Advanced Cell Biology. Lecture 18

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Outline

DNA and chromosomes (end)

Pre-exam review

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DNA and chromosomes (end)

Pre-exam review

Previous final question: the answer

What is the transformation of bacteria?

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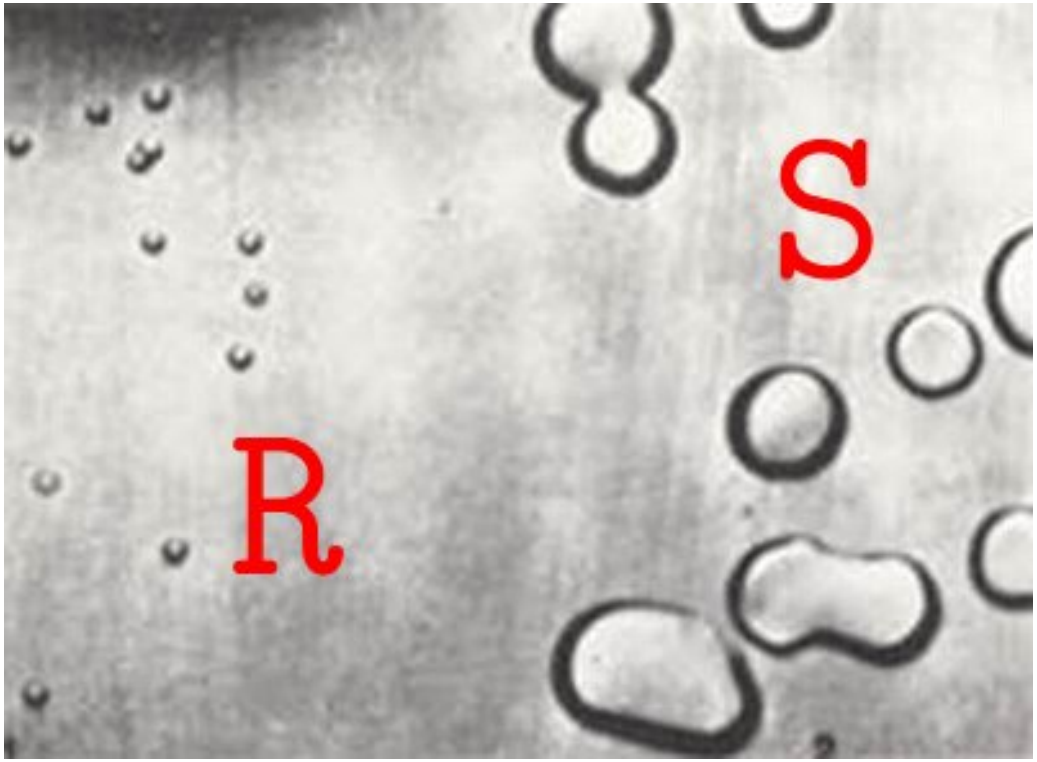
What is the transformation of bacteria?

- Lateral/horizontal gene transfer (LGT/HGT) from bacterium to bacterium.

Rough (nonvirulent) and smooth (virulent) pneumococci



Lab 4 notes

Chromatin remodeling complexes

- To make DNA readable, it should be detached from histones
- Chromatin-remodeling proteins “move” DNA alongside histone octamers and/or compactize/decompactize nucleosomes

Chromatin-remodeling complexes

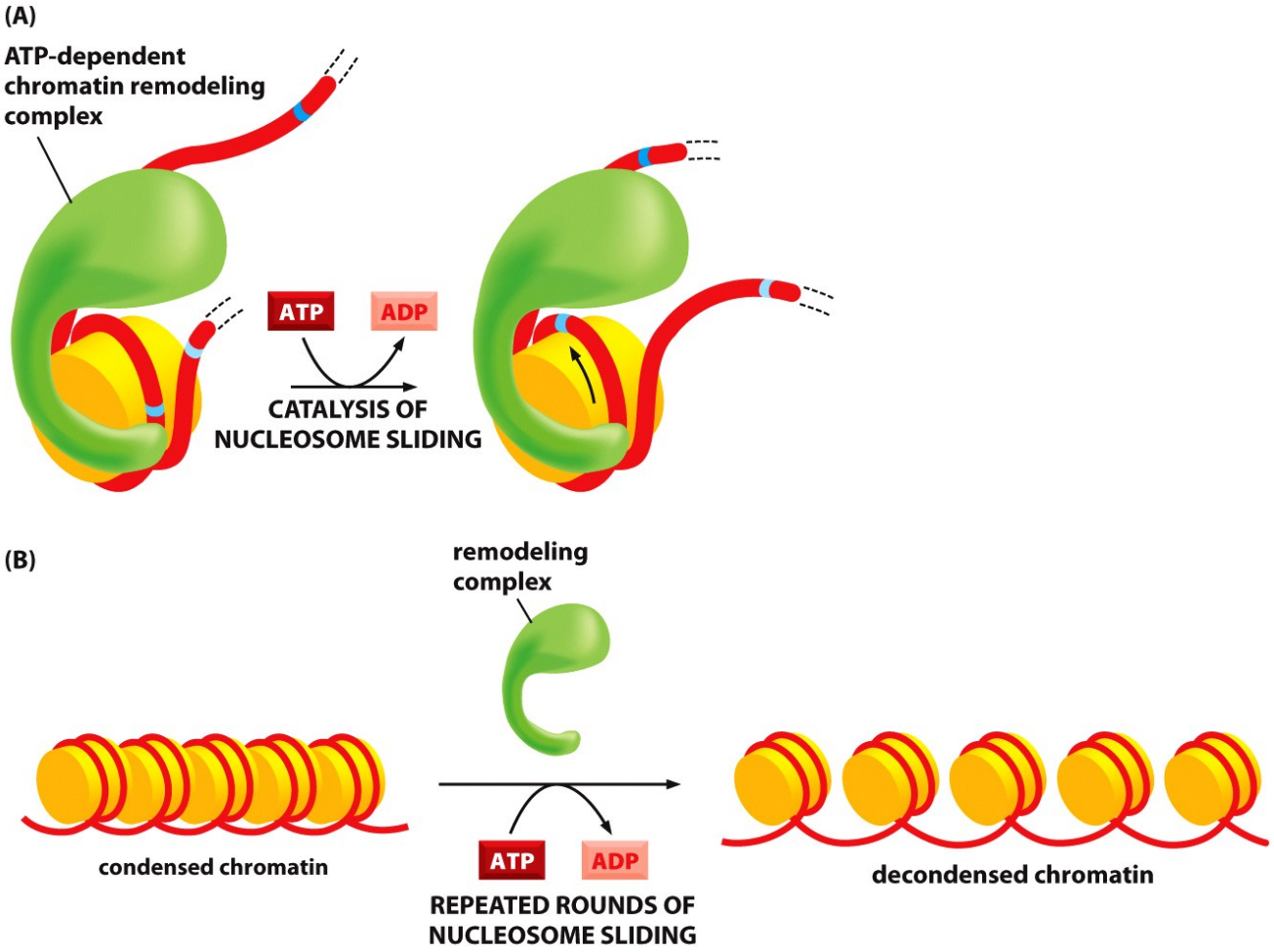


Figure 5-27 Essential Cell Biology 3/e (© Garland Science 2010)

Heterochromatin and euchromatin

- Folded DNA with condensed nucleosomes are restricted from being expressed
- This DNA is a main component of heterochromatin
- Expression will decrease even if gene is too close to heterochromatin part
- Non-condensed DNA is euchromatin

DNA inversion near heterochromatin

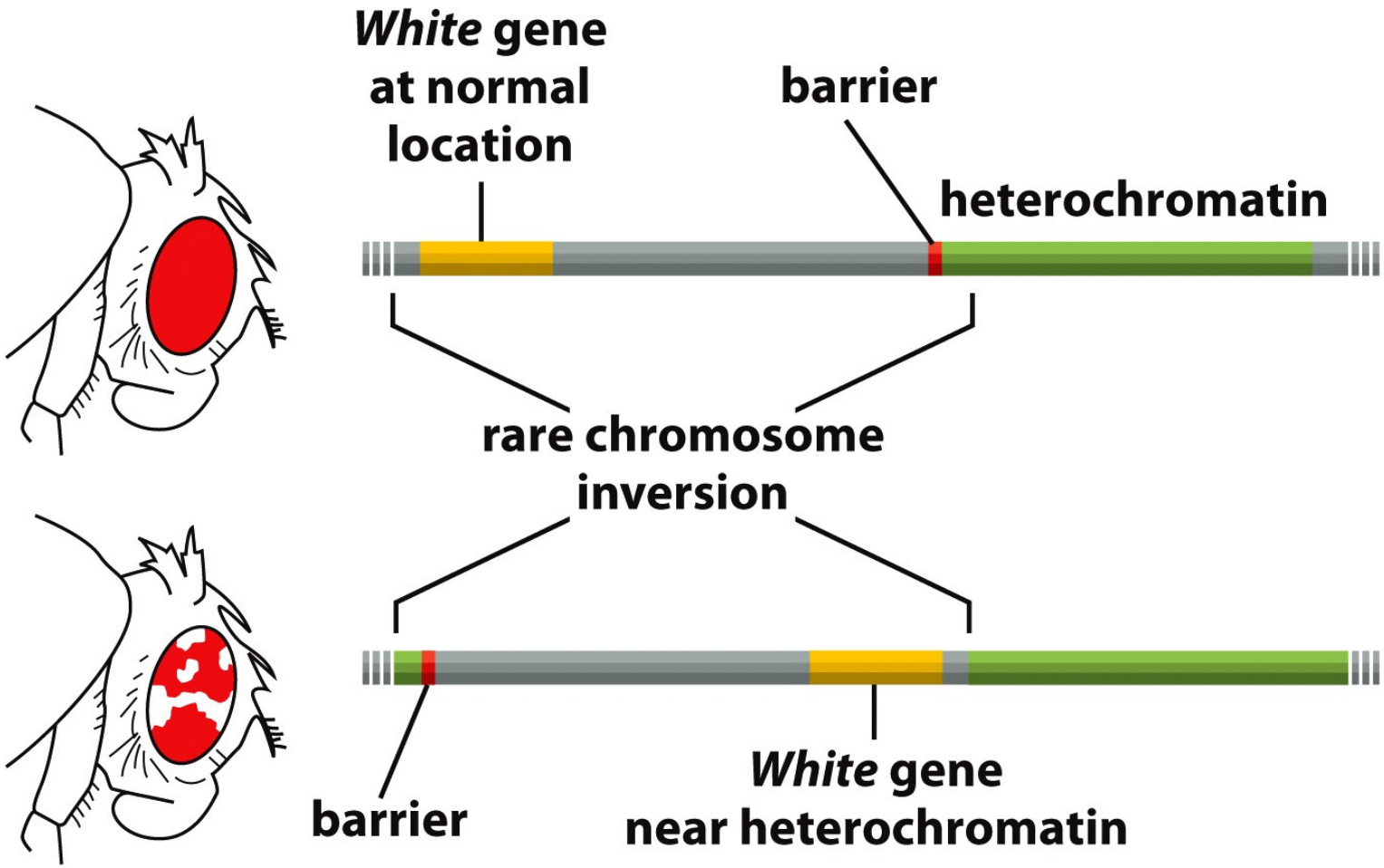


Figure 5-29 Essential Cell Biology 3/e (© Garland Science 2010)

Inactivation of X chromosome

- One of two female X chromosomes in mammals should be deactivated
- It is normally deactivated via DNA silencing with DNA folding (making heterochromatin)
- During the development, every cell lineage will inherit the pattern of deactivation (which X chromosome, #1 or #2 is deactivated)
- In human cells, deactivated X chromosomes are visible as Barr bodies—this is the way of cytological determination of sex

Inactivation of X chromosome

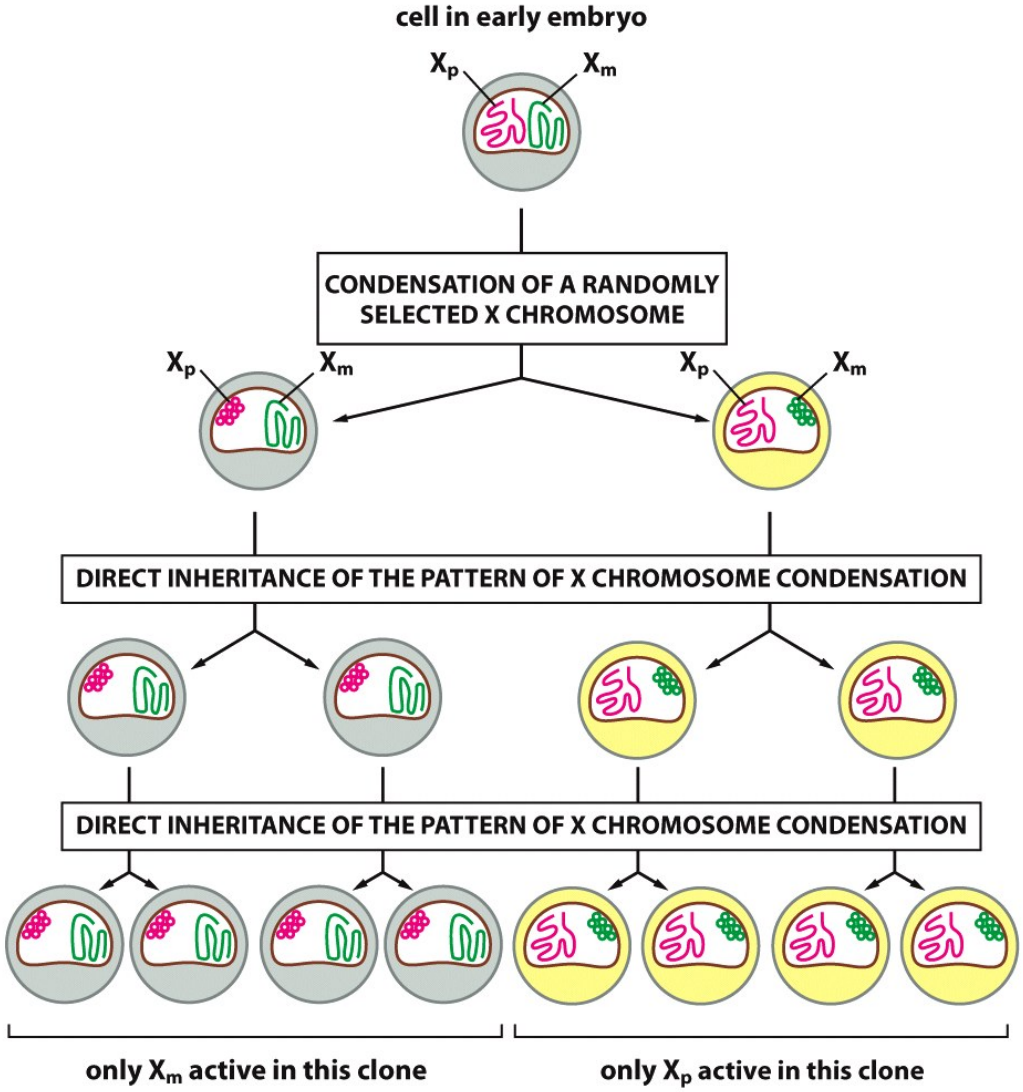
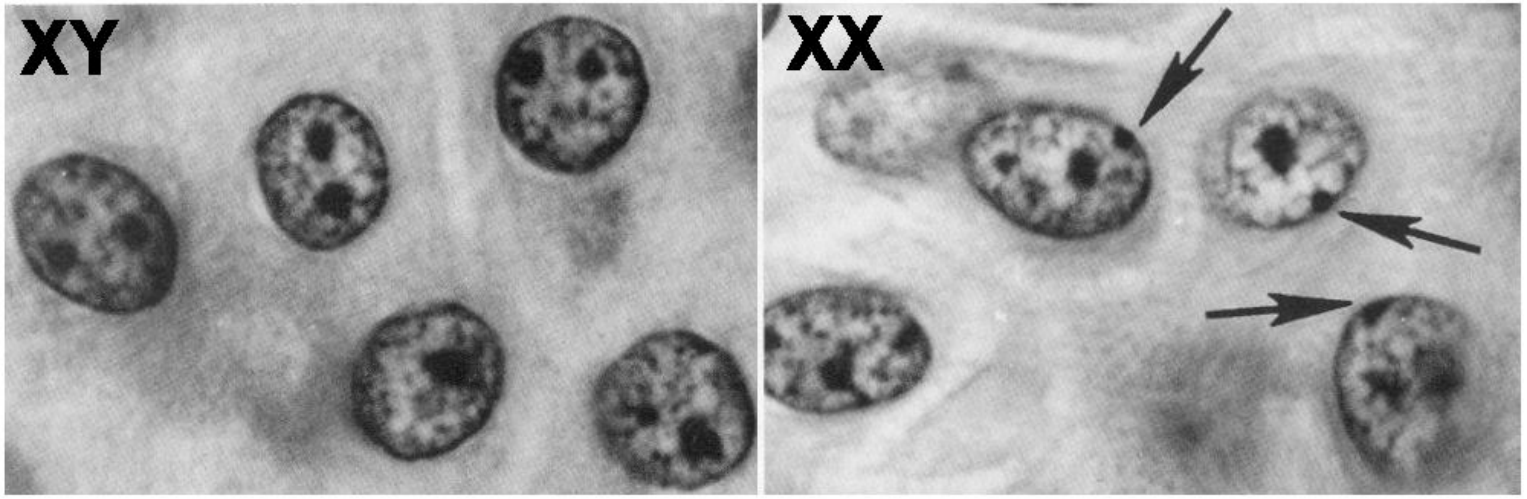


Figure 5-30 Essential Cell Biology 3/e (© Garland Science 2010)

Barr bodies

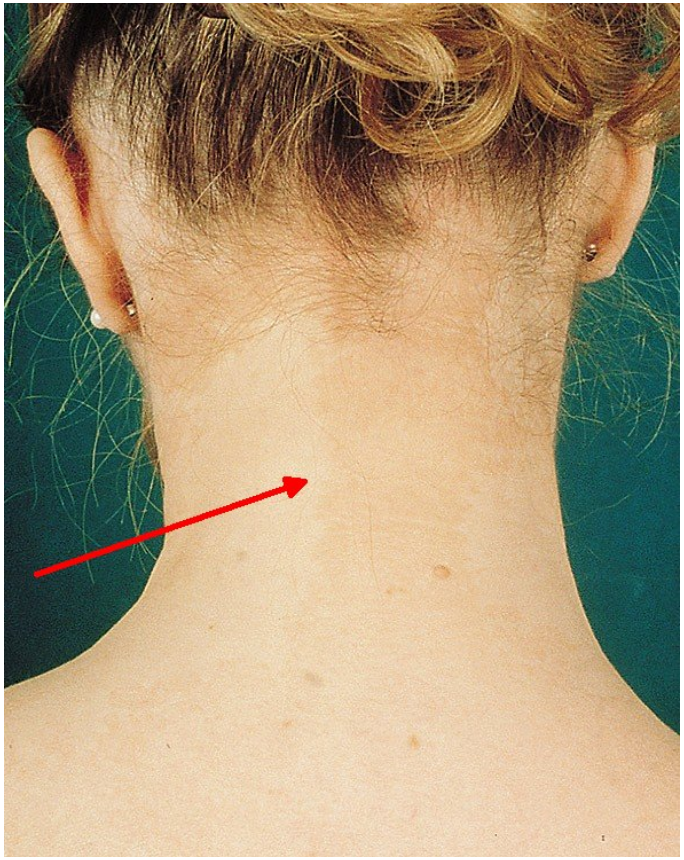


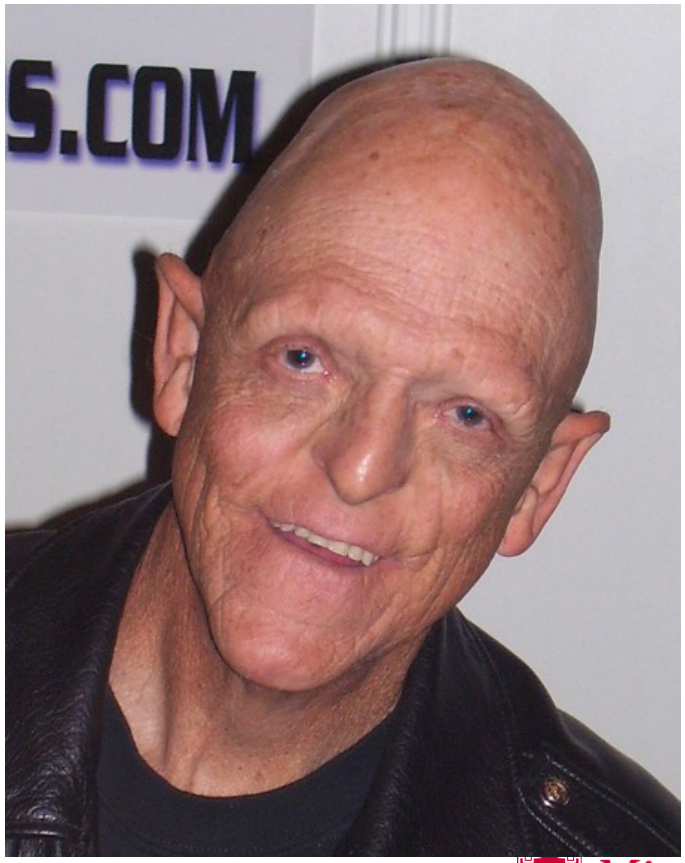
Tri-colored (tortoiseshell and calico) cats

- Cats have three alleles of same gene which correspond with color, and the gene is located in X chromosomes
- X^o will produce white color, homozygote X^OX^O produce white with orange spots, X^BX^B—white and black. But X^OX^B will be tricolor cats, and a size of spots will depend on the time of X chromosome inactivation
- Males have genotype $X^?Y$ and therefore cannot be tricolored (with an exception of chromosome aberrant XXY Klinefelter's syndrome etc.)

Calico cat (left) with early and tortoiseshell cat (right) with late X chromosome inactivation

Human hypohidrotic ectodermal dysplasia has the same pattern of inheritance





Histone modification

- Histones' amino acids may bind methyl (1–3 groups per lysine), phosphate, acetyl or other groups
- Every modification will have its own "meaning" and will allow or restrict the work with specific DNA sequence

Epigenetic inheritance

- Modifications of histones may be inherited
- This is because modified old histones have templating ability for newly attached histones
- Inherited histone modification and other similar processes are called epigenetic inheritance

One of ways of epigenetic inheritance

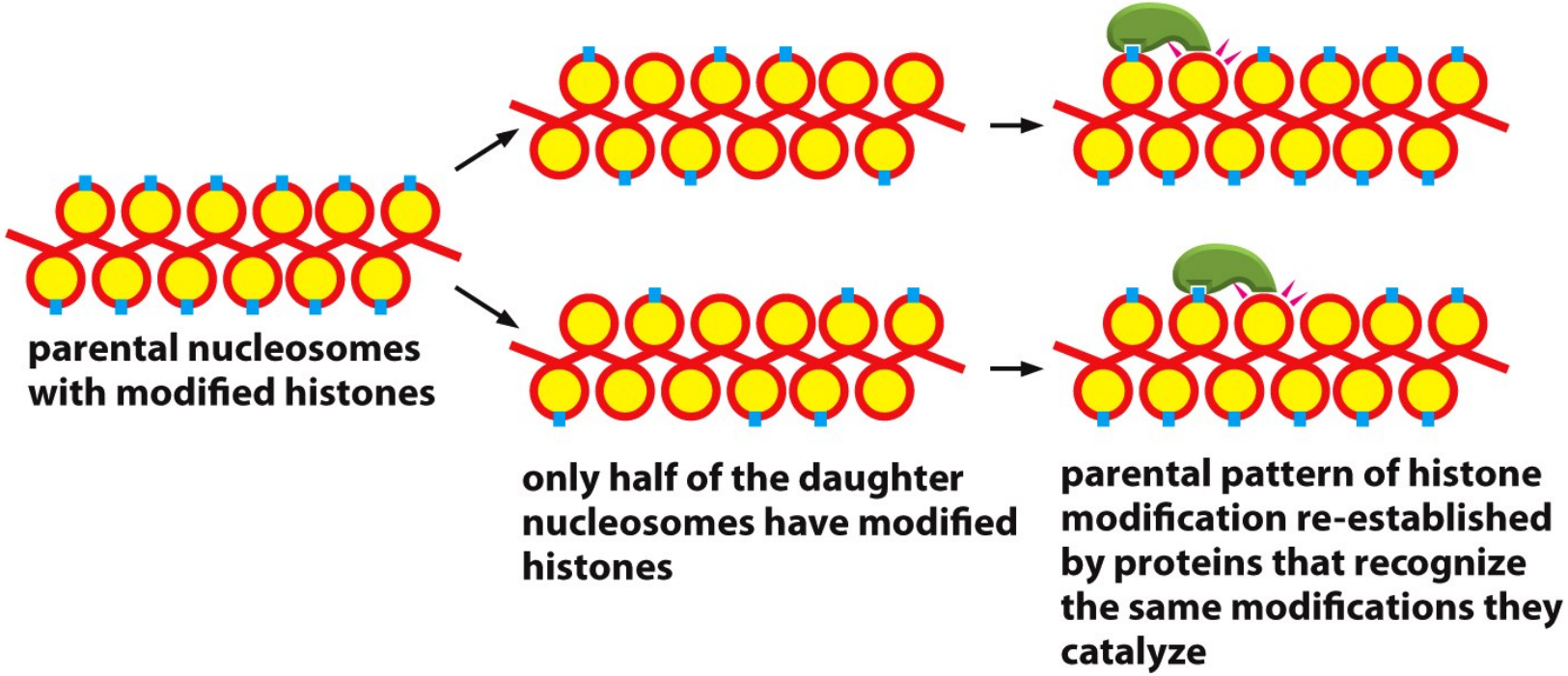


Figure 5-32 Essential Cell Biology 3/e (© Garland Science 2010)

From lecture 10 to lecture 19

- Protein structure and functions
- DNA structure, replication and reparation

Summary 10

- Proteins have a diverse set of functions:
  - Enzymatic
  - Structural
  - Transport
  - Movement
  - Storage
  - Signal
  - Sensitivity
  - Gene regulation
- Most important protein secondary structures are α helices and β sheets

Summary 11–12

- Almost all proteins bind to other molecules (ligands)
- Antibodies have 4 protein chains and hyper-variable regions used for binding any alien proteins (antigens)
- Enzymes convert ligands
- Some other proteins use ligands as additions to their active sites

Summary 13

- Homogenization produce the initial mixture of proteins
- Separation of this mixture could be done through centrifugation, sedimentation, electrophoresis and chromatography
- Mass spectrometry + software similarity analysis is used for protein sequencing
- X-rays, NMR and/or software folding are used for understanding 3D protein structures
- Results of analyses are depositing into on-line protein databases

Summary 14

- DNA replication is a semiconservative process
- DNA replication could go only in one direction
- Proofreading and RNA priming are helping in replication

Summary 15

- DNA replication system is a multienzyme complex
- Ends of chromosomes are constantly shortening and extending with new telomeres
- DNA suffers from multiple damaging events; multiple reparation systems are trying to lower mutation risks

Summary 16–17

- DNA suffers from multiple damaging events; multiple reparation systems are trying to lower mutation risks
- Homologous recombination is used when two similar DNA duplexes (homologous DNAs) are available
- Viruses are transposons escaped from cells

Summary 18

- DNA in cells have two states: unpacked (interphase DNA, “interphase chromosomes”) and packed (chromosomes)
- Histones are proteins responsible for first two levels of chromosome packing

Papers for Lab 4

1. Koltsov (1936) “Hereditary molecules”
2. Avery et al. (1944) “Studies on the chemical nature of the substance inducing transformation of Pneumococcal types”
3. Wilkins et al. (1953) “Molecular Structure of Deoxypentose Nucleic Acids”
4. Watson & Crick (1953) “A Structure for Deoxyribose Nucleic Acid”, and (if possible) also “Genetical Implications of the structure of Deoxyribonucleic Acid”

Summary 19 (today's)

- Heterochromatin existence allows cell to deactivate parts of DNA
- Deactivation may be inherited in epigenetic way

Final question (2 points)

Final question (2 points)

If you see a male tricolored cat, what does it mean genetically?

For Further Reading

A. Shipunov.
Advanced Cell Biology [Electronic resource].
2011—onwards.
Mode of access: `http://ashipunov.info/shipunov/school/biol_250`.
Lecture notes 10–19 + papers for Lab 4.

B. Alberts et al.
Essential Cell Biology. 3rd edition.
Garland Science, 2009.
Chapters 4, 5 and 6.