Vitamin A and carotenoids can be quantified in several different units, but it is preferable to use the International System of Units (SI) such as µmol:

**SI Units**
- 1 µmol retinol (vitamin A) = 286 µg retinol (vitamin A)
- 1 µmol β-carotene = 537 µg β-carotene

**Supplements, food, and animal feed:**
- 0.00349 µmol retinol (vitamin A) = 1 µg retinol (vitamin A)
- 1.15 µg retinyl acetate
- 1.83 µg retinyl palmitate
- 3.33 IU (1 IU = 0.3 µg)

For example, vitamin A in an oil supplement:
- 209 µmol retinol (vitamin A) = 200,000 IU
- 60,000 µg retinol (vitamin A)

**Retinol concentrations in:**
- Serum: 1 µmol/L = 28.6 µg/dL
- Liver: 1 µmol/g = 286 µg/g
- Milk: 1 µmol/L = 28.6 µg/dL
- Fat: 1 µmol/g = 286 µg/g

Unit conversion for commonly used cutoff values for serum retinol (vitamin A) concentration:
- 0.35 µmol/L = 10 µg/dL
- 0.70 µmol/L = 20 µg/dL
- 1.05 µmol/L = 30 µg/dL
The term “retinol activity equivalent” (RAE) was introduced by the U.S. Institute of Medicine (IOM)\(^1\) to replace “retinol equivalent” (RE) used by FAO/WHO\(^2\) to take into account new research on the vitamin A activity (bioefficacy) of carotenoids. The IOM deemed carotenoid bioefficacy in mixed foods eaten by healthy people in developed countries to be half the required amount set by FAO/WHO. Bioefficacy may, in fact, be even lower in populations in developing countries.\(^3\)

References:

<table>
<thead>
<tr>
<th>Retinol Activity Equivalent (RAE)</th>
<th>Commonly Used Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 µg RAE</td>
<td>1 RE of retinol (vitamin A)</td>
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<tr>
<td></td>
<td>1 µg retinol (vitamin A)</td>
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<tr>
<td></td>
<td>2 µg β-carotene in oil</td>
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<tr>
<td></td>
<td>12 µg β-carotene in mixed foods</td>
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<tr>
<td></td>
<td>24 µg other provitamin A carotenoids in mixed foods</td>
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</table>

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