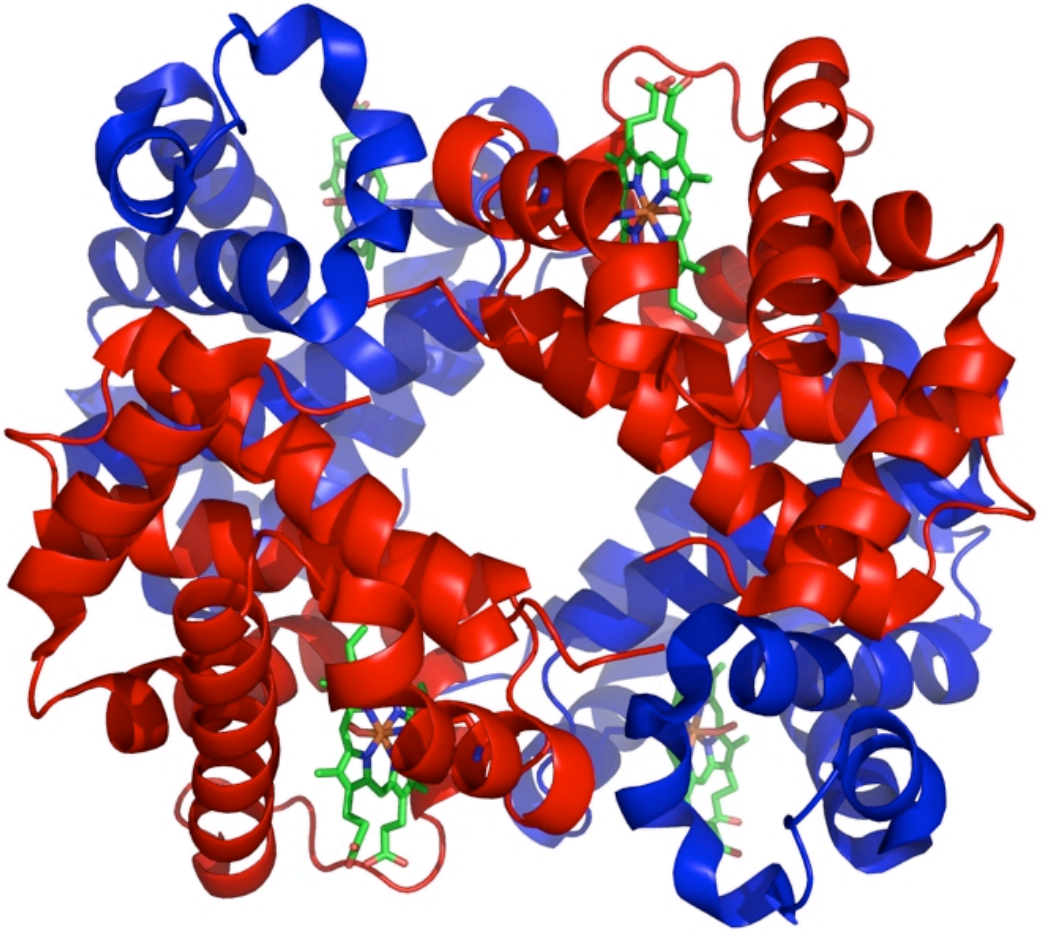
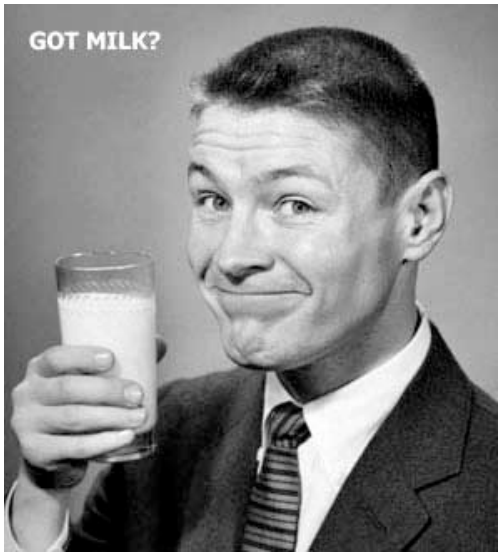
Proteins

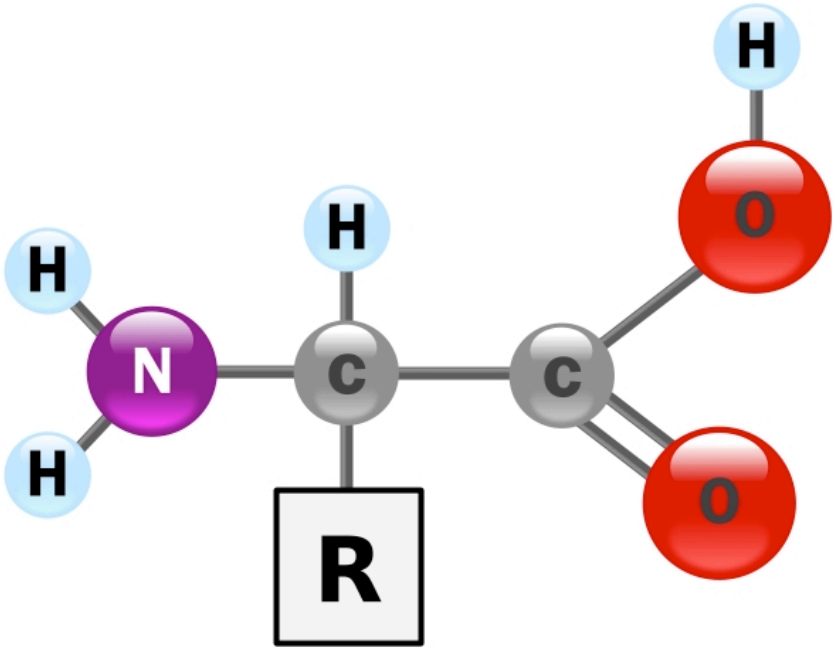


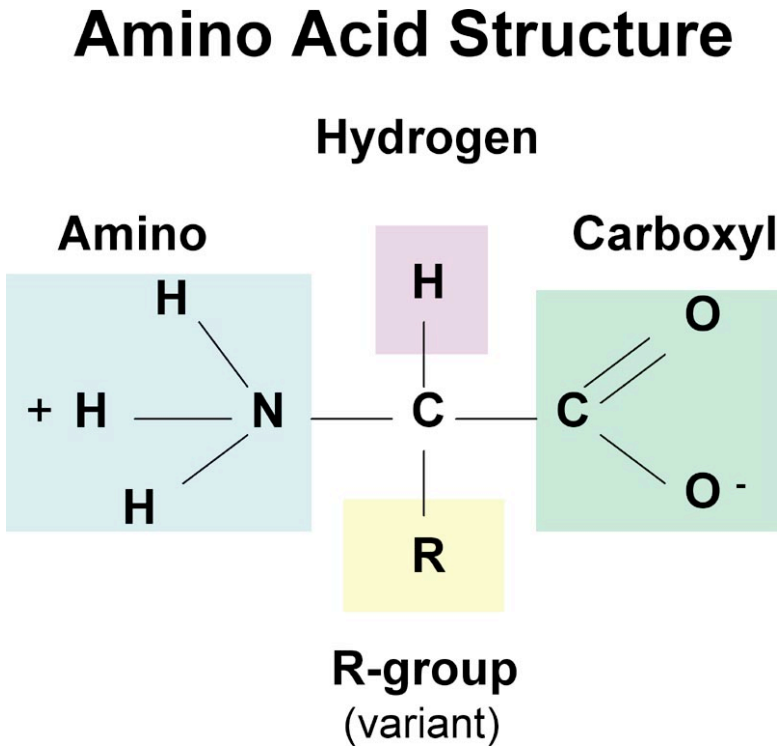


RWF Chemistry H2A

Proteins

Proteins are made up of amino acids:





$H_2N\text{-}CHR\text{-}COOH$

neutral form

$^{+}H_3N\text{-}CHR\text{-}COO^{-}$

zwitterionic form

There are twenty standard amino acids:

A ala alanine
R arg arginine
N asn asparagine
D asp aspartic acid
C cys cysteine
Q gln glutamine
E glu glutamic acid
G gly glycine
H his histidine
I ile isoleucine
L leu leucine
K lys lysine
M met methionine
F phe phenylalanine
P pro proline
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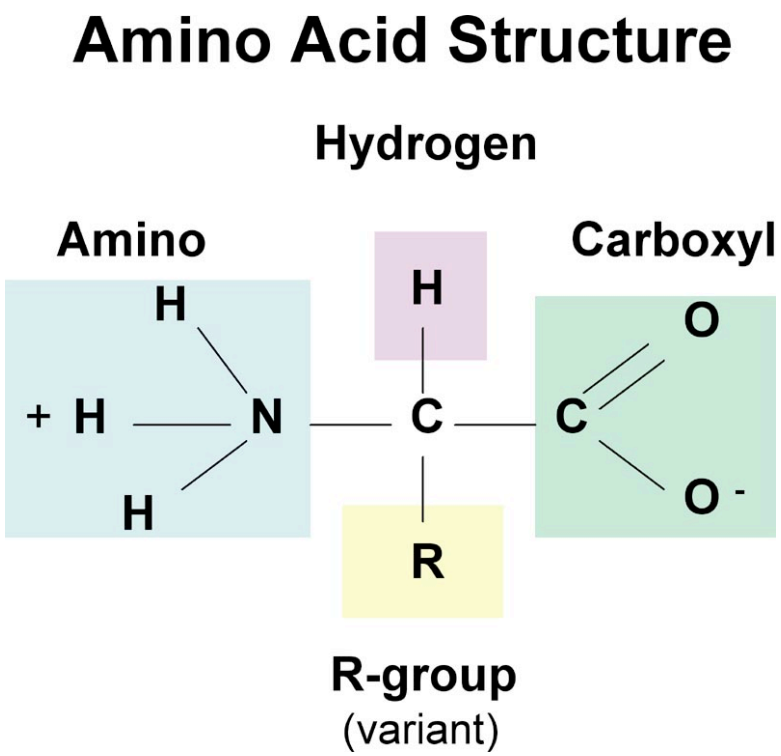
Y tyr tyrosine
V val valine



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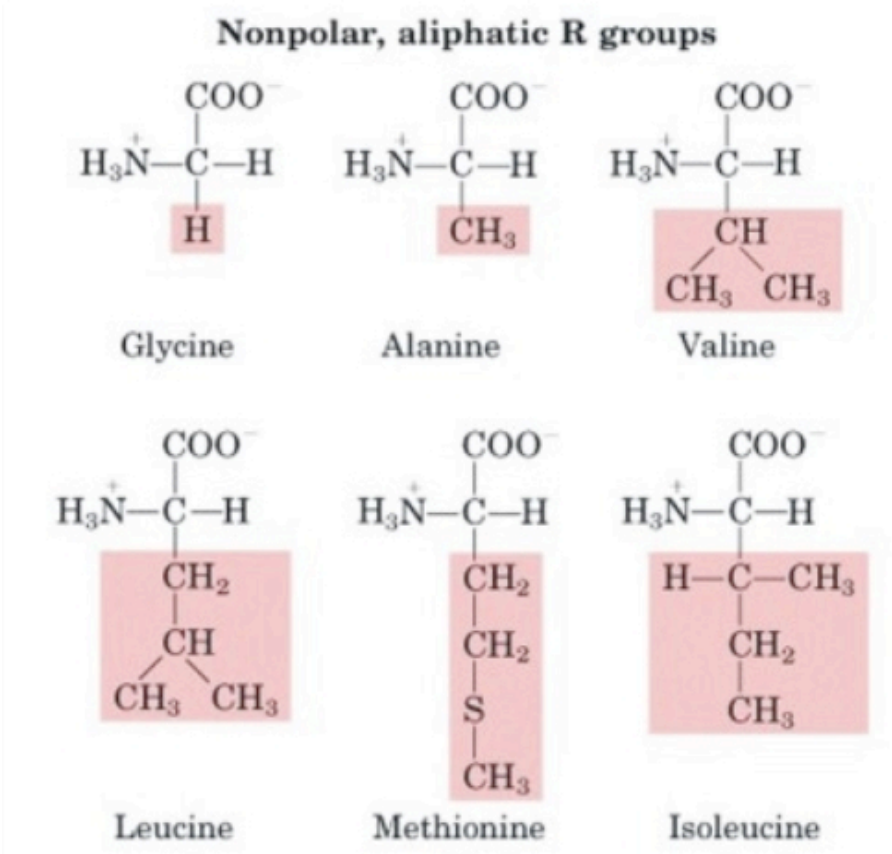

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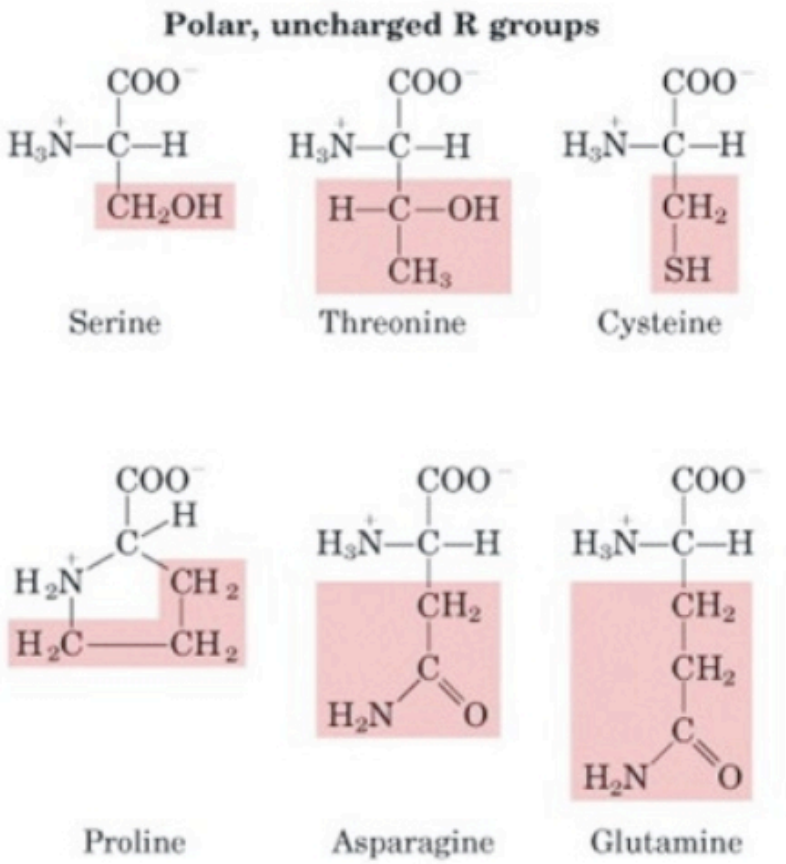

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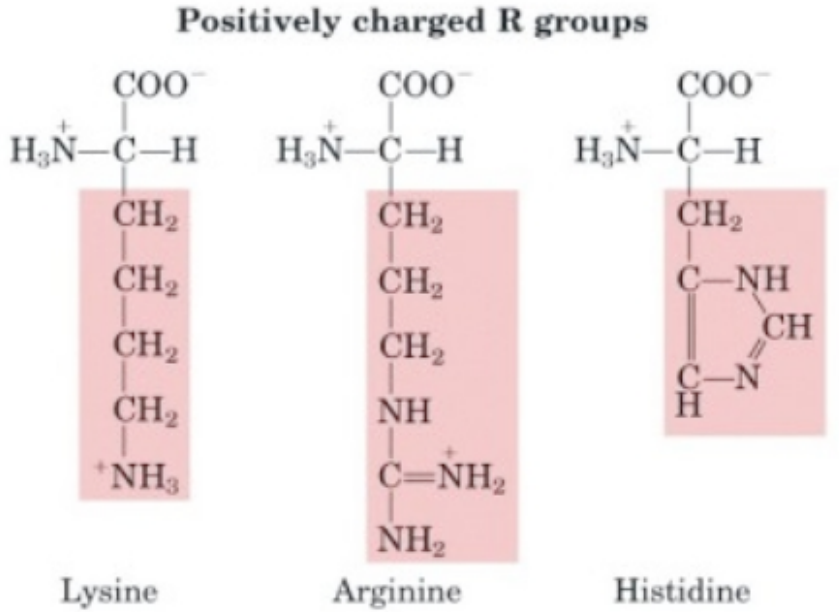

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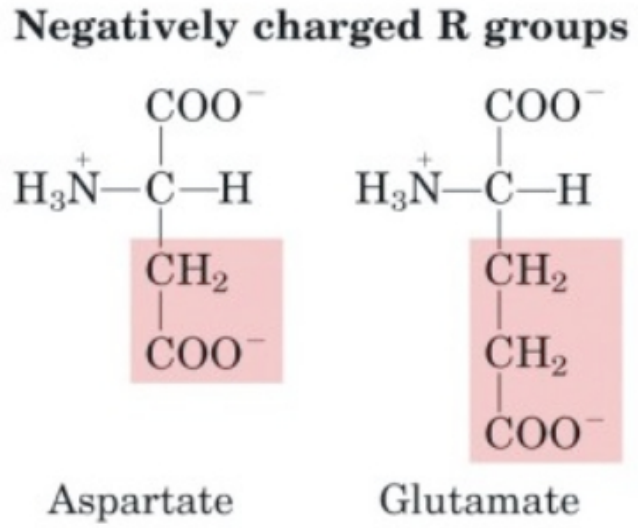

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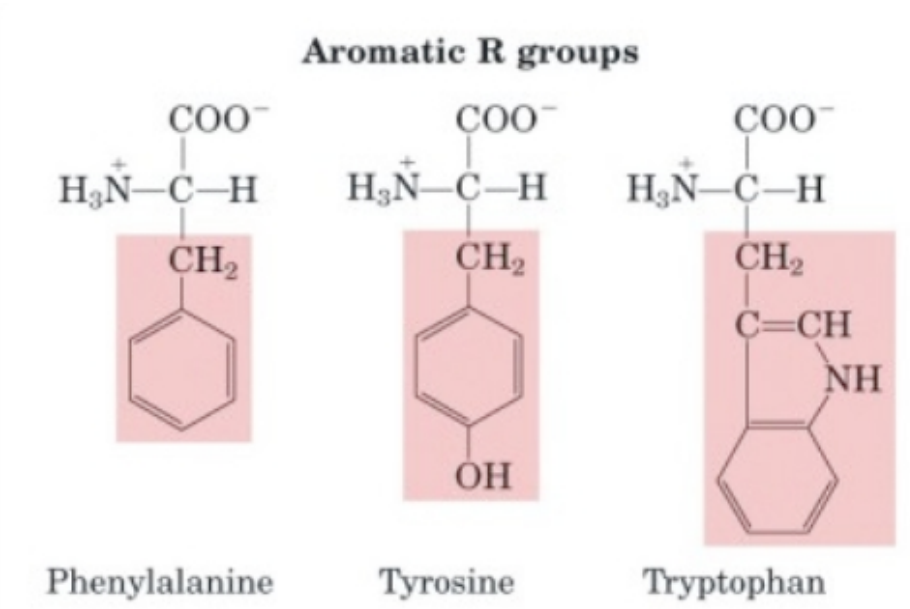

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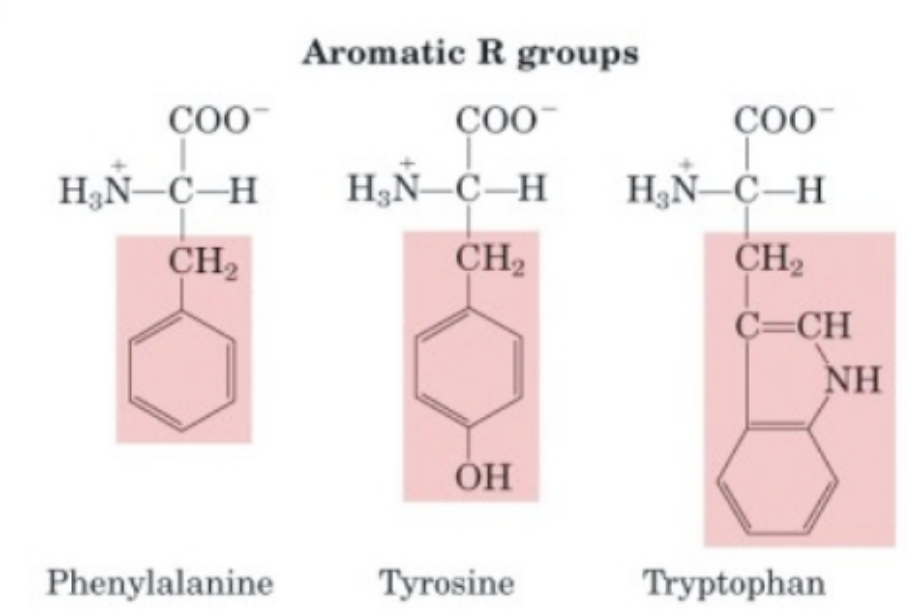
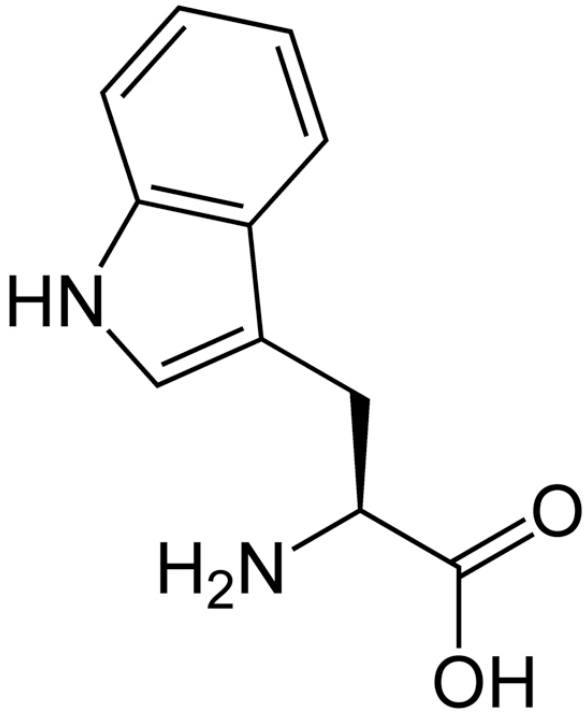


Tryptophan

Tryptophan

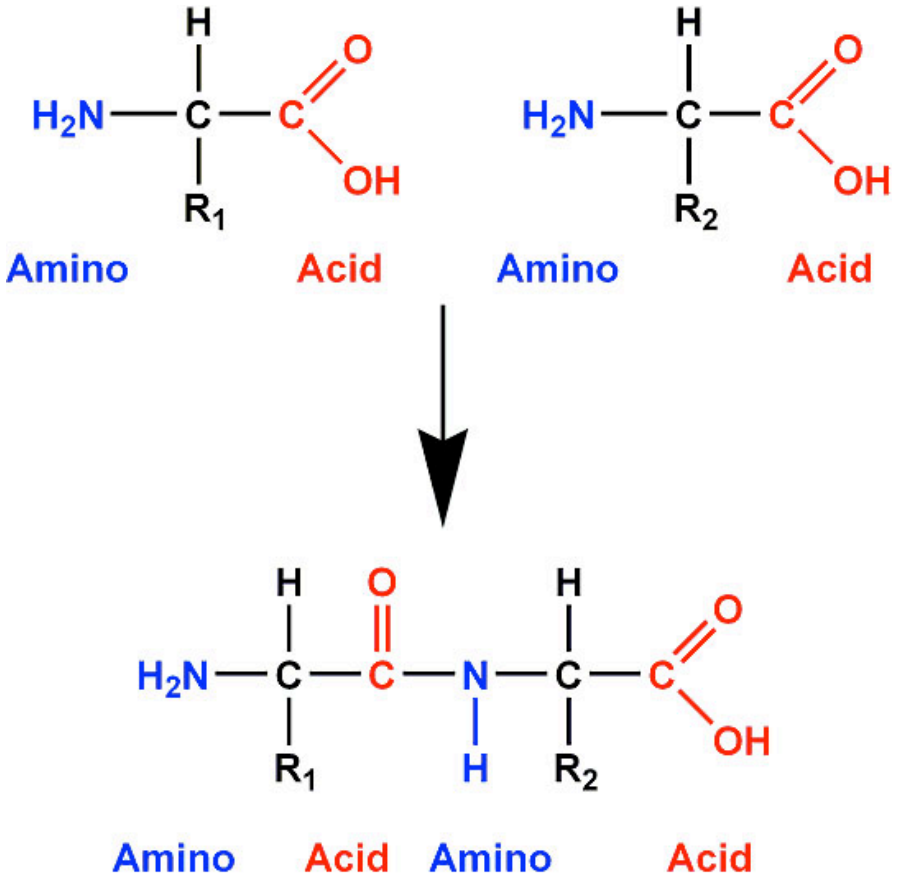
A common belief is that heavy consumption of turkey meat (as for example in a Thanksgiving or Christmas feast) results in drowsiness, which has been attributed to high levels of the amino acid tryptophan contained in turkey. While turkey does contain high levels of tryptophan, the amount is comparable to that contained in most other meats. Furthermore, postprandial Thanksgiving sedation may have more to do with what else is consumed along with the turkey, in particular carbohydrates and alcohol.

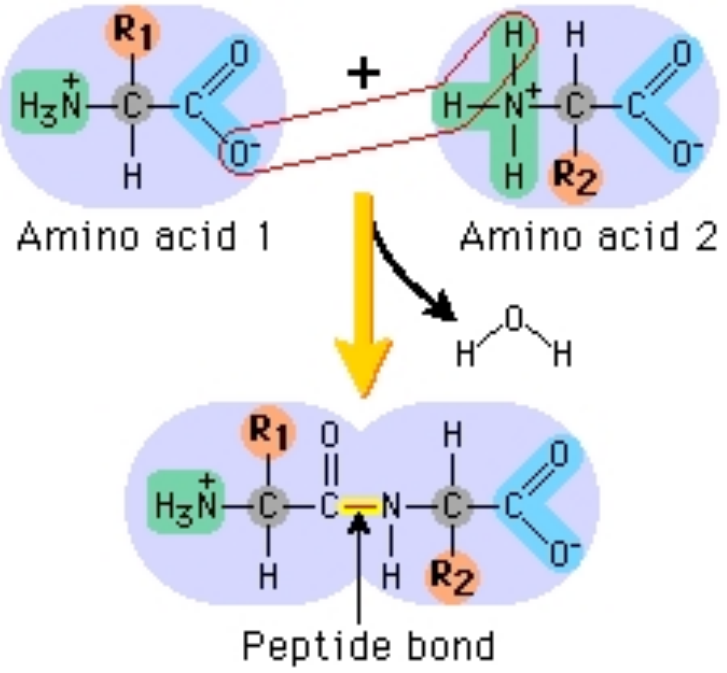


Tryptophan

Peptides

The amino acids can be linked together with peptide bonds:

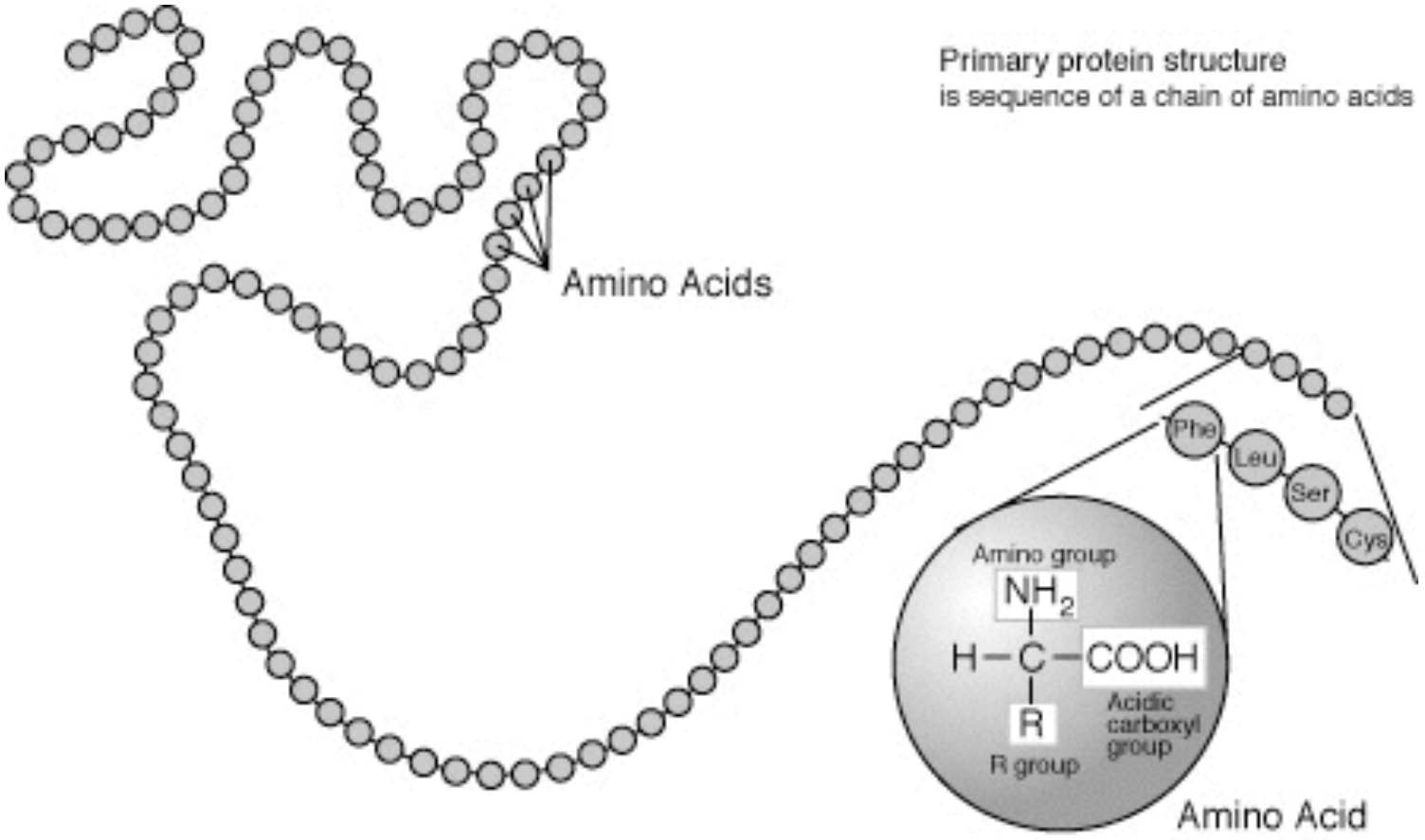




amide linkage

Proteins

Proteins are made up of many amino acids linked together with many peptide bonds.



Proteins

Proteins fold into useful structures.
An example: Cytochrome C

x-ray crystal structure

Cytochrome c is an electron-carrying mitochondrial protein. The transition of cytochrome c between the ferrous and ferric states within the cell makes it an efficient biological electron-transporter. It plays a vital role in cellular oxidation in both plants and animals, and is generally regarded as a universal catalyst of respiration.

Proteins

Proteins fold into useful structures.
An example: Cytochrome C

x-ray crystal structure

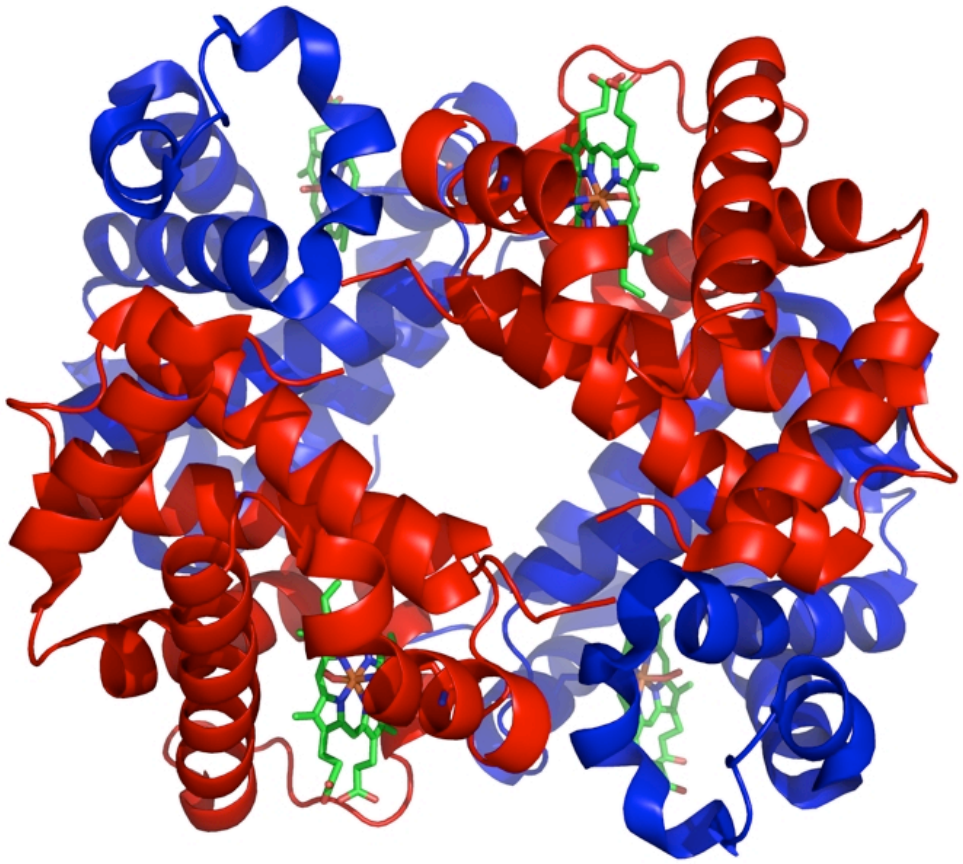
Molecular mass:
12,233 Da (Human Cyt c)

Residue Sequences:
Human:
mgdvekgkki fimkcsqcht vekggkhktg pnlhglfgrk tgqapgysyt aanknkgiiw gedtlmeyle npkkyipgtk mifvgikkke eradliaylk katne

Fruit Fly:
mgvpagdvek gkklfvqrca qchtveaggk hkvgpnlhgl igrktgqaag faytdankak gitwnedtlf eylenpkkyi pgtkmifagl kkpnergdli aylksatk

Proteins

Another example: Hemoglobin

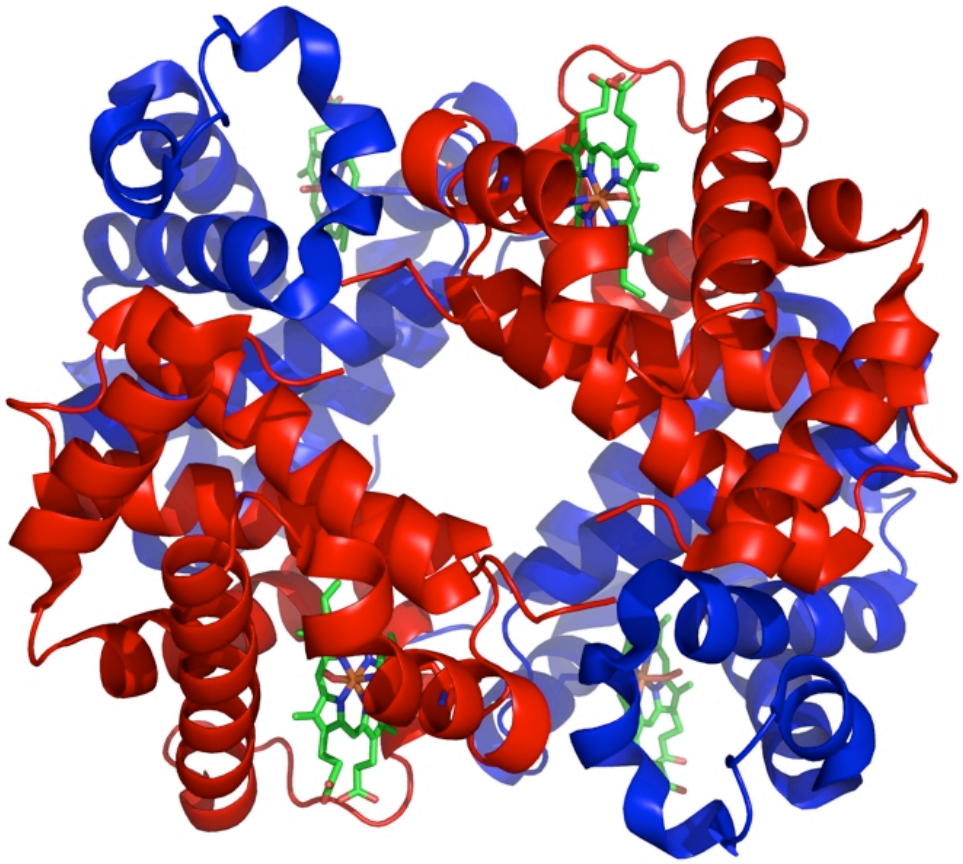


Hemoglobin (abbreviated Hb or Hgb) is the iron-containing oxygen-transport metalloprotein in the red blood cells of vertebrates, and the tissues of some invertebrates.

In mammals, the protein makes up about 97% of the red blood cell's dry content, and around 35% of the total content (including water). Hemoglobin transports oxygen from the lungs or gills to the rest of the body (i.e. the tissues) where it releases the oxygen for cell use.

Proteins

Another example: Hemoglobin



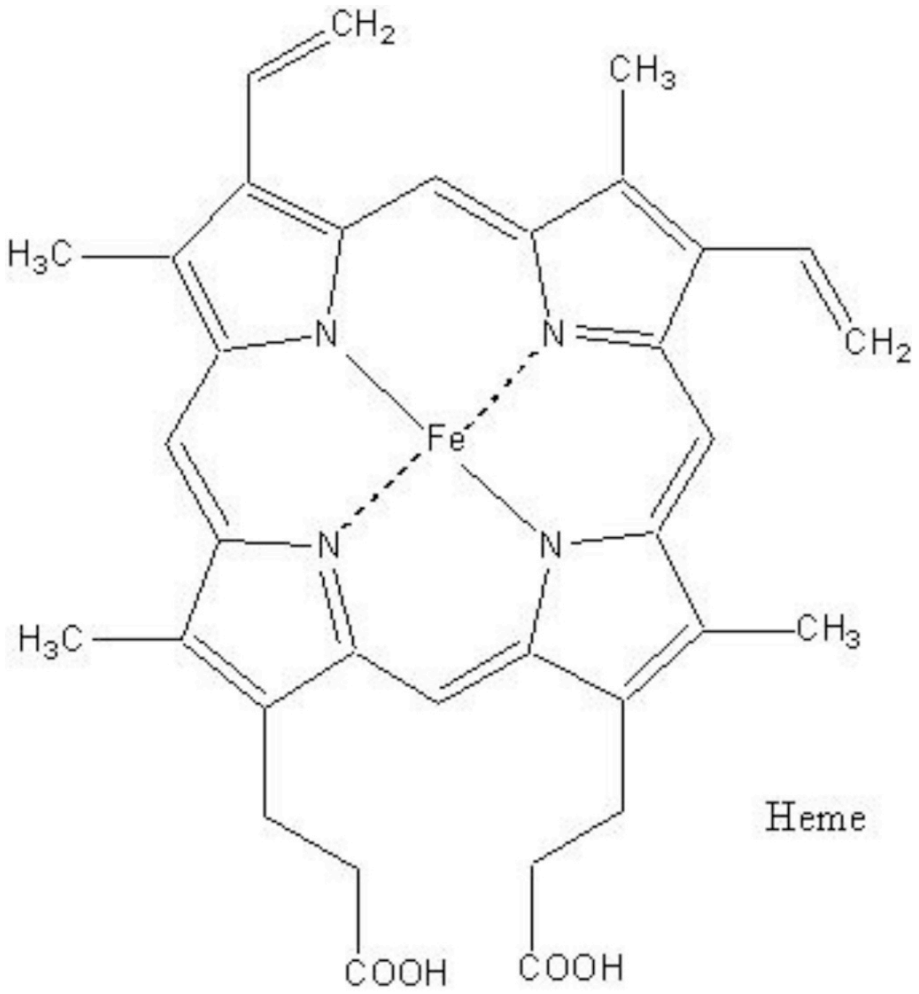
In adult humans, the most common hemoglobin type is a tetramer called hemoglobin A, consisting of two α and two β structurally similar subunits non-covalently bound, each made of 141 and 146 amino acid residues, respectively. Each subunit is composed of a protein chain tightly associated with a non-protein heme group. Each subunit has a molecular weight of about 17,000 daltons, for a total molecular weight of the tetramer of about 68,458 daltons.

Proteins

Cytochrome C and Hemoglobin transport oxygen and electrons with Fe-containing heme groups:

heme group

Fe^{2+} or Fe^{3+}

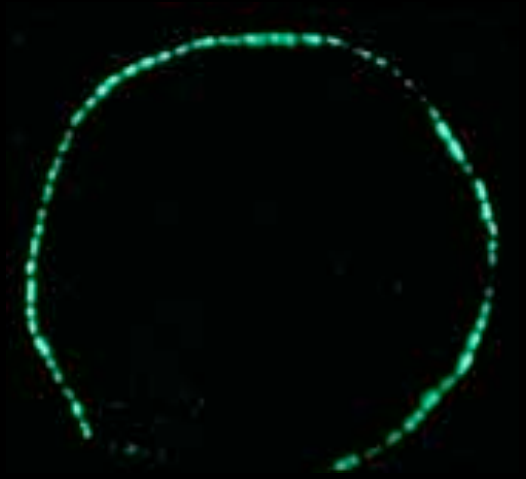


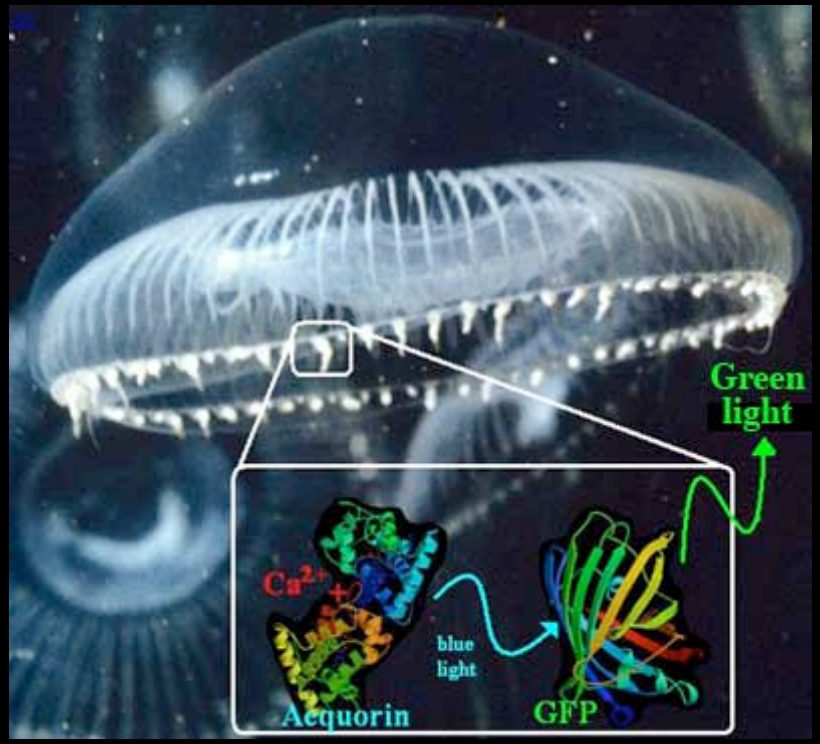
Not just any jellyfish...

Not just any jellyfish...

Not just any jellyfish...

But the jellyfish Aequorea victoria from which the bioluminescent protein green fluorescent protein (GFP) was originally extracted...





Leads to a Nobel Prize on 10/8/08:

The Nobel Prize in Chemistry 2008

"for the discovery and development of the green fluorescent protein, GFP"

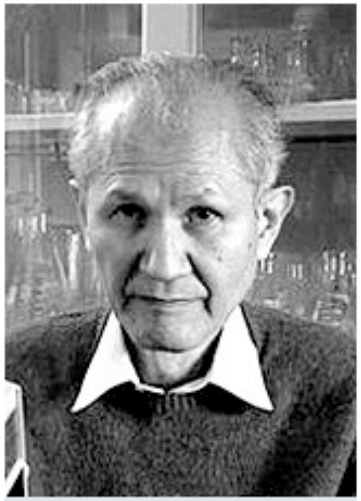


Photo: J. Henriksson/SCANPIX

Osamu Shimomura

1/3 of the prize

USA

Marine Biological Laboratory (MBL)
Woods Hole, MA, USA

b. 1928

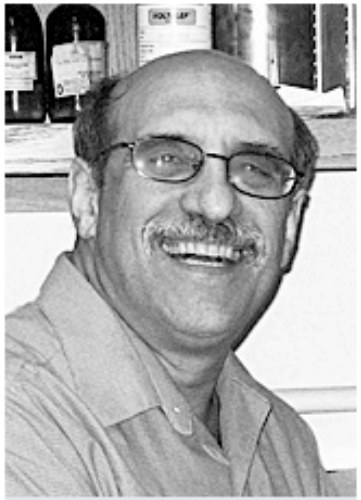


Photo: J. Henriksson/SCANPIX

Martin Chalfie

1/3 of the prize

USA

Columbia University
New York, NY, USA

b. 1947

Photo: UCSD

Roger Y. Tsien

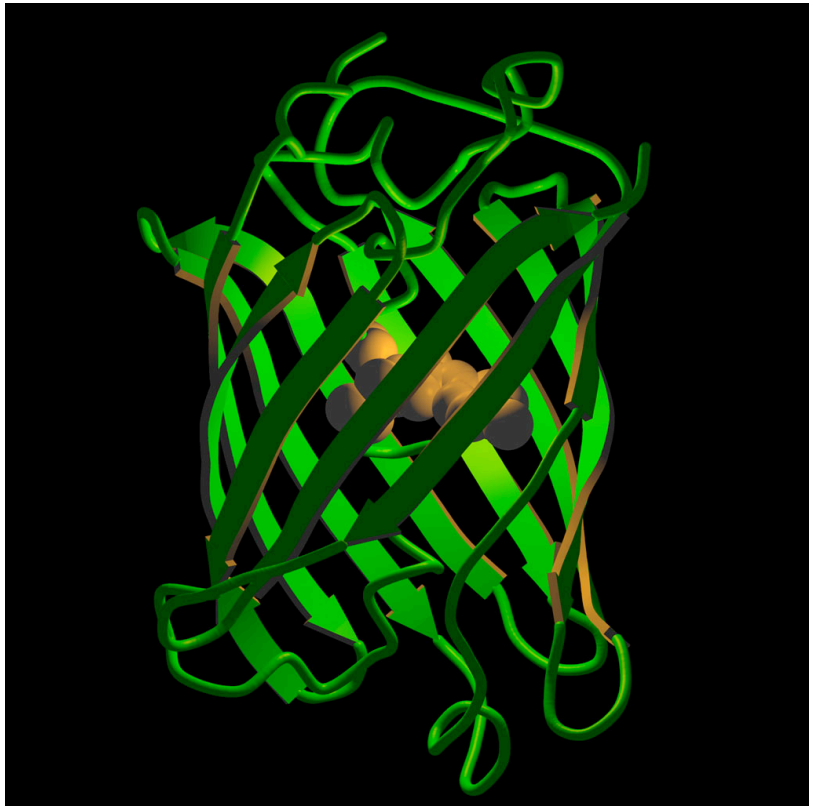
1/3 of the prize

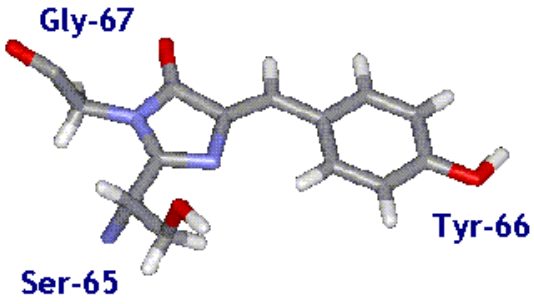
USA

University of California
San Diego, CA, USA

b. 1952

Green fluorescent protein (GFP) makes jellyfish glow in the dark...





GFP Amino Acid Sequence: 238 Amino Acids (26.9 kDa)

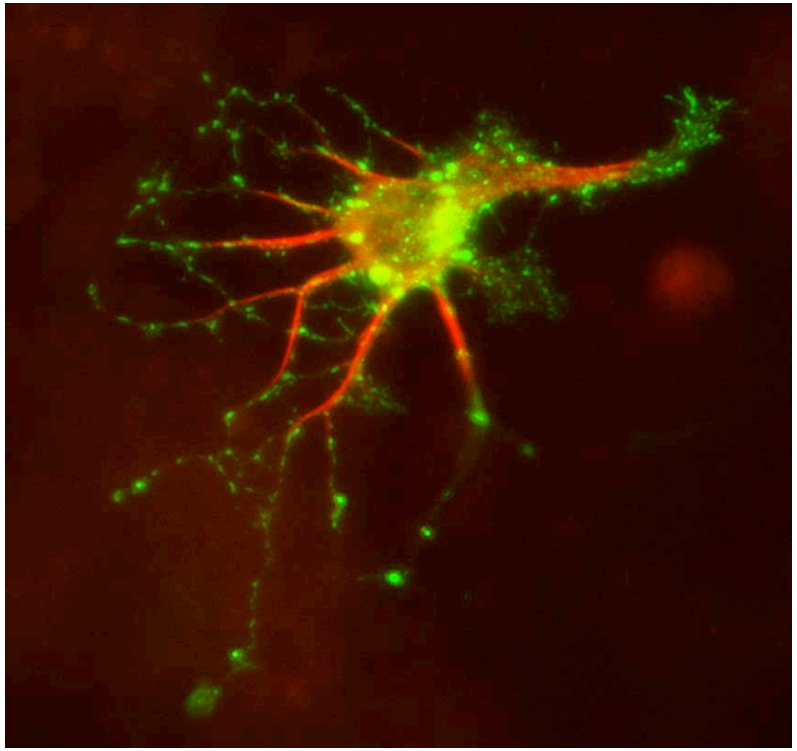
MSKGEELFTGVVPVLVELDGDVNGQKFSVSGEGEGDATYGKLTLNFICT
TGKLPVPWPTLVTTFSYGVQCFSRYPDHMKQHDFFKSAMPEGYVQERTI
FYKDDGNYKTRAEVKFEGDTLVNRIELKGIDFKEDGNILGHKMEYNYNS
HNVYIMGDKPKNGIKVNFKIRHNIKDGSVQLADHYQQNTPIGDGPVLLP
DNHYLSTQSALSKDPNEKRDHMILLEFVTAARITHGMDELYK

GFP DNA Sequence: 714 DNA bases (3 x 238)

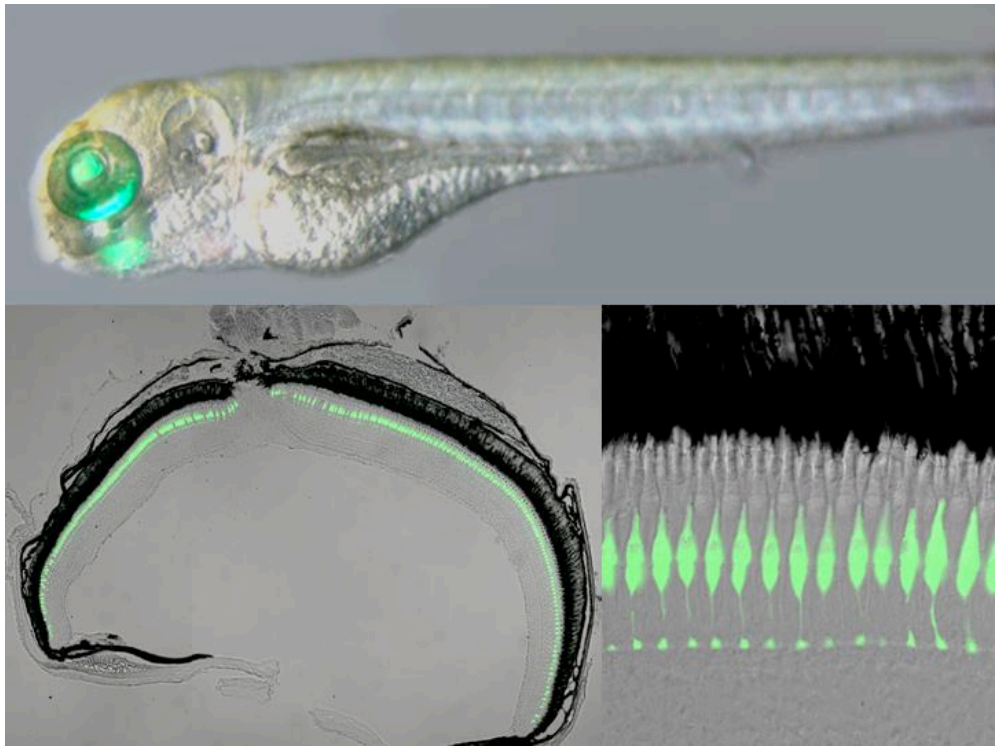
001 atgagtaaag gagaagaact tttcactgga gtggtcccag ttcttgttga attagatggc
061 gatgttaatg ggcaaaaatt ctctgtcagt ggagagggtg aaggtgatgc aacatacgga
121 aaacttaccc ttaattttat ttgcactact gggaagctac ctgttccatg gccaacactt
181 gtcactactt tctcttatgg tgttcaatgc ttctcaagat acccagatca tatgaaacag
241 catgactttt tcaagagtgc catgcccgaa ggttatgtac aggaaagaac tatattttac
301 aaagatgacg ggaactacaa gacacgtgct gaagtcaagt ttgaaggtga tacccttgtt
361 aatagaatcg agttaaaagg tattgatttt aaagaagatg gaaacattct tggacacaaa
421 atggaataca actataactc acataatgta tacatcatgg gagacaaacc aaagaatggc
481 atcaaagtta acttcaaaat tagacacaac attaaagatg gaagcgttca attagcagac
541 cattatcaac aaaatactcc aattggcgat ggccctgtcc ttttaccaga caaccattac
601 ctgtccacac aatctgccct ttccaaagat cccaacgaaa agagagatca catgatcctt
661 cttgagtttg taacagctgc taggattaca catggcatgg atgaactata caaa

http://www.tsienlab.ucsd.edu/

GFP fusion proteins tag and identify specific molecules…



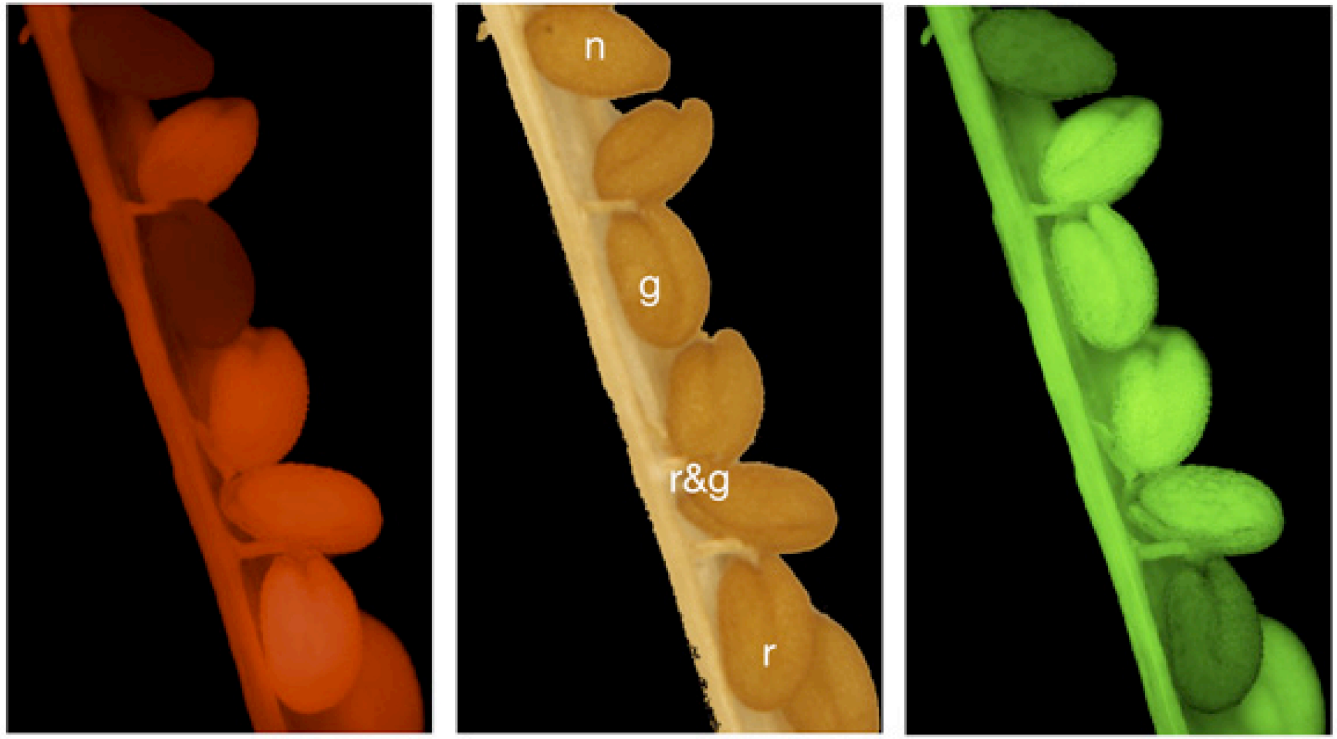
Mannose phosphate receptor (MPR) GFP



GFP in UV cones in the retina

…allowing us to ascertain their biological function!

RFP, YFP and GFP fusion proteins in *Arabidopis Thaliana*



Read more about GFP at:

http://nobelprize.org/nobel_prizes/chemistry/laureates/2008/chemadv08.pdf

or http://unicorn.ps.uci.edu/H2A/handouts/PDFs/RWFGFP.pdf

Why do we need people who know about Chemistry?

Protein Analysis

Kjeldahl method

The classic assay for protein concentration in food is the Kjeldahl method. This test determines the total nitrogen in a sample. The only major component of most food which contains nitrogen is protein (fat, carbohydrate and dietary fibre do not contain nitrogen). If the amount of nitrogen is multiplied by a factor depending on the kinds of protein expected in the food the total protein can be determined. On food labels the protein is given by the nitrogen multiplied by 6.25, because the average nitrogen content of proteins is about 16%. The Kjeldahl test is used because it is the method the AOAC International has adopted and is therefore used by many food standards agencies around the world.

Supplement Facts

Serving Size: Two (2) scoops (60 g)

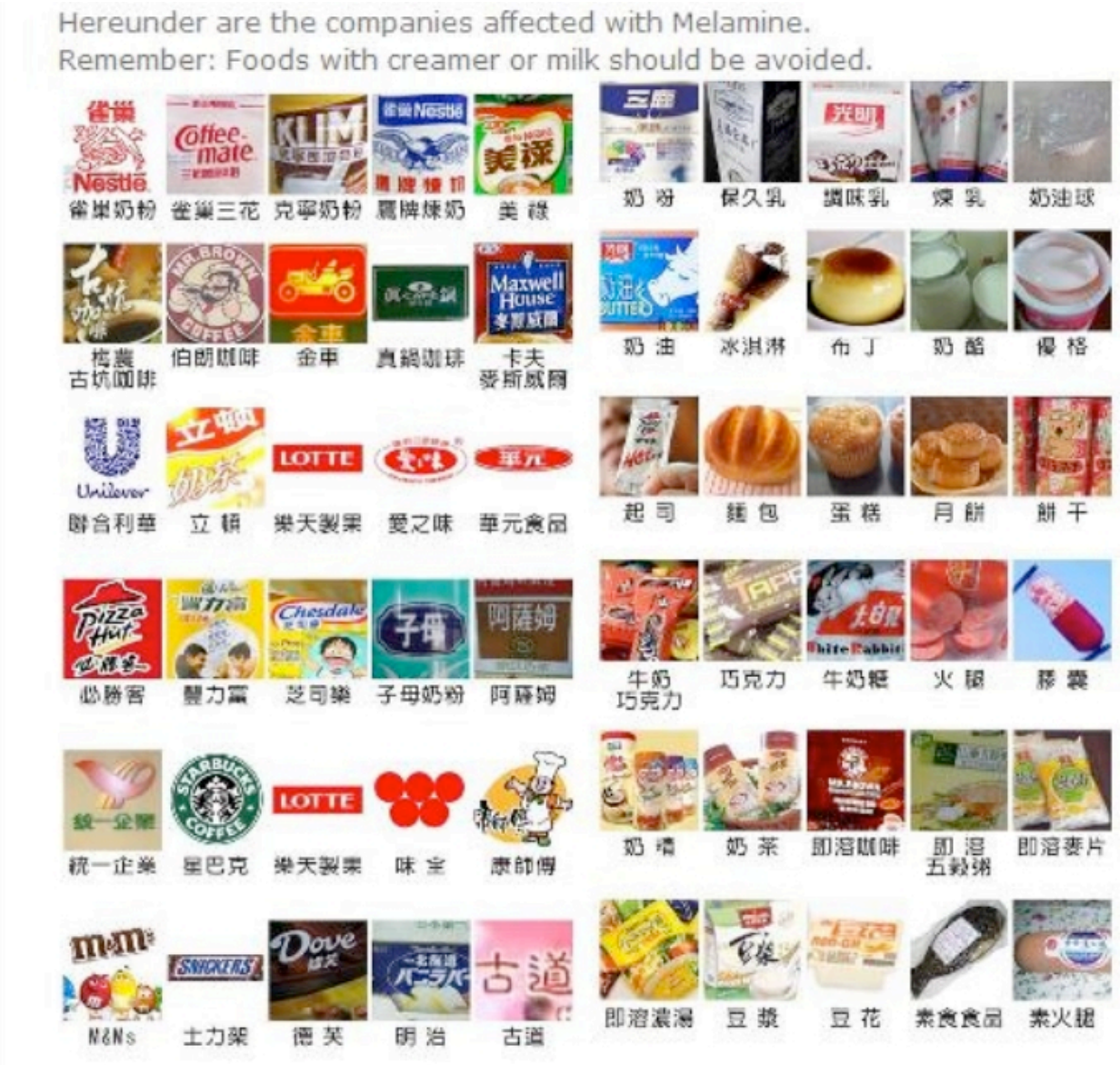
	Amount per serving	%Daily Value*
Calories	213	
Calories from Fat	27	
Total Fat	3 g	5%
Saturated Fat	1 g	5%
Polyunsaturated Fat	1 g	
Monounsaturated Fat	0.5 g	
Trans Fat	0 g	
Cholesterol	75 mg	25%
Sodium	90 mg	3%
Total Carbohydrate	7 g	3%
Dietary Fiber	1 g	3%
Sugars	3 g	
Protein	40 g	70%

* Percent Daily Values are based on a 2,000 calorie diet.

Other ingredients: Whey protein concentrate (containing Beta-Lactoglobulin (MW 18300), Alpha-Lactalbumin (MW 14000), Immunoglobulin G (MW 150000), Lactoferrin (MW 77000), Bovine Serum Albumin (MW 69000)), fiber blend (carragenan, xanthan, guar), natural vanilla flavor blend, sucralose, sodium chloride.)

Protein Analysis

2008 Chinese Melamine Scandal



Protein Analysis

2008 Chinese Melamine Scandal

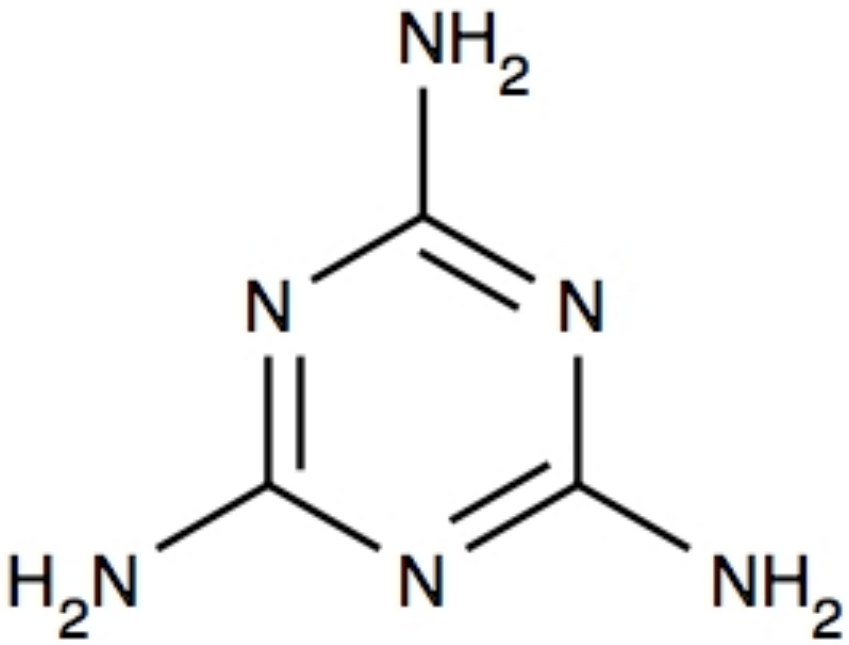
In 2008, thousands of babies in China became ill, having suffered acute kidney failure, with several fatalities, having been fed formula milk contaminated with the industrial chemical melamine.

On 17 September 2008, Health Minister Chen Zhu stated that tainted milk formula had "sickened more than 6,200 children, and that more than 1,300 others, mostly newborns, remain hospitalised with 158 suffering from acute kidney failure". By 23 September, about 54,000 children were reported to be sick and 4 had died. An additional 10,000 cases were reported from the provinces by 26 September. A WHO official said 82 percent of the children made ill were 2 years of age or below. The Hong Kong Centre for Food Safety said that 99% of victims were aged under 3 years. Ten Hong Kong children were diagnosed with kidney problems, at least four cases were detected in Macau, and six in Taiwan.

Manufacturer, Sanlu, part-owned by New Zealand's Fonterra Cooperative, recalled all of its powdered milk products in China's north-west province of Gansu. However, twenty-two brands, including China Mengniu Diary Co and Inner Mongolia Yili Industrial Group, of milk powder were quickly identified as containing melamine. "The majority of afflicted infants ingested Sanlu-brand milk powder over a long period of time, their clinical symptoms showed up three to six months after ingesting the problematic products," Health Minister Chen Zhu told Bloomberg Asia.

So, what is melamine and how does it spoof the protein levels in baby formula milk?

Protein Analysis



Melamine

$C_3H_6N_6$

Melamine is an organic compound with chemical formula $C_3H_6N_6$. Officially it is 1,3,5-triazine-2,4,6-triamine in the IUPAC nomenclature system. It is has a molecular mass of just over 126, forms a white, crystalline powder, and is only slightly soluble in water. It is used in fire retardants in polymer resins because its high nitrogen content is released as flame-stifling nitrogen gas when the compound is burned or charred.

It is its high nitrogen level – 66% nitrogen by mass – that gives melamine the analytical characteristics needed to fake the nitrogen in protein samples.

The world needs to use better methods for measuring protein content!!! This scandal should have never happened. :(

Why do we need to eat Turkey?

Protein Consumption

Most health groups insist on you eating protein daily! Turkey is usually on the list:

Meal Ideas:

Here are some easy ways for you to get your daily protein!

Breakfast	Snack	Lunch	Dinner
Toast with peanut butter	String cheese	Cold-cuts with vegetables and cheese (in a sandwich or wrap)	Baked or grilled fish
Scrambled eggs (or egg substitute) with cheese and salsa, rolled in a tortilla	Yogurt	Chili with cornbread	Turkey burger
Poached egg on an English muffin	Hummus with carrots	Bean burrito	Stir-fried tofu or chicken with vegetables

Remember: Try to include some protein at every meal. It will help keep your muscles strong!

Written by the Center for Young Women's Health Staff

Protein Consumption

Why do we eat protein? The following are "Essential Amino Acids," amino acids that we can not synthesize ourselves.

Essential	Nonessential
Isoleucine	Alanine
Arginine*	
Lysine	Aspartate
Methionine	Cysteine*
Phenylalanine	Glutamate
Threonine	Glutamine*
Tryptophan	Glycine*
Valine	Proline*
Histidine*	Serine*
Tyrosine*	Asparagine*
Leucine	Selenocysteine**

RDAs

Amino acid	mg per kg body weight	mg per 70 kg	mg per 100 kg
I Isoleucine	20	1400	2000
L Leucine	39	2730	3900
K Lysine	30	2100	3000
M Methionine + **C** Cysteine	10.4 + 4.1 (15 total)	1050	1500
F Phenylalanine + **Y** Tyrosine	25 (total)	1750	2500
T Threonine	15	1050	1500
W Tryptophan	4	280	400
V Valine	26	1820	2600

Protein Consumption

Limiting Amino Acids: Stoichiometry applied to eating.

What type of protein should we eat? Our bodies use amino acids in a specific ratio to each other, so if a person doesn't get enough of one of them to match with the rest, the rest can only be used at a level to balance with that low one. Most of these amino acids are fairly easy to get in a reasonably well-balanced diet. However, if you only get protein from one source, you could be limited by the specific amino acid content of your food. Stoichiometrically limited! The three most typical limiting amino acids include the two sulfur-containing amino acids (methionine and cysteine), tryptophan, and lysine.

Protein source	Limiting amino acid
Wheat	lysine
Rice	lysine
Legumes	tryptophan or methionine (or cysteine)
Maize	lysine and tryptophan
Egg, chicken	none; the reference for absorbable protein

Turkey has plenty of all of the various amino acids, and lots of protein. So enjoy!

Meat Type	Calories	Total Fat	Protein
Breast with skin	194	8 grams	29 grams
Breast w/o skin	161	4 grams	30 grams
Wing w/skin	238	13 grams	27 grams
Leg w/skin	213	11 grams	28 grams
Dark meat w/skin	232	13 grams	27 grams
Dark meat w/o skin	192	8 grams	28 grams
Skin only	482	44 grams	19 grams

Resource: USDA Nutrient Data Laboratory – Turkey (Young Hen)

Happy Thanksgiving!

See you on Monday!