

# What is Protein Metabolism?

## Worksheet

Protein metabolism is the process of digesting proteins into amino acids, removing their amino groups by transamination and deamination, and converting the toxic ammonia produced into safe, excretable urea via the liver's urea cycle.

## Questions

1. What toxic byproduct does amino acid breakdown produce?
  - A) Lactic acid
  - B) Ammonia
  - C) Carbon monoxide
  - D) Uric acid only
2. Which organ converts ammonia into urea?
  - A) Kidney
  - B) Liver
  - C) Pancreas
  - D) Spleen
3. What is the main function of transamination?
  - A) Building new proteins
  - B) Transferring an amino group between molecules
  - C) Breaking peptide bonds
  - D) Storing amino acids as fat
4. How is urea eliminated from the body?
  - A) Exhaled as gas
  - B) Excreted in urine by the kidneys
  - C) Stored in muscle
  - D) Converted back to protein
5. In transamination, alanine transfers its amino group to alpha-ketoglutarate. What two products form?
6. One turn of the urea cycle uses 2 nitrogen atoms (from  $\text{NH}_4^+$  and aspartate), 1  $\text{CO}_2$ , and consumes 3 ATP (4 high-energy phosphate bonds) to make 1 urea. How many ATP and nitrogen atoms are needed to make 5 urea molecules?
7. A protein of 250 amino acid residues is fully hydrolyzed during digestion. How many peptide bonds must be broken to release all free amino acids?
8. Define: What is transamination?
9. Define: What is deamination?
10. Define: Why must ammonia be converted to urea?

## Answer Key

1. B) Ammonia - Deamination releases ammonia ( $\text{NH}_3$ ), which is toxic and must be converted to urea.
2. B) Liver - The urea cycle enzymes are located in the liver.
3. B) Transferring an amino group between molecules - Transaminase enzymes move an amino group from one molecule to another, usually onto alpha-ketoglutarate.
4. B) Excreted in urine by the kidneys - Urea travels in the blood to the kidneys and is excreted in urine.
5. Alanine (amino donor) + alpha-ketoglutarate (amino acceptor) The amino group moves to alpha-ketoglutarate  
Products: pyruvate (from alanine) and glutamate (from alpha-ketoglutarate)
6. ATP needed =  $5 \times 3 = 15$  ATP Nitrogen atoms needed =  $5 \times 2 = 10$  nitrogen atoms Result: 15 ATP and 10 nitrogen atoms are used to produce 5 urea molecules
7. A chain of  $n$  residues has  $(n - 1)$  peptide bonds Bonds =  $250 - 1 = 249$  Result: 249 peptide bonds must be hydrolyzed
8. The transfer of an amino group from an amino acid to a keto acid (usually alpha-ketoglutarate), forming a new amino acid (glutamate) and a new keto acid.
9. The removal of an amino group from an amino acid as free ammonia ( $\text{NH}_3$ ), typically via oxidative deamination of glutamate.
10. Ammonia is toxic, especially to the brain and nervous system; urea is far less toxic and water-soluble for safe excretion.

### **Bounlu**

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