**Glutamine Transports Ammonia in the Blood**

* Ammonia is toxic to animal tissues.
* In most animals, much of the free ammonia is converted to a nontoxic compound.
* The free ammonia is combined with glutamate to yield glutamine by the action of **glutamine synthetase** **(Fig. 18-8)**.





**Alanine Transports Ammonia from Skeletal Muscles to the Liver**

* Alanine plays a special role in transporting amino groups to the liver in a nontoxic form, via a pathway called the **glucose-alanine cycle (Fig. 18–9)**.





* In muscle, amino acids are degraded for fuel. Amino groups are collected in the form of glutamate.
* Glutamate can transfer its -amino group to pyruvate. Alanine is formed.
* The alanine passes into the blood and travels to the liver.
* The amino group is transferred from alanine to -ketoglutarate, forming pyruvate and glutamate.
* The pyruvate, in the liver, is converted to glucose, which is transported back to muscle as part of the glucose alanine cycle.
* Glutamate can enter mitochondria, where the glutamate dehydrogenase reaction releases NH4+. NH4+ is converted to urea by urea cycle.
* Glutamate can undergo transamination with oxaloacetate to form aspartate.