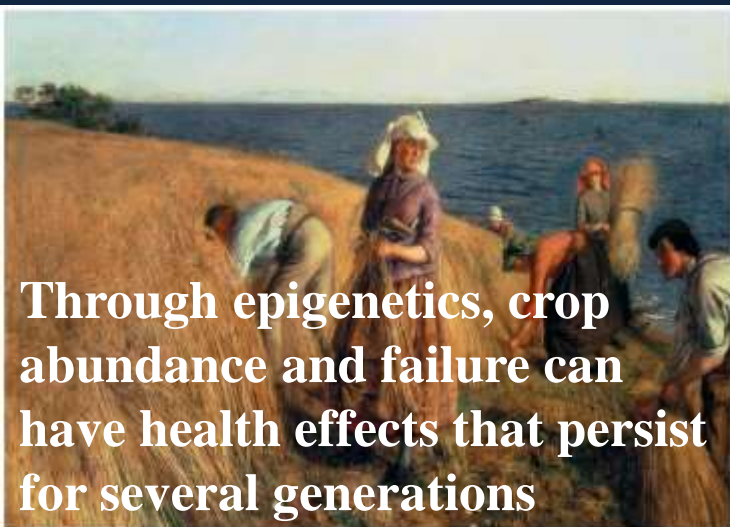


Epigenetics



Through epigenetics, crop abundance and failure can have health effects that persist for several generations

**Dr. N K Chaurasia
MSSSoA, CUTM**

21.1 What is Epigenetics?

- **How, through the process of development, a genotype produces a phenotype**
- **“epigenesis”–how an embryo develops**
- **“genetics”–the study of genes and heredity**
- **Changes that are heritable**



Figure 21.1
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21.2 Several Molecular Processes Lead to Epigenetic Changes

- **Changes in chromatin structure, which alter gene expression**
- **Molecular mechanisms that alter chromatin structure:**
 - Changes in patterns of DNA methylation
 - Chemical modification of histone proteins
 - RNA molecules that affect chromatin structure and gene expression

21.2 Several Molecular Processes Lead to Epigenetic Changes

- **DNA methylation:** addition of methyl groups to nucleotide bases
- **Most common:** methylation of cytosine to produce 5-methylcytosine

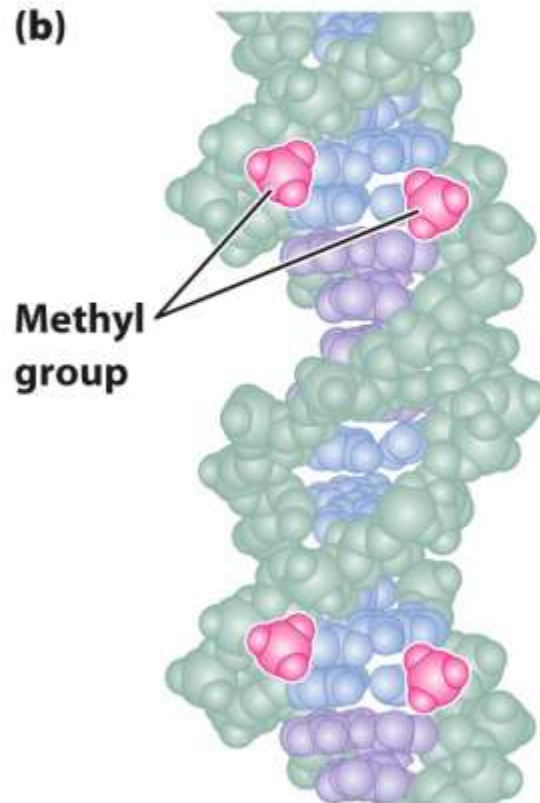
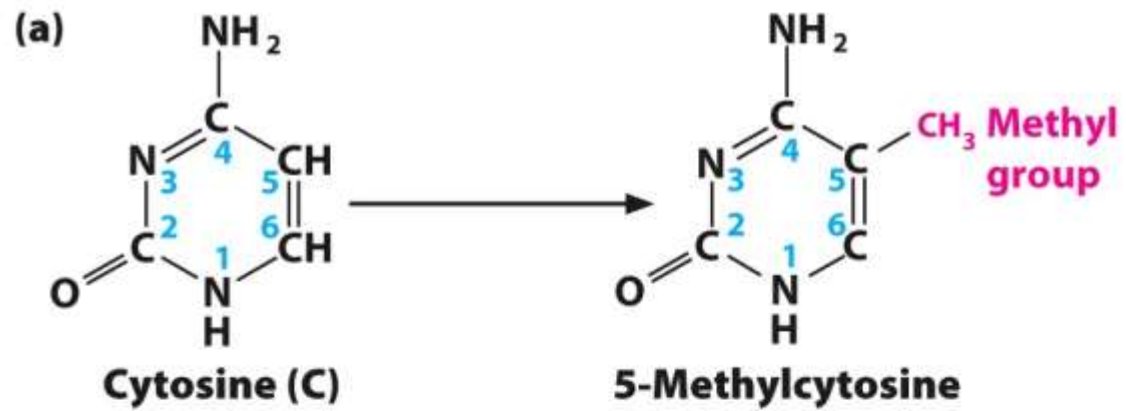


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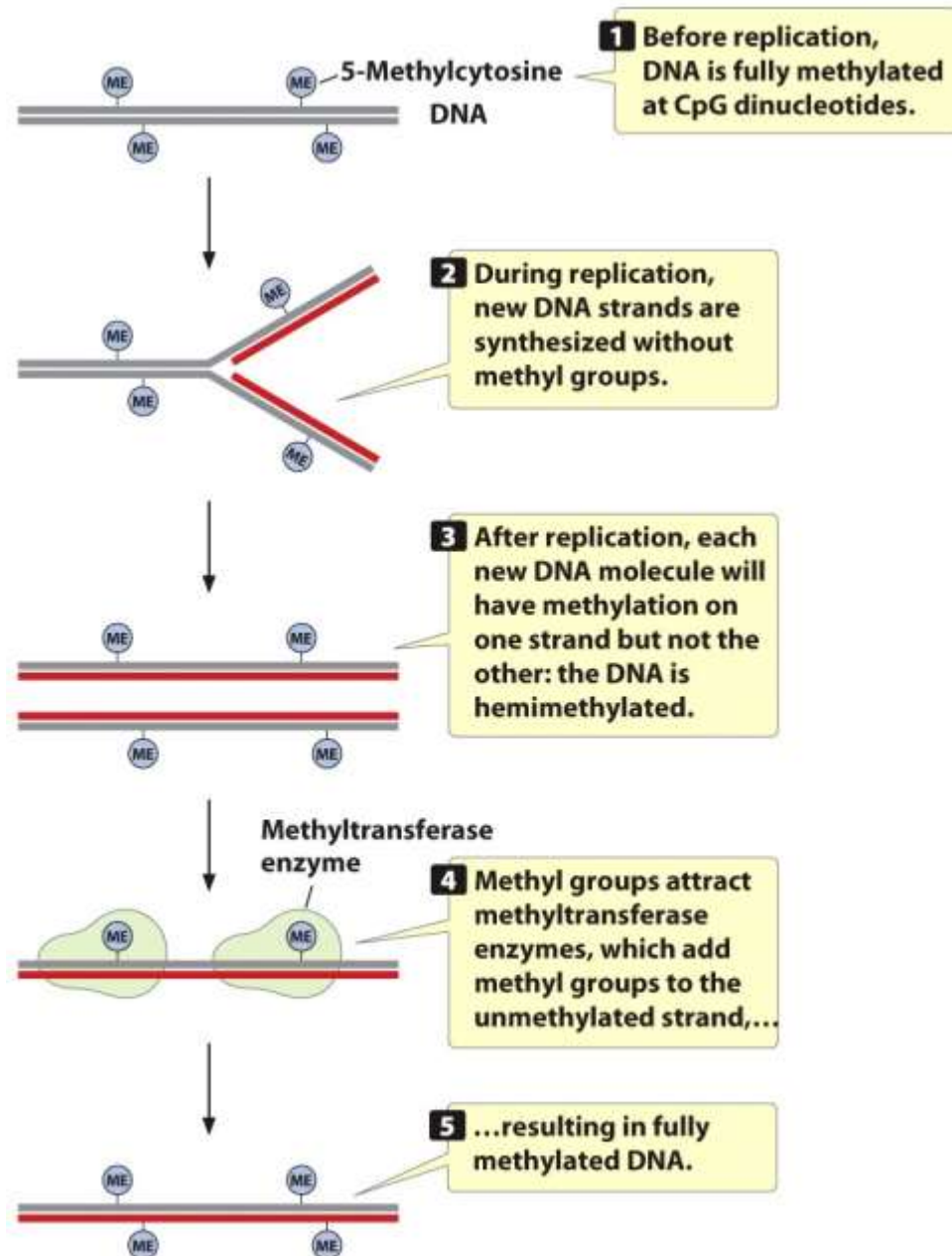


Figure 21.3

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Figure 21.4

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21.2 Several Molecular Processes Lead to Epigenetic Changes

- **Histone modifications:** more than 100 different posttranslational modifications of histone proteins
- **Modifications include addition of:**
 - Phosphates
 - Methyl groups
 - Acetyl groups
 - ubiquitin

21.2 Several Molecular Processes Lead to Epigenetic Changes

- **Epigenetic effects by RNA molecules**
- **Examples:**
 - X inactivation by *Xist*
 - Paramutation in corn by siRNAs

21.3 Epigenetic Processes Produce a Diverse Set of Effects

- **Paramutation:** an interaction between two alleles that leads to a heritable change in expression of one of the alleles
- **Examples:**
 - Paramutation in corn
 - Paramutation in mice

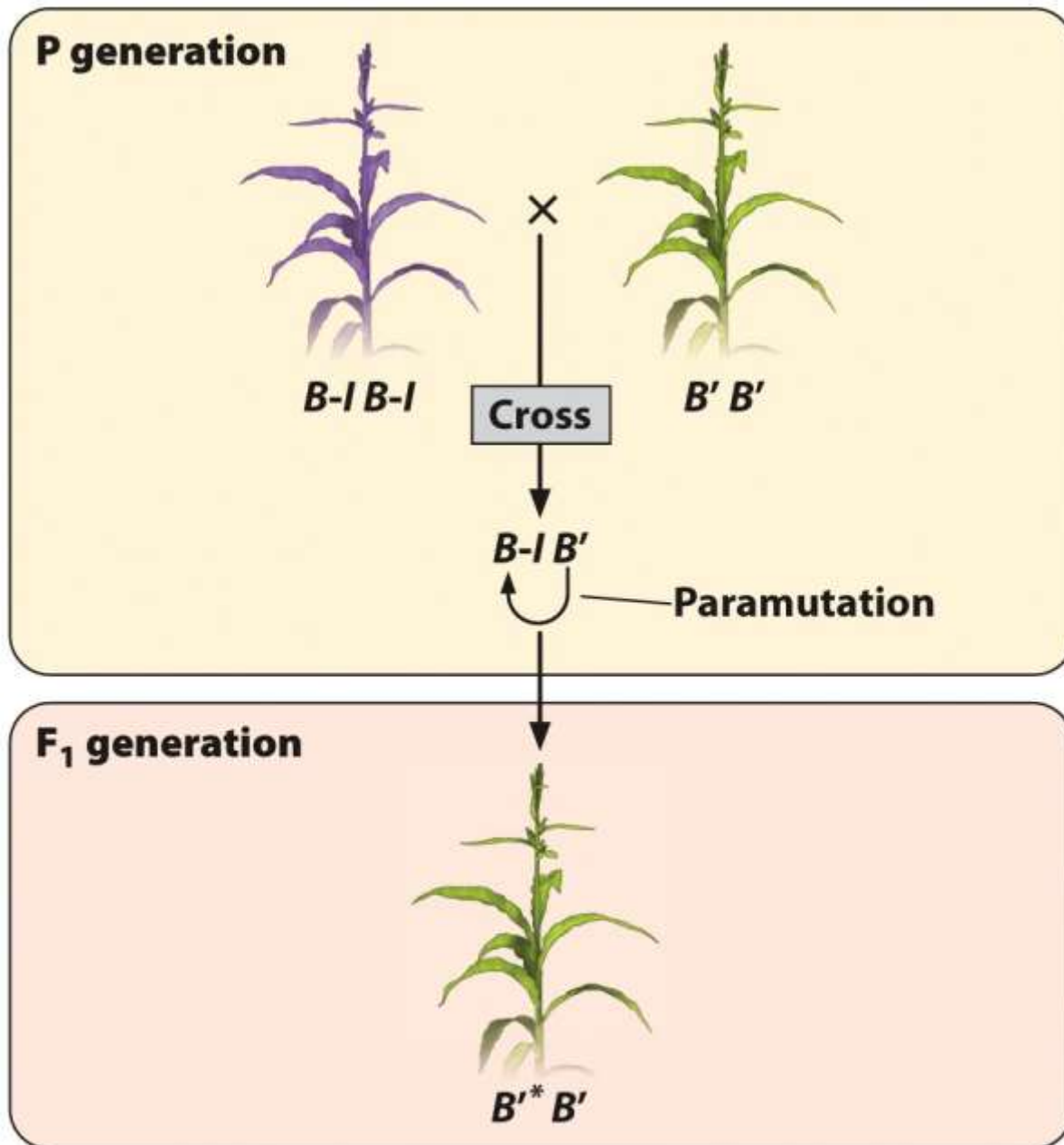


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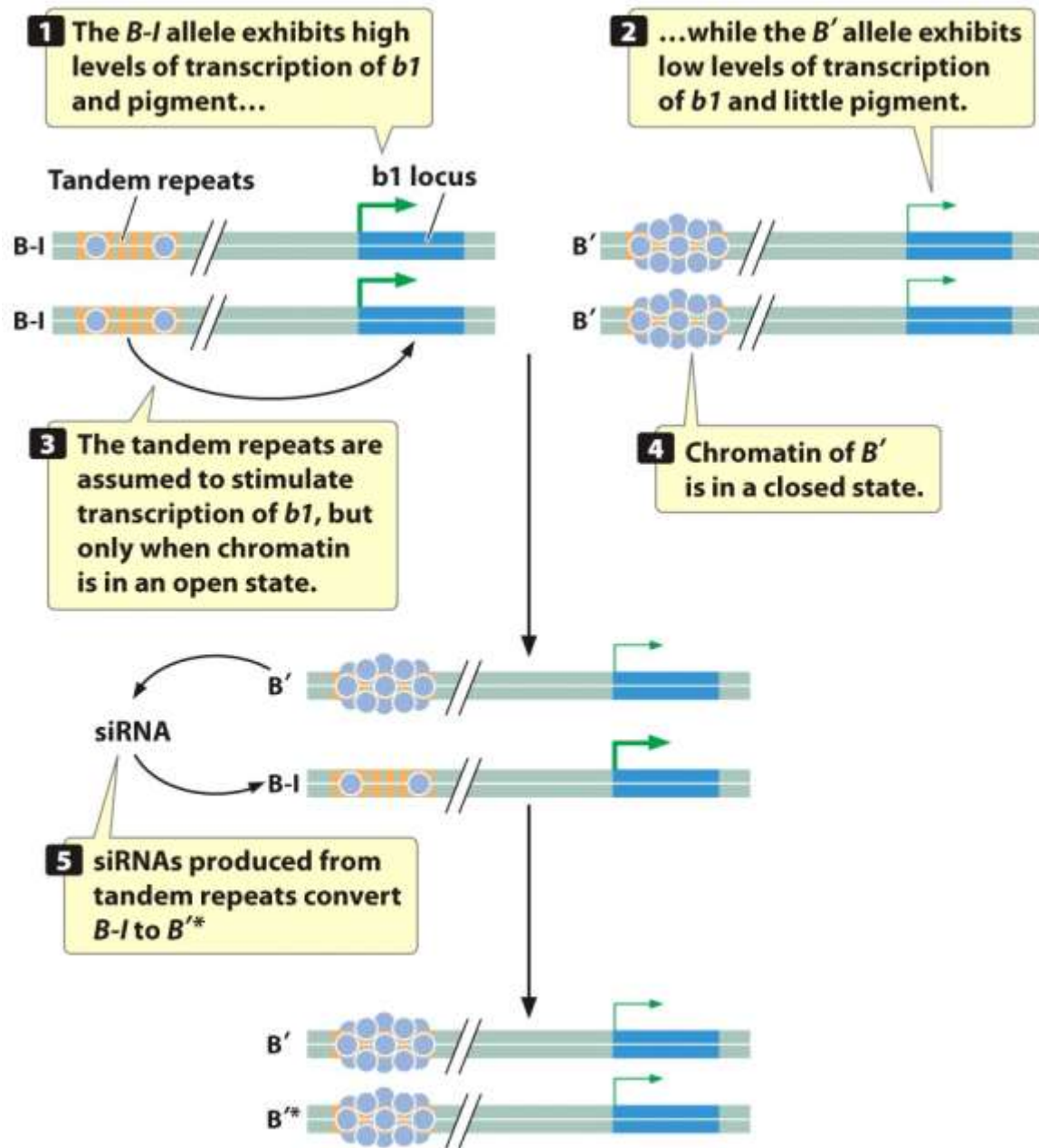


Figure 21.6

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P generation

$Kit^+ Kit^+$ homozygotes
have solid color.



$Kit^+ Kit^+$

$Kit^+ Kit^t$ heterozygotes
have white feet and tail tip.



$Kit^+ Kit^t$

×



F₁ generation

Some $Kit^+ Kit^+$
progeny develop
the phenotype of
 $Kit^+ Kit^t$ genotype.



$1/2 Kit^+ Kit^+$

$1/2 Kit^+ Kit^t$

Conclusion: A cross between $Kit^+ Kit^+$ and $Kit^+ Kit^t$ produces $1/2 Kit^+ Kit^+$ and $1/2 Kit^+ Kit^t$ progeny, but some $Kit^+ Kit^+$ develop the phenotype of heterozygotes.

Figure 21.7

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Table 21.1 Effects of injection of different types of RNA into wild-type mice ($Kit^+ Kit^+$)

Type of RNA Injected	Presence of White Tail Tips and Feet
$Kit^{\Delta E} Kit^{\Delta E}$ mRNA	Uncommon
$Kit^{\Delta E} Kit^t$ mRNA	More common
miRNA to Kit mRNA	More common
nonspecific miRNA	Uncommon

Table 21.1

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21.3 Epigenetic Processes Produce a Diverse Set of Effects

- **Behavioral epigenetics:** life experiences, especially early in life, have long-lasting effects on behavior
- **Epigenetic changes induced by maternal behavior**
- **Epigenetic effects of early stress in humans**
- **Epigenetics in cognition**



Figure 21.8

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21.3 Epigenetic Processes Produce a Diverse Set of Effects

- **Epigenetic effects of environmental chemicals**
- **Transgenerational epigenetic effects on metabolism**
- **Epigenetic effects in monozygotic twins**
- **X inactivation**

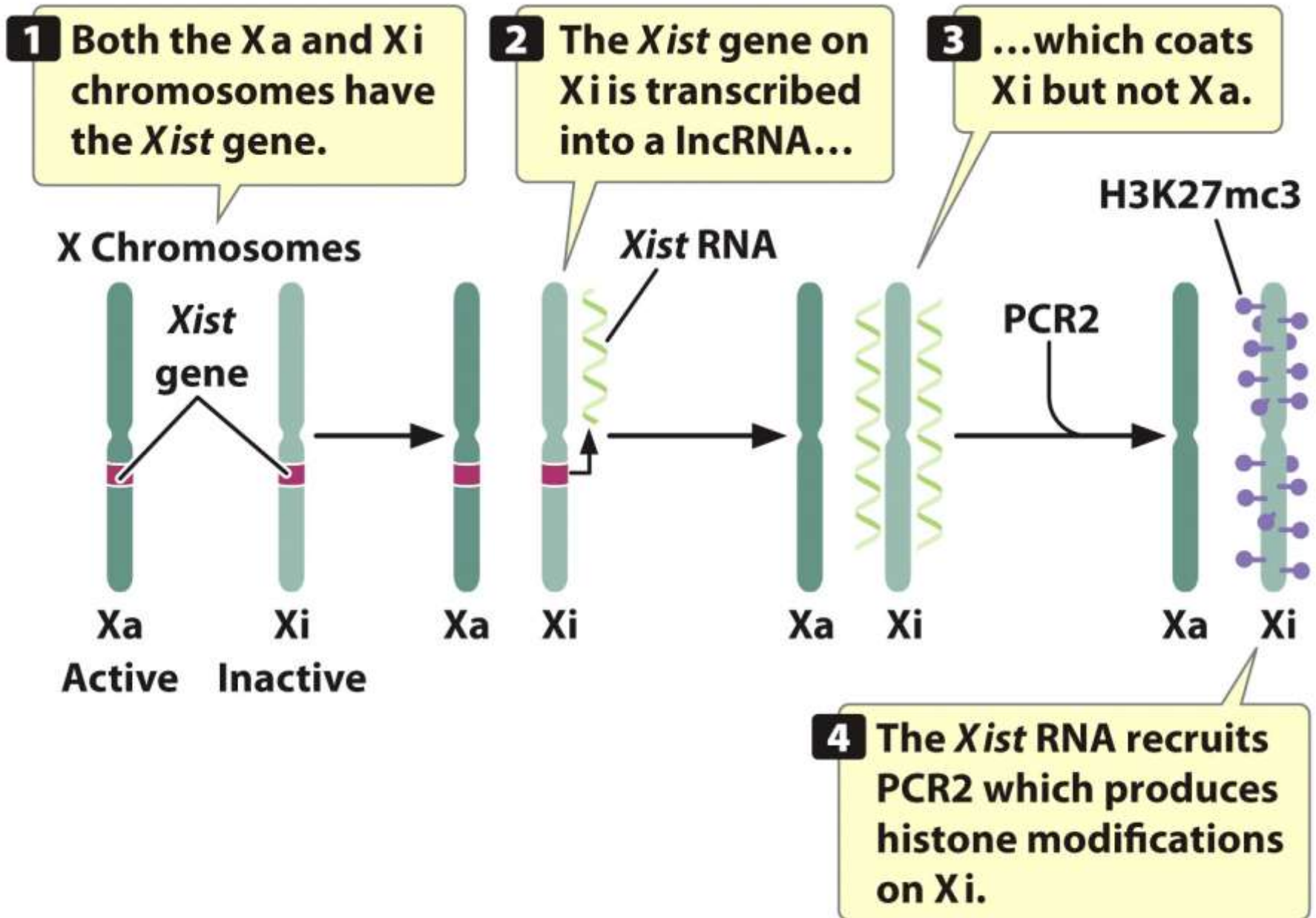
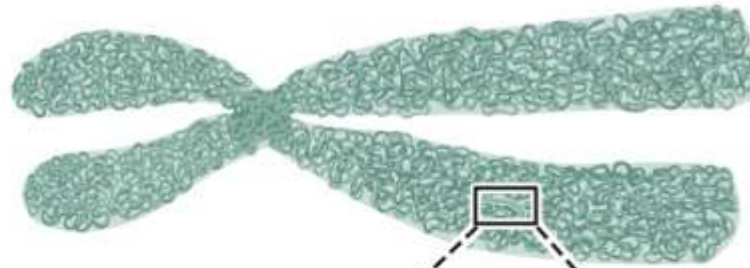


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X chromosome



X-inactivation center

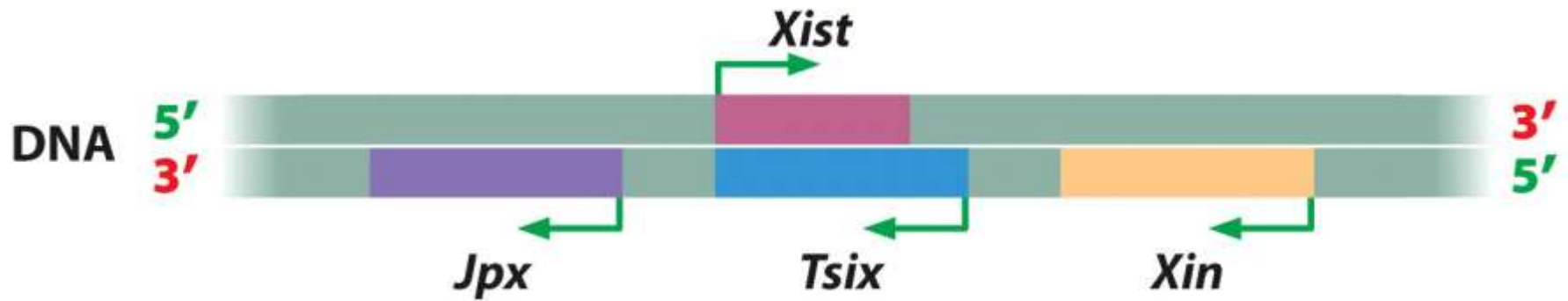
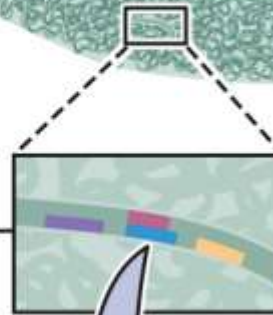


Figure 21.10

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Table 21.2 Major genes involved in X inactivation

Gene	Encodes	Action of Gene
<i>Xist</i>	lncRNA	Coats inactive X chromosome and leads to silencing of transcription of many genes on the inactive X
<i>Tsix</i>	lncRNA	Inhibits transcription of <i>Xist</i> on active X chromosome
<i>Jpx</i>	lncRNA	Stimulates transcription of <i>Xist</i> on inactive X chromosome
<i>Xite</i>	lncRNA	Sustains <i>Tsix</i> expression on active X, which inhibits <i>Xist</i> and maintains transcription of genes on active X chromosome

Table 21.2

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21.3 Epigenetic Processes Produce a Diverse Set of Effects

- **Epigenetic Changes Associated with Cell Differentiation**
- **Genomic Imprinting**
- **Epigenetic effects in monozygotic twins**

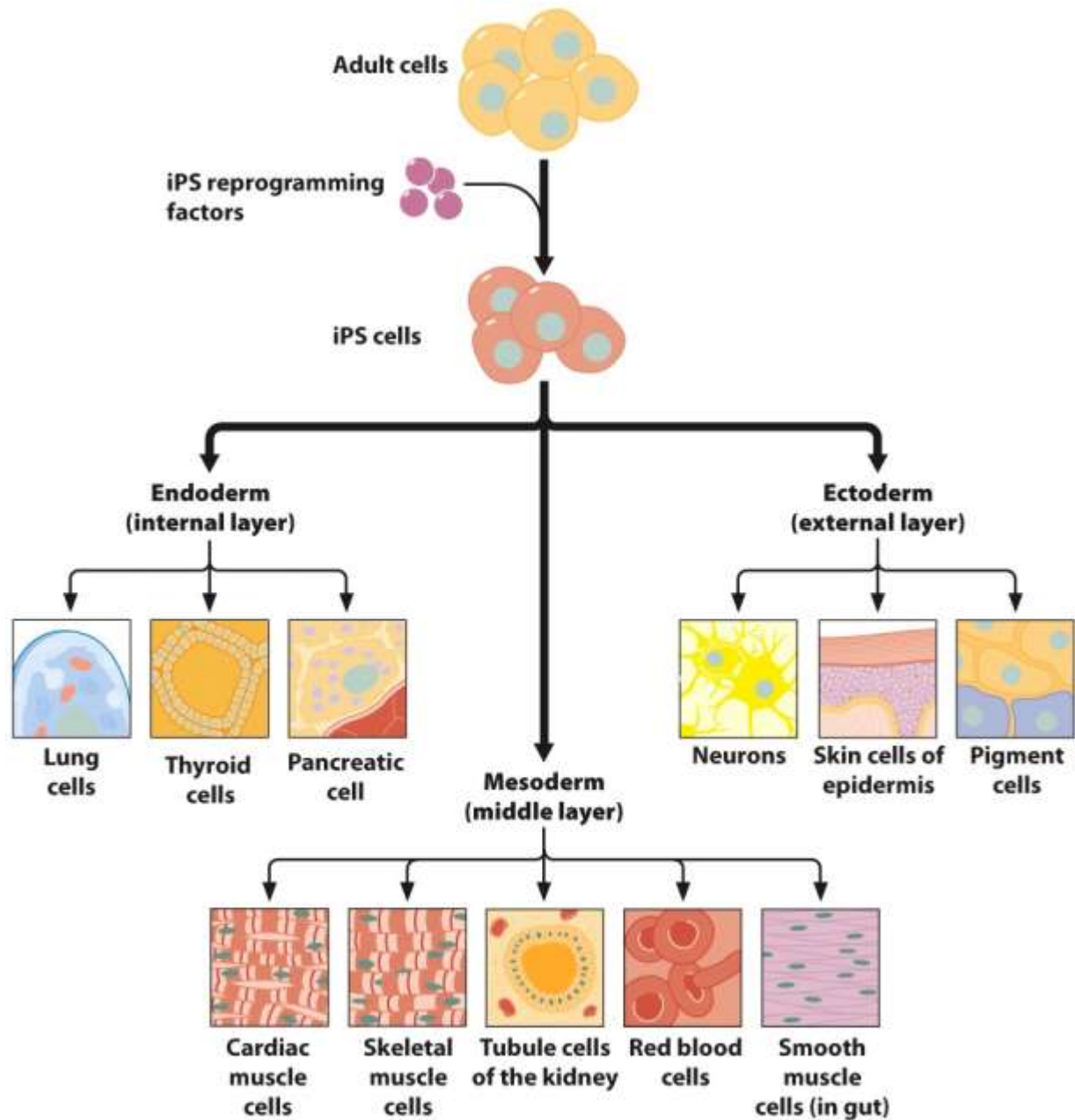


Figure 21.11

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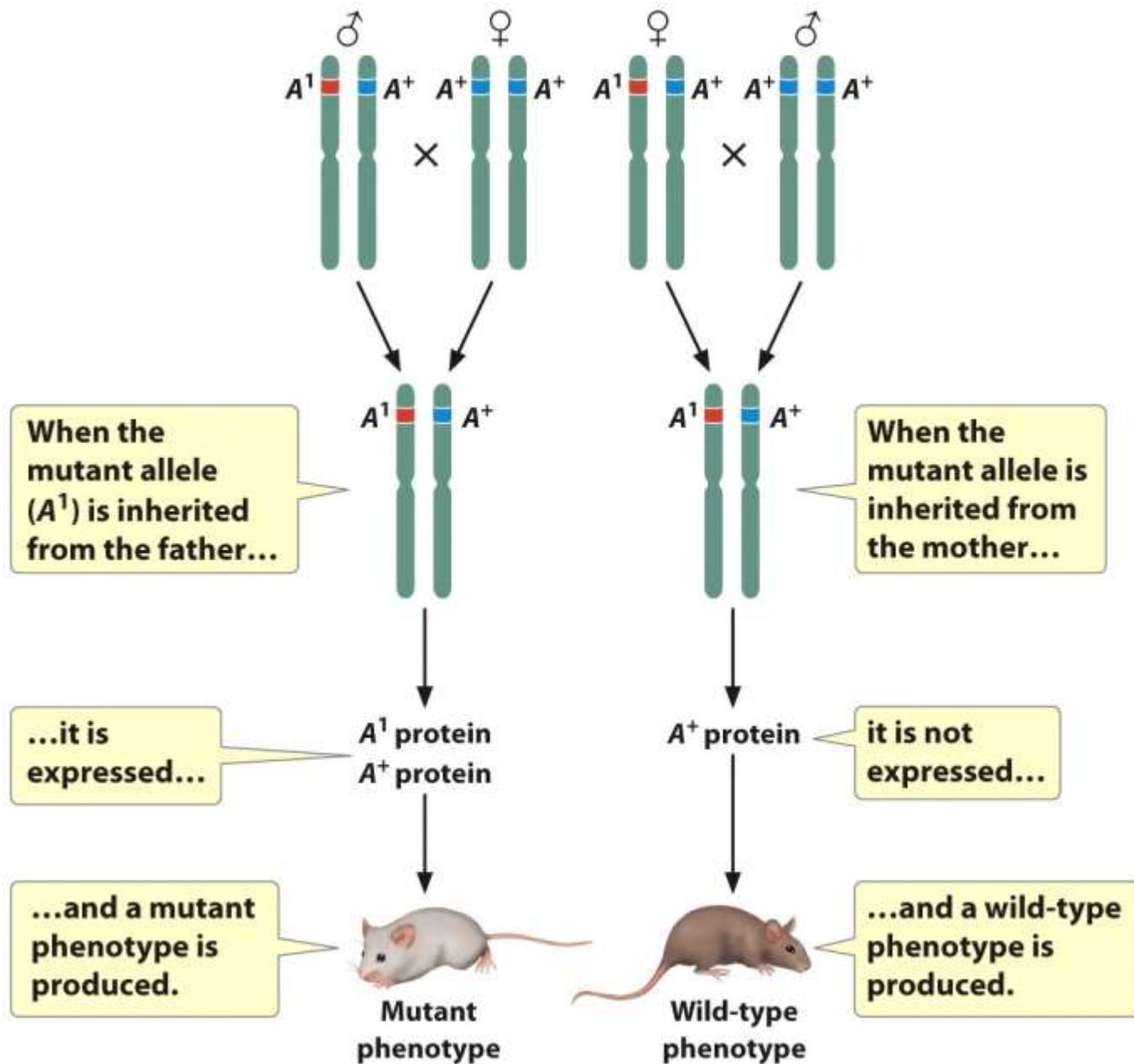


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21.4 The Epigenome

- **Epigenome:** overall pattern of chromatin modifications possessed by each individual organism
- **Detecting DNA methylation**
 - Restriction endonucleases
 - Bisulfate sequencing
- **Detecting histone modifications**
 - ChIP
- **Genome-wide epigenetic marks**

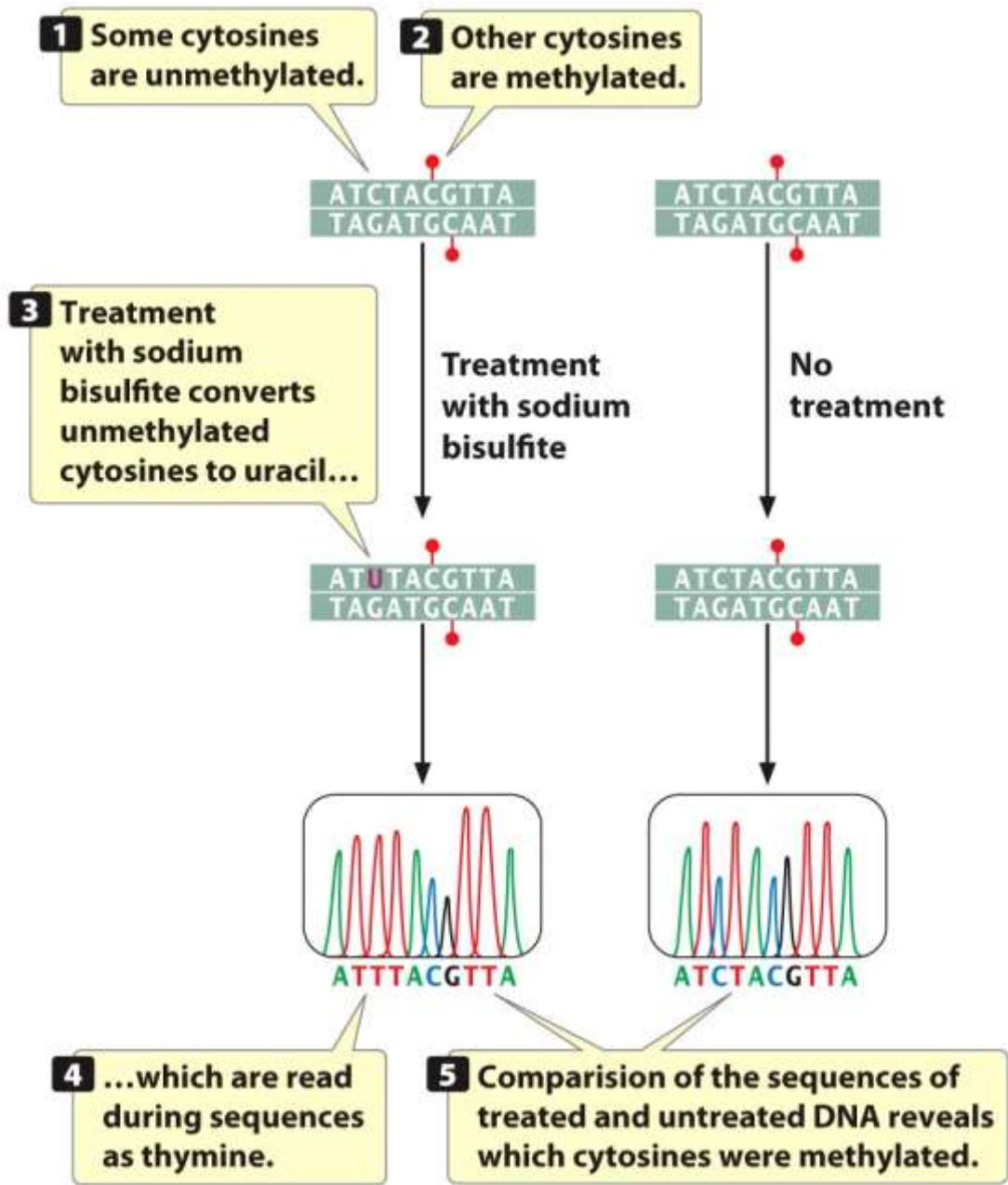


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Thank You..