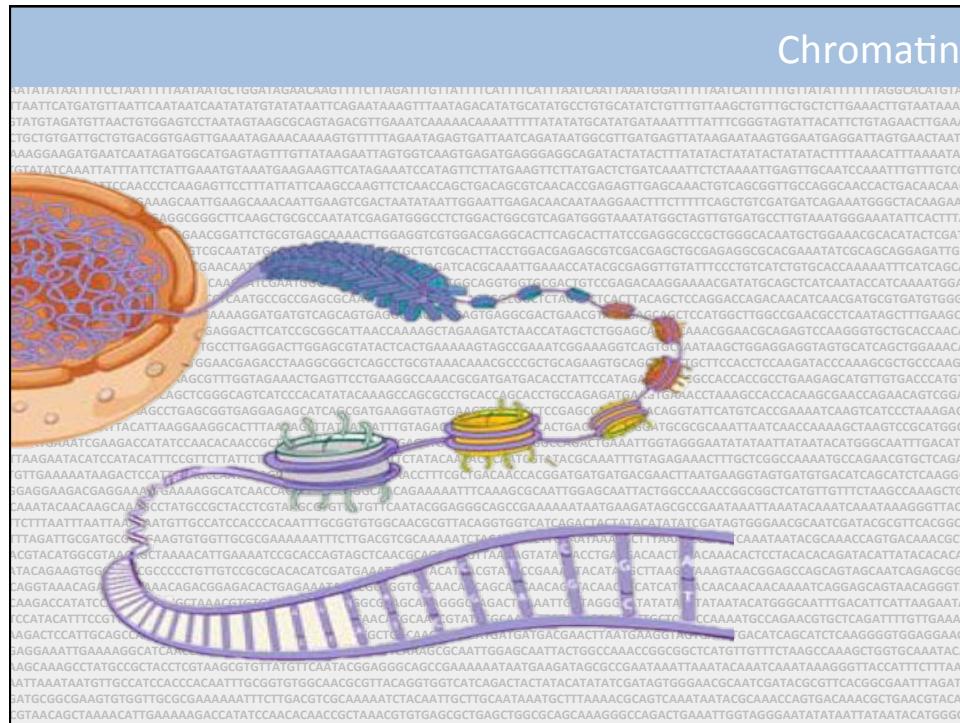
in the extreme case: any heritable cell property that is not a change in the DNA sequence



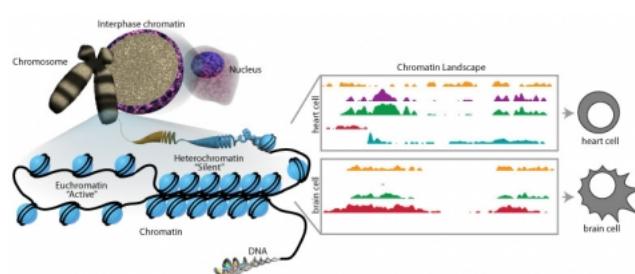


## Genome organization

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# What is Epigenetics?



## What is Epigenetics?

C.H. Waddington

**a Normal development**

**b Pluripotent reprogramming**

**c Direct conversion**

**dedifferentiation**

**transdifferentiation**

Waddington. Evolution 1956; 10(1): 1-13  
Ladewig et al. Nat Rev Molecular Cell Biology 2013; 14, 225-36

## Evolution of epigenetic marks during development

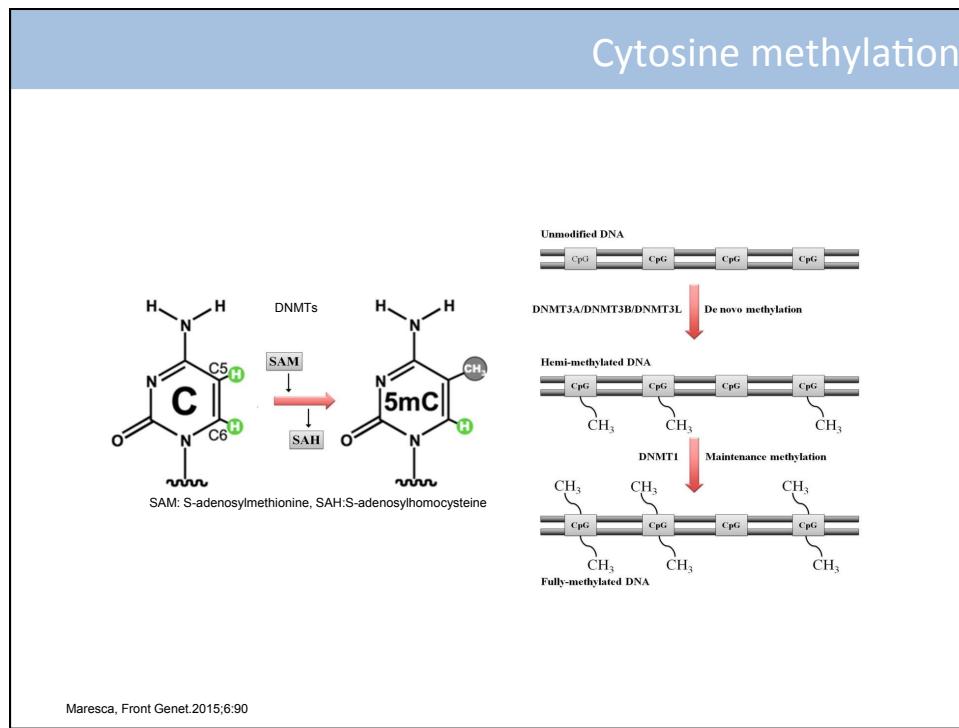
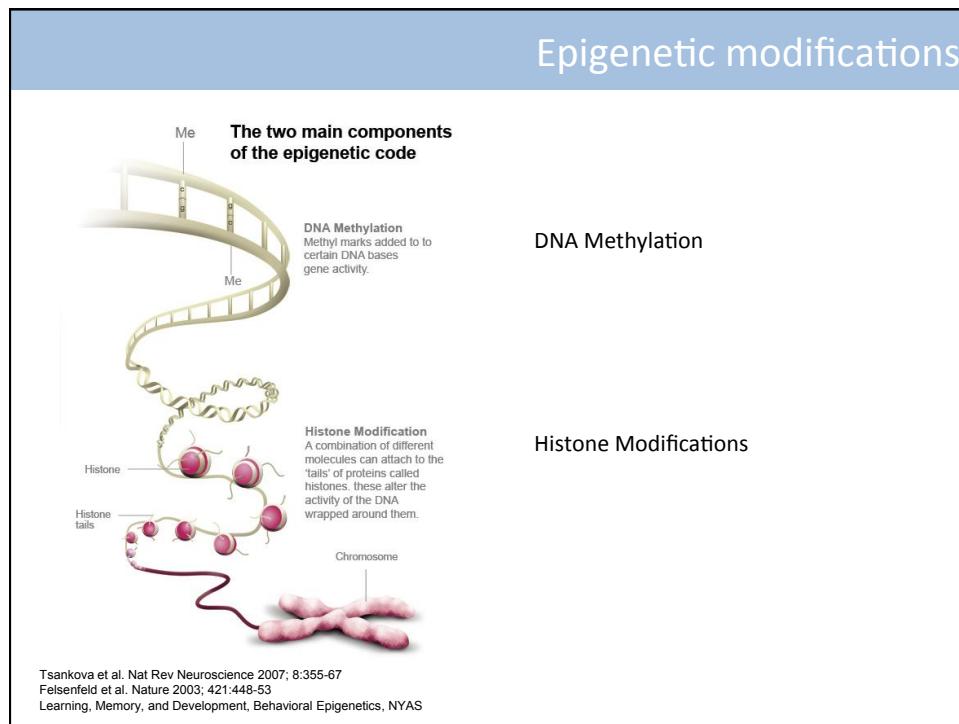
**Examples:**

- Circulatory System
- Nervous System
- Immune System

**PLURIPOTENT CELL**

**UNIPOTENT CELL**

Zakhari, Alcohol Res 2013, 35(1):6-16  
Nakamura, Cell Stem Cell 2014;14(4): 535-48



## Methylation inheritance

Epigenetic modifications are susceptible to external influences, they are therefore a **link between genes and the environment**, providing an adequate mechanism for the environment to exert an inheritable influence on the phenotype.

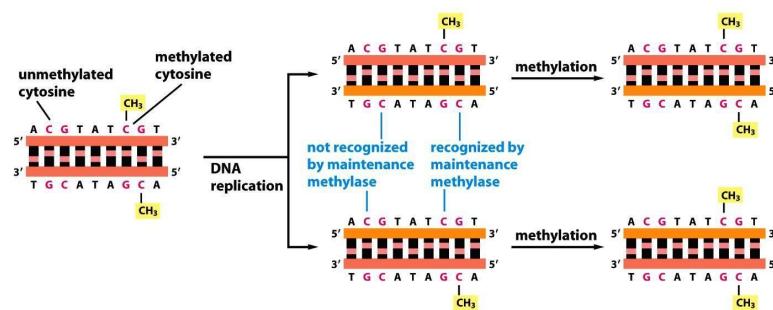
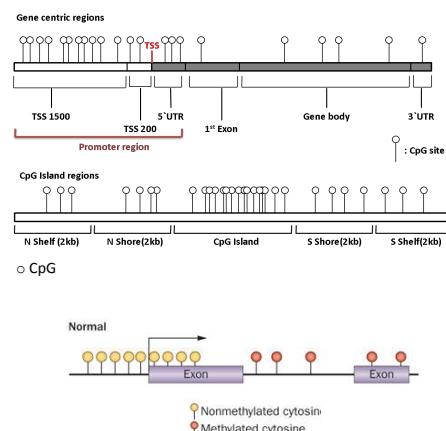


Figure 7-80 Molecular Biology of the Cell 5/e (© Garland Science 2008)

## Genome distribution of DNA methylation



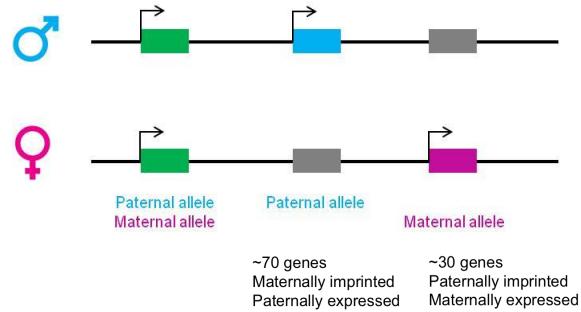
CpG Islands is a region with at least 200 bp, a GC % >50% and with an observed-to-expected CpG ratio greater than 60%

CpG Islands are normally unmethylated at promoters, and help recruit transcription factors (TF) and cause genes to be transcribed.

*Hypermethylation of CpG Islands shuts down transcription and silences gene expression*

## Imprinting

Imprinting is the unequal expression of the maternal and paternal alleles of a gene

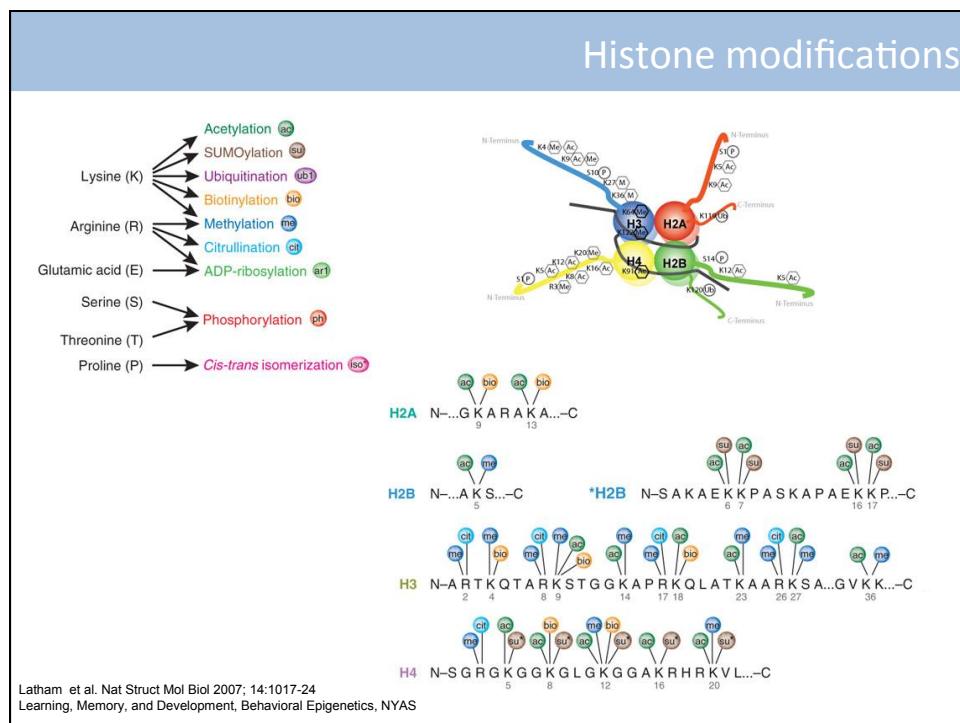
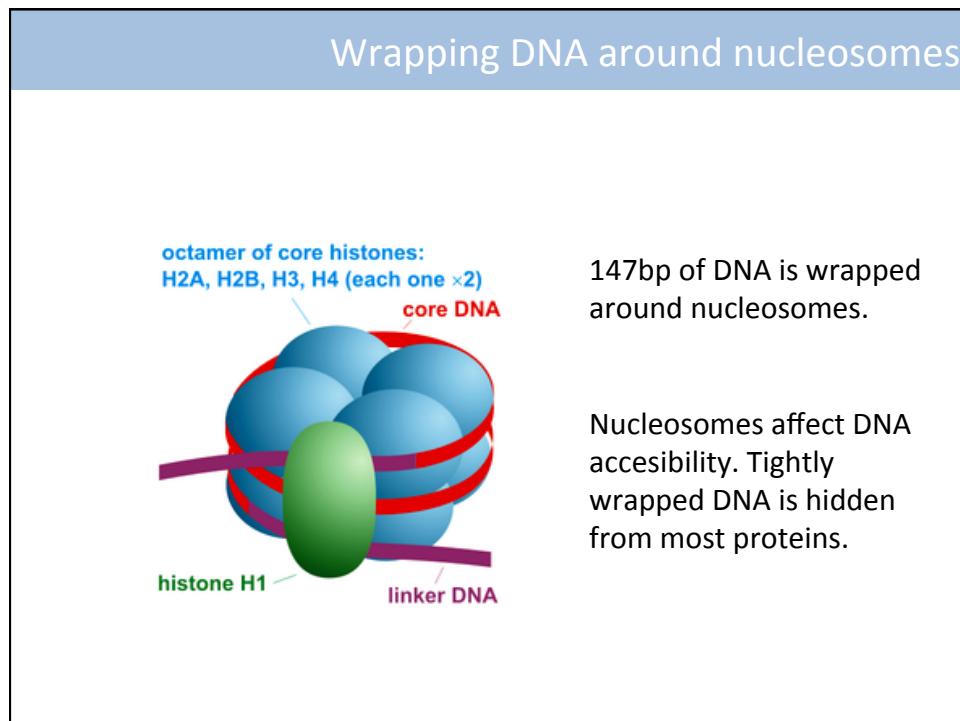


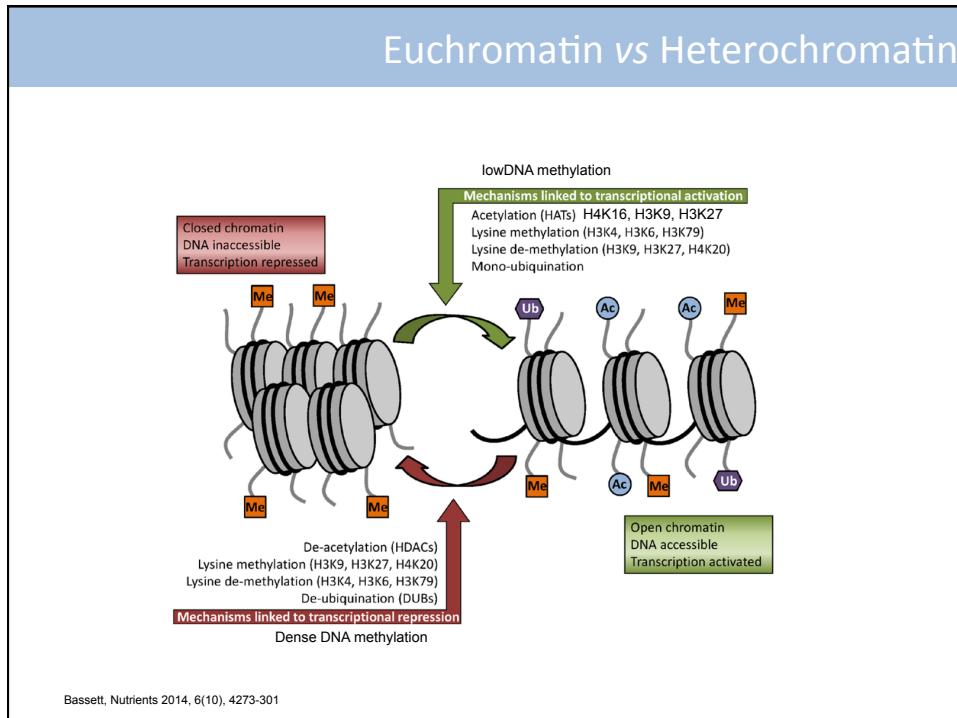
DNA methylation is a common imprinting mechanism.  
Paternal or maternal alleles may also be expressed in a tissue-specific manner

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Define:

Histone  
Nucleosome





## GROUP ACTIVITY

- Explain, in one or two slides, a technique that uses NGS sequencing to study the function of the genome.
  - How does it work?
  - Which data does it provide?

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<ul style="list-style-type: none"> <li>– Methylation sensitive restriction enzymes</li> <li>– Bisulfite sequencing</li> <li>– DNasel hypersensitivity sites</li> </ul>	<ul style="list-style-type: none"> <li>– ATAC-seq</li> <li>– Chip-seq</li> <li>– mCIP</li> <li>– FRAIRE-seq</li> <li>– Hi-C (and 3C, 4C, 5C)</li> </ul>
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## Epigenomics and dimensionality

