Principles of cellular biology, genetics and evolutionary genetics
Any name that sounds unfamiliar to you?
Try: http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/
a very useful web-site for any definition in the field of Biology:
Fig. 3.2 The DNA double-helix. A DNA sequence, which specifies the properties of each gene, is read (transcribed) in a particular direction—referred to as 5' to 3'—along the molecule. Bases on each strand of the helix are linked by a sugar-phosphate backbone and the bases are joined between strands by hydrogen bonds which bind A to T (or U) bases and C to G bases. From Dickerson (1983) with permission (illustration by Irving Geis).
A) Essential definitions in Evolutionary Biology …

Evolutionary biology is the study of how biological diversity changes through time; It is an inference of historical organismic processes through the study of phenotypes (morphological, physiological, behavioural traits) or genotypes (genes, non-coding DNA, genome).

Evolutionary changes are the results of variation in reproductive success correlated with heritable variation in a trait. Both types of variations are necessary conditions for evolutionary changes. The correlation between those variations can be negative, positive –ADAPTIVE EVOLUTION- or zero –NEUTRAL EVOLUTION.

Evolution occurs both in information (in genotypes) and in matter (phenotypes). Genes function as information replicators while organisms function as material interactors. An evolutionary biologist sees the world both ways: from the bottom-up (from DNA to species) and from the top-down (from selection to molecules).
Eukaryotic cell

Diagram showing the process of gene expression in eukaryotes:

1. **DNA** in the nucleus is transcribed into a **Primary mRNA transcript**.
2. **Introns** are removed during RNA processing to produce a **Mature mRNA transcript**.
3. The mature mRNA transcript is transported to the **cytoplasm**.
4. The **tRNA molecule** brings the appropriate amino acid to the **ribosome**.
5. The amino acids are assembled into a **growing amino acid chain**.

**Cell membrane** surrounds the cell and facilitates the transport of molecules between the cytoplasm and the extracellular environment.
Eukaryote (*Drosophila melanogaster*)

**Promoter region**
- TATA box
- CAAT box (in mammals)
- GC box (GGGCGG)

![Diagram of Eukaryote gene structure](image)

- Initiation codon
- Exon 1
- Intron 1
- Exon 2
- Intron 2
- Exon 3
- Intron 3
- Exon 4
- Stop codon
- Polyadenylation signal AATAAA

Bacteria (*Bacillus stearothermophilus*)

**Promoter region**
- Shine-Dalgarno box (AGGAGG)
- -10 site (TATAAT)
- -35 site (TTGACA)

![Diagram of Bacteria gene structure](image)

- Initiation codon
- 5'
- Stop codon
- 3'

250 bp
Basic Gene Anatomy

Protein Coding Locus

ATG CCG ...

RNA

Protein

Met-Pro...
Prokaryotic Genes

Enzyme 1  Enzyme 2  Enzyme 3

transcription of a polycistronic message
mRNA

translation

protein
Regulation of Transcription

Activators

Repressor

Enhancer
Silencer
TATA Box
Coding Reg.

Coactivators

Basal Factors
Amino Acids within Proteins

Positively Charged Amino Group

Negatively Charged Carboxy Group

Chemical properties are determined by the side chain on the a carbon
Charged Amino Acids

Asparagine
Glutamine
Acidic

Lysine
Asparagine
Basic
Histidine
Primary Structure
Linear Order of Amino Acids

Secondary Structure
α-helix
β-pleated sheet
Local Interactions of Amino Acids

Tertiary Structure
Hydrogen Bond
Hydrophobic Interaction
Covalent Bond
Ionic Bond
Long Range Interactions of Amino Acids

Quaternary Structure
Interactions of Multiple Peptides
Fig. 3.13 Different types of DNA and chromosome mutations. Two DNA sequences (a and b) are shown with point mutations and insertions and deletions (indels) between them. At the chromosomal level, mutations such as polyploidy and aneuploidy alter chromosome number whilst inversions, translocations, duplications and deletions change chromosome structure.

DNA mutations

(a) Leu His Thr Phe Gly Lys Gin Gly Cys Gly Ile Amino acid
CTG CAC ACA TTT GGA AAA CAG GGA C-- TGT GGT ATA DNA

(b) CTG CAC ACA TTC GGA AAA CAG GGA CTT TGT GTT ATA
Leu His Thr Phe Gly Lys Gin Gly Leu Cys Val Ile

Chromosomal mutations

Polyploidy

Inversion

Translocation

Aneuploidy

1. Trisomy

2. Monosity

Dedication

Deletion