11.2A: Introduction to Vitamin B₁₂

Vitamin B₁₂ is unique among vitamins in that it contains an element (cobalt) and is found almost exclusively in animal products. Neither plants nor animals can synthesize vitamin B₁₂. Instead, vitamin B₁₂ in animal products is produced by microorganisms within the animal that the products came from. Animals consume the microorganisms in soil or bacteria in ruminant animals that produce vitamin B₁₂¹. Some plant products, such as fermented soy products (tempeh, miso) and the sea algae supplement, spirulina, are advertised as being good sources of B₁₂. However, fermented soy products are not a reliable vitamin B₁₂ source² and spirulina contains a pseudovitamin B₁₂ compound that is not bioavailable³. For vegans, supplements, nutritional yeast, and fortified products like fortified soy milk can help them meet their vitamin B₁₂ needs⁴.

Vitamin B₁₂'s scientific name is cobalamin, which makes sense when you consider it contains cobalt and many amine groups, as shown in the figure below.
The other feature that is important in cobalamin is the circled R group. This is what differs between the different cobalamins, whose names and R groups are shown in the following table.

**Table 11.21 Different cobalamin forms**

<table>
<thead>
<tr>
<th>R Group</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>CN</td>
<td>Cyanocobalamin</td>
</tr>
<tr>
<td>OH</td>
<td>Hydroxocobalamin</td>
</tr>
<tr>
<td>H₂O</td>
<td>Aquocobalamin</td>
</tr>
<tr>
<td>NO₂</td>
<td>Nitritocobalamin</td>
</tr>
<tr>
<td>5'-deoxyadenosyl</td>
<td>Adenosylcobalamin*</td>
</tr>
<tr>
<td>CH₃</td>
<td>Methylcobalamin*</td>
</tr>
</tbody>
</table>

*Cofactor Forms

The two cofactor forms are adenosylcobalamin and methylcobalamin. We can convert most cobalamins into these 2 cofactor forms. Most foods contain adenosylcobalamin, hydroxocobalamin, or methylcobalamin. The most common form
found in supplements is cyanocobalamin, with some also using methylcobalamin. Cyanocobalamin is a synthetic form of the vitamin B₁₂.

### Uptake, Absorption, and Transport

The uptake, absorption, and transport of vitamin B₁₂ is a complex process. The following descriptions explain, and figures illustrate, this process.

Vitamin B₁₂ is normally bound to protein in food. Salivary glands in the mouth produce haptocorrin (formerly known as R protein), which travels with the food into the stomach. In the stomach, acid converts pepsinogen into pepsin, and the protein intrinsic factor is released from the parietal cells.

![Figure 11.22 Vitamin B₁₂ in the stomach part 1](https://med.libretexts.org/Bookshelves/Nutrition/Book%3A_Intermediate_Nutrition_(Lindshield)/11%3A_One-Carbon_Metabolism_Micronutrients/11.2%3A_Vitamin_B%E2%82%81%E2%82%82/11.2A%3A_Introduction_to_Vitamin_B%E2%82%81%E2%82%82)

As pepsin frees B₁₂ from protein, haptocorrin binds to the newly freed vitamin B₁₂ (haptocorrin + B₁₂). Intrinsic factor escapes digestion and, along with haptocorrin + B₁₂, exits the stomach and enters the duodenum.

![Figure 11.23 Vitamin B₁₂ in the stomach part 2](https://med.libretexts.org/Bookshelves/Nutrition/Book%3A_Intermediate_Nutrition_(Lindshield)/11%3A_One-Carbon_Metabolism_Micronutrients/11.2%3A_Vitamin_B%E2%82%81%E2%82%82/11.2A%3A_Introduction_to_Vitamin_B%E2%82%81%E2%82%82)
In the duodenum, pancreatic proteases break down haptocorrin, and again vitamin B₁₂ is freed. Intrinsic factor then binds vitamin B₁₂ (intrinsic factor + B₁₂); intrinsic factor + B₁₂ continues into the ileum to prepare for absorption¹,⁸.

*Figure 11.24 Vitamin B₁₂ in the duodenum⁸,⁹*

In the ileum, intrinsic factor + B₁₂ is believed to be endocytosed by cubulin (aka intrinsic factor receptor), forming an endosome inside the enterocyte. Intrinsic factor is broken down in the enterocyte, freeing vitamin B₁₂. The free vitamin B₁₂ is then bound to transcobalamin II (TC II + B₁₂); TC II + B₁₂ moves into circulation⁸.

*Figure 11.25 Vitamin B₁₂ absorption⁸,⁹*

The liver is the primary storage site for vitamin B₁₂. Unlike most other water-soluble vitamins, the liver is able to maintain significant stores of vitamin B₁₂. Uptake into the liver occurs through the binding of TC II + B₁₂ to the TC II Receptor and the endocytosis of both the compound and the receptor⁸. Vitamin B₁₂ is once again freed after degradation of TC II. Vitamin B₁₂ is primarily stored in the liver as adenosylcobalamin⁶,⁸.
The overall bioavailability of vitamin B12 is believed to be approximately 50%, with the different cobalamin forms having similar bioavailabilities. Sublingual supplements of vitamin B12 have been found to be equally efficacious as oral supplements. Excretion occurs mostly through bile, with little loss in urine.

References & Links

Contributors
- Brian Lindshield (Kansas State University). Content ordinates from the Human Nutrition (FNDH 400) Flexbook. goo.gl/vOAnR.