

Week One – Macromolecules and Their Building Blocks

Amino Acids:

- 20 common amino acids
- They make up proteins
- Glycine is most simple
- Each has properties well suited to carry out various biological functions
- Each has a carboxylic acid group, central alpha carbon, amino group, hydrogen group and an R group
- The R group is different in each different amino acid but the rest stays the same
- The central alpha carbon is chiral (except in glycine)
- Essential amino acids are the ones which we must consume as we do not naturally produce them, whilst non-essential ones are those that we can naturally produce

# A GUIDE TO THE TWENTY COMMON AMINO ACIDS

AMINO ACIDS ARE THE BUILDING BLOCKS OF PROTEINS IN LIVING ORGANISMS. THERE ARE OVER 500 AMINO ACIDS FOUND IN NATURE - HOWEVER, THE HUMAN GENETIC CODE ONLY DIRECTLY ENCODES 20. 'ESSENTIAL' AMINO ACIDS MUST BE OBTAINED FROM THE DIET, WHILST NON-ESSENTIAL AMINO ACIDS CAN BE SYNTHESISED IN THE BODY.

**Chart Key:** ● ALIPHATIC ● AROMATIC ● ACIDIC ● BASIC ● HYDROXYLIC ● SULFUR-CONTAINING ● AMIDIC ○ NON-ESSENTIAL ○ ESSENTIAL

Chemical Structure single letter code	ALANINE (A) <i>Ala</i> GGT, GCC, GCA, GCG	GLYCINE (G) <i>Gly</i> GGT, GGC, GGA, GGG	ISOLEUCINE (I) <i>Ile</i> ATT, ATC, ATA	LEUCINE (L) <i>Leu</i> CTT, CTC, CTA, CTG, TTA, TTG	PROLINE (P) <i>Pro</i> CCT, CCC, CCA, CCG	VALINE (V) <i>Val</i> GTT, GTC, GTA, GTG
NAME (A) three letter code DNA codons						
PHENYLALANINE (F) <i>Phe</i> TTT, TTC	TRYPTOPHAN (W) <i>Trp</i> TGG	TYROSINE (Y) <i>Tyr</i> TAT, TAC	ASPARTIC ACID (D) <i>Asp</i> GAT, GAC	GLUTAMIC ACID (E) <i>Glu</i> GAA, GAG	ARGININE (R) <i>Arg</i> CGT, CGC, CGA, CCG, AGA, AGG	HISTIDINE (H) <i>His</i> CAT, CAC
LYSINE (K) <i>Lys</i> AAA, AAG	SERINE (S) <i>Ser</i> TCT, TCC, TCA, TCG, AGT, AGC	THREONINE (T) <i>Thr</i> ACT, ACC, ACA, ACG	CYSTEINE (C) <i>Cys</i> TGT, TGC	METHIONINE (M) <i>Met</i> ATG	ASPARAGINE (N) <i>Asn</i> AAT, AAC	GLUTAMINE (Q) <i>Gln</i> CAA, CAG

**Note:** This chart only shows those amino acids for which the human genetic code directly codes for. Selenocysteine is often referred to as the 21st amino acid, but is encoded in a special manner. In some cases, distinguishing between asparagine/aspartic acid and glutamine/glutamic acid is difficult. In these cases, the codes asx (B) and glx (Z) are respectively used.



## Amino Acid Classification (Varies from above table):

- Nonpolar, aliphatic: side chain hydrophobic – not soluble in water – can be isolated by extraction with organic solvents:
  - Glycine
  - Alanine
  - Proline

- Valine
- Leucine
- Isoleucine
- Methionine
- Polar, uncharged: more soluble in water – can form H bonding – weakly polar:
  - Serine
  - Threonine
  - Cysteine (stabilise structure of many proteins via cys-cys reversible disulfide bond following oxidation)
  - Asparagine
  - Glutamine
- Aromatic: absorb light in UV region – can form hydrophobic interactions:
  - Phenylalanine
  - Tyrosine
  - Tryptophan
- Positively charged, basic: strongly polar:
  - Lysine
  - Arginine
  - Histidine (least polar, often involved in catalysis by serving as a proton donor)
- Negatively charged, acidic:
  - Aspartate
  - Glutamate

### Modified Amino Acids in Proteins:

- After translation, modifications can occur
- Modifications can also be made to amino acids after they are added to a protein
- Types of modification include:
  - Phosphorylation: reversible modification, important in regulation of cell function
  - Covalent modifications (in collagen)
- Bioactive amino acid derivatives are not included in proteins

### Biology and pH:

- pH = power of hydrogen
- $\text{pH} = -\log [\text{H}^+]$
- Increase  $\text{H}^+$  ions = decreased pH
- Increase  $\text{OH}^-$  ions = increased pH
- Strong acids and bases completely dissociate in water ( $\text{HCl} \rightarrow \text{H}^+ + \text{Cl}^-$ )
- Weak acids and bases do not completely dissociate in water – their behaviour is best understood in terms of their pKa
- pKa = (acid dissociation constant ) mid point where conc of starting and final solution is equal

•