

# Bil 255 – CMB

## amino acids & their role in protein structure

# Amino Acids & their role in Proteins...

Proteins - the penultimate molecules ?

structurally complex

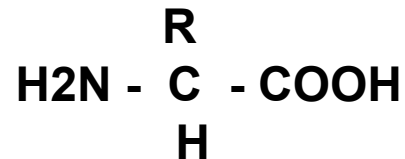
functionally sophisticated

long repeats of individual monomers (amino acid's)

most abundant molecule in cells

15% of cell's dry mass

## Amino Acids



20 common amino acids - p74-75 [panel 2.5](#)

lys-arg-his-asp-glu-ala-val-leu-ile-pro-phe-met-trp-gly-cys-ser-thr-tyr

k - r - h - d - e - a - v - l - i - p - f - m - w - g - c - s - t - y

## why only these 20 ?

all are structurally similar  
alpha-amino acids and the L-stereoisomers...

it may be an evolutionary anomaly...

there are some unusual aa's...  
but all play structurally important roles

4-hydroxy proline	occurs in plant cell wall proteins
5-hydroxy lysine	occurs in fibrous proteins as collagen
N-methyl lysine	occurs in myosin contractile proteins
γ-carboxy glutamate	occurs in prothrombin

Amino Acids... [structures & chemical properties of AA's \[m.w.king\]](#)

1st amino acid discovered was **asparagine** (1806 in asparagus)  
last amino acid found was **threonine** (1938)

**STRUCTURE** - amino acids have a carboxyl group (- **COOH**) &  
amino group (-**NH<sub>2</sub>**) ...bound to an asymmetric carbon

20 ubiquitous aa's have 4 groups in a tetrahedron shape

2 stereo-isomers (**enantiomers** = mirror images)  
**levo-rotatory** (left) & **dextro-rotatory** (right)  
only **L**-amino acids occur in living cell proteins

**Zwitterion** - (an **ampholyte**) holds 2 groups of opposite sign

**Isoelectric Point** - pH where **no net charge** in molecule

**pK** - pH where groups are 50% ionized & 50% non-ionized

## classes of amino acids [classified... by R-Groups]

<b>ACIDIC</b> ... negatively charged <b>ASP &amp; GLU</b> R group with 2nd <b>COOH</b> that ionizes above pH 7.0      mcb 2.13*
<b>BASIC</b> ... positively charged <b>LYS, ARG, HIS</b> R group with 2nd <b>amide</b> that protonates below pH 7.0
<b>POLAR UNCHARGED</b> ... <b>SER, THR, TYR, ASN, GLN</b> are soluble in water, i.e., <b>hydrophilic</b>
<b>NON-POLAR</b> ... (aliphatic) <b>ALA, VAL, LEU, ILE,</b> contain only hydrocarbons R groups = <b>hydrophobicity</b>
<b>AROMATIC</b> (hydrophobic non-polars) <b>PHE, MET, TRP, GLY, PRO, CYS</b> contain R groups with <b>ring</b> structures & <b>others</b>

## Peptide Bond...

formed by condensation reaction between  
**amino** of one aa... & **carboxyl** of another aa ...

substituted amide covalent bond –

dipeptide has partial double bond character –

shorter & stronger than C-C longer, yet weaker than C=C

no free rotation (group in same plane, but TRANS)

results in zig-zag planar molecule [figure](#)\*

[peptide bonds](#)\* & [a polypeptide](#)\*

## There are only 3 known ways to make a peptide bond...

1. chemical abiotic synthesis in the laboratory
2. genetic engineering cloning mechanisms
3. biologically in cells... (@25aa/sec in prokaryotic cells)

### Some common terminology:

dipeptide, tripeptide, oligopeptide, polypeptide  
protein - polymer of  $\alpha$ -L-amino acids joined by peptide bonds

[whale myoglobin](#) - [panel 4.2 pg 132-133](#)

## some naturally occurring small oligopeptides

[many are vertebrate hormones]

<p><u>insulin</u> - two polypeptides... controls carbohydrate metabolism 1. <b>alpha chain</b> of 30 aa's &amp; 2. <b>beta chain</b> of 21 aa</p>
<p><u>glucagon</u> -pancreatic hormone 29 aa... opposes insulin action</p>
<p><u>Nutra Sweet</u> - a dipeptide (2aa) of L-aspartyl-phenylalanyl-methyl</p>
<p><u>corticotropin</u> - 39aa - anterior pituitary hormone... stimulates adrenal cortex</p>
<p><u>oxytocin</u> - 9aa - hormone of posterior pituitary... stimulates uterine contractions</p>
<p><u>bradykinin</u> - 9aa – hormone acts on smooth muscle... vasodilatation/inflammation</p>
<p><u>angiotensin octapeptide</u> (derived from angiotensinogen by kidney enzyme renin) - increases blood pressure <u>ACE Inhibitors</u> block AT &amp; lower bp. [<u>sport</u>]</p>
<p><u>thyrotropin relasing factor</u> (<u>TSH</u>) 3 aa's of hypothalamus... - stimulates thyroid to release thyroid hormone</p>
<p><u>enkephalins</u> - either of two <b>penta-peptides</b> with opiate &amp; analgesic activity, occurs naturally in brain &amp; have marked affinity for opiate receptors... compare <u>endorphins</u></p>