Useful Genetics Module 2 Overview– How DNA molecules change

Reference Abbreviations
OG: Open Genetics
OSB: Open Stax Biology
IGAG: Introduction to Genetic Analysis, 10th Ed. (Griffiths et al.)

2A – Errors in DNA replication
Outline
- Why mutations are so important
- How mutations arise
- Sequence mismatches, proofreading, and mismatch repair
Learning objectives
- Describe how errors by DNA polymerase create mutations
- Describe how proofreading and mismatch repair prevent mutations
Reading resources
OG: none
OSB: 14.6
IGAG: (Mismatch repair: 7.4, 16.4)

2B – Mutation rates and natural genetic variation
Outline
- How often they arise, and why
- Consequences
- Evolutionary history
Learning objectives
- Interpret information about mutation rates
- Explain the relationship between mutation and genetic variation
Reading resources
OG: none
OSB: 18.1 “Processes and patterns of evolution”, Fig 26.7 (caption)
IGAG: (Evolution: Ch20 “Introduction”, 20.1)

2C – Why most mutations are harmless
Outline
- Most mutations are not in genes
- Most mutations in genes are in introns
Learning objectives
- Describe the major categories of non-coding DNA
- Explain why most mutations in the DNA are functionally neutral

2D – Neutral mutations in coding sequences
Outline
- Silent mutations in coding sequences
- Neutral mutations in coding sequences
Learning objectives
- Explain why many mutations in coding sequences are functionally neutral
Reading resources
OG: 4.4
OSB: 15.2 “The genetic code is degenerate and universal”
IGAG: (Silent and neutral mutations: 16.1)

2E – Frameshift mutations in coding sequences
Outline
- DNA polymerase can erroneously insert or delete bases
- In coding sequences these create frameshift mutations
Learning objectives
- Predict the effect of different mutations on translation of coding sequences
Reading resources
OG: Fig 4.4, 10.2
OSB: 13.3 “Career connection”, Fig 14.21, Fig 15.5, 15.2 “The genetic code is degenerate and universal”
IGAG: (Insertions and deletions: 16.1-16.2 “Frameshift mutations”)

2F – Mutations in other functional sequences
Outline
- In regulatory sequences recognized by proteins
- In RNAs that act in translation
- In regulatory RNAs
Learning objectives
- Describe the different non-coding functions that can be altered by mutation
Reading resources
(also see previous references for translation)
Useful Genetics Module 2 Overview– How DNA molecules change

OG: 12.2
OSB: 16.4-16.5
IGAG: (Mutations in noncoding regions: 16.1)

2G – Other causes of mutations
Outline
- Kinds of mutational change to DNA sequences:
  - Insertions of mobile elements
  - Duplications and deletions
  - Rearrangements
  - Ploidy changes
Learning objectives
- Explain how mobile elements accumulate and how they can change gene expression
- Describe how chromosomes can change
Reading resources
OG: 2.5, Box 4-1, 9.1, 12.4.2
OSB: none
IGAG: (Mobile elements: Ch 15), (Duplications, deletions: 17.2)

2H – Somatic and germline mutations
Outline
- Our bodies consist of germline and somatic cells
- Mutations accumulate in both
- Only germline mutations are inherited
Learning objectives
- Distinguish between germline and somatic cells
- Explain why male germlines have more mutations
- Distinguish between the consequences of mutations in germline and somatic cells
Reading resources
OG: 4.3
OSB: p389 (bottom)
IGAG: none

2I – Somatic mutations
Outline
- Mutations affect cells in different ways than they affect organisms
- Better cell growth may harm the organism
- Some somatic mutations cause cancer
Learning objectives
- Explain when somatic mutations cause problems and when they don't
Reading resources
OG: 13.5-13.6
OSB: Fig 10.14, 16.7
IGAG: (Cancer as a result of mutation: 16.5)

2J – Mutagens
Outline
- Agents that damage DNA cause mutations
- Radiation & chemical mutagens damage DNA
- Damage can cause mispairing in DNA replication
- Example: how UV causes mutations
Learning objectives
- Discuss the relative roles of chance and controllable factors in mutagenesis
- Explain how DNA damage can cause mutations
Reading resources
OG: 4.2, 13.4
OSB: Fig 14.19
IGAG: (Mutations by chance: 16.2), (Mutagenesis: 16.3)

2K – What should we worry about?
Outline
- Mutations and birth defects
- Spiderman
- What mutagens and exposures should we and shouldn't we worry about?
Learning objectives
- Distinguish between serious risks (worth worrying about) and trivial ones
Reading resources
(see readings from Lecture 2J)

2L – Mutations and natural selection
Outline
- The consequence of a mutation for an organism's fitness do not change the chance that it will arise
- The environment doesn't affect which mutations happen
- Organisms haven't evolved mechanisms to control when or which mutations happen
Learning objectives
- Explain why organisms can't control the kind of mutations they get
Useful Genetics Module 2 Overview– How DNA molecules change

- Explain why we mostly see the good mutations but not the bad ones

**Reading resources**
- none

**2M – Gene evolution: origins**

**Outline**
- Most new genes begin as copies of existing genes
  1. From within a genome: duplication within a genome (of a segment, chromosome, or genome)
  2. DNA inserted from another species' genome
- Some genes arise from non-functional sequences

**Learning objectives**
- Describe the ways that new genes can arise

**Reading resources**
(see also readings from Lecture 2G)
- OG: none
- OSB: 18.1 “Evidence for evolution: Molecular biology”, 20.3 “Horizontal gene transfer”
- IGAG: (Gene genesis by duplications: 20.6)

**2N – Gene evolution: outcomes**

**Outline**
- New gene copies can be good or bad for the organism
- Genes that arise by duplication give rise to gene families

**Learning objectives**
- Describe the different fates of duplicated genes

**Reading resources**
- OG: 12.4.2
- OSB: 27.1 “The role of Hox genes in animal development”
- IGAG: none

**2O – DNA differences accumulate over time**

**Outline**
- Lineages of species accumulate both shared and distinguishing mutations

**Learning objectives**
- Explain how neutral mutations accumulate over time

**Reading resources**
(see readings from Lecture 2O)