### Enzyme activity

Enzyme activity = moles of substrate converted per unit time = rate × reaction volume. Enzyme activity is a measure of the quantity of active enzyme present and is thus dependent on conditions, *which should be specified*. The SI unit is the [katal](https://en.wikipedia.org/wiki/Katal%22%20%5Co%20%22Katal), 1 katal = 1 mol s−1, but this is an excessively large unit. A more practical and commonly used value is [enzyme unit](https://en.wikipedia.org/wiki/Enzyme_unit) (U) = 1 [μmol](https://en.wikipedia.org/wiki/%CE%9C%22%20%5Co%20%22%CE%9C) min−1. 1 U corresponds to 16.67 [nanokatals](https://en.wikipedia.org/wiki/Nano-%22%20%5Co%20%22Nano-).

Enzyme activity as given in katal generally refers to that of the assumed natural target substrate of the enzyme. Enzyme activity can also be given as that of certain standardized substrates, such as [gelatin](https://en.wikipedia.org/wiki/Gelatin), then measured in *gelatin digesting units* (GDU), or milk proteins, then measured in *milk clotting units* (MCU). The units GDU and MCU are based on how fast one gram of the enzyme will digest gelatin or milk proteins, respectively. 1 GDU equals approximately 1.5 MCU.

An increased amount of substrate will increase the rate of reaction with enzymes, however once past a certain point, the rate of reaction will level out because the amount of active sites available has stayed constant.

The **enzyme unit**, or **international unit** for enzyme (symbol **U**, sometimes also **IU**) is a [unit](https://en.wikipedia.org/wiki/Unit_of_measurement) of [enzyme](https://en.wikipedia.org/wiki/Enzyme)'s [catalytic activity](https://en.wikipedia.org/wiki/Enzyme_assay).[[1]](https://en.wikipedia.org/wiki/Enzyme_unit#cite_note-1)

1 U (μmol/min) is defined as the amount of the enzyme that [catalyzes](https://en.wikipedia.org/wiki/Catalysis) the conversion of one [micro](https://en.wikipedia.org/wiki/Micro-)[mole](https://en.wikipedia.org/wiki/Mole_%28unit%29) of [substrate](https://en.wikipedia.org/wiki/Substrate_%28biochemistry%29) per minute under the specified conditions of the assay method.[[2]](https://en.wikipedia.org/wiki/Enzyme_unit#cite_note-2)

The specified conditions will usually be the optimum conditions, which including but not limited to temperature, pH and substrate concentration, that yield the maximal substrate conversion rate for that particular enzyme. In some assay method, one usually takes a temperature of 25°C[[3]](https://en.wikipedia.org/wiki/Enzyme_unit%22%20%5Cl%20%22cite_note-3).

The enzyme unit was adopted by the [International Union of Biochemistry](https://en.wikipedia.org/wiki/International_Union_of_Biochemistry_and_Molecular_Biology) in 1964. Since the minute is not an [SI](https://en.wikipedia.org/wiki/SI) base unit of time, the enzyme unit is discouraged in favor of the [katal](https://en.wikipedia.org/wiki/Katal%22%20%5Co%20%22Katal), the unit recommended by the [General Conference on Weights and Measures](https://en.wikipedia.org/wiki/General_Conference_on_Weights_and_Measures) in 1978 and officially adopted in 1999.

One katal is the enzyme activity that converts one mole of substrate per second under specified assay conditions, so

1 U = 1 μmol/min = 1/60 μmol/s ≈ 16.67 nmol/s;

16.67 nkat = 16.67 nmol/s;

Therefore, 1 U = 16.67 nkat[[4]](https://en.wikipedia.org/wiki/Enzyme_unit%22%20%5Cl%20%22cite_note-isbn_9781461585329-4)

The concept of enzyme unit should not be confused with the one of [international unit](https://en.wikipedia.org/wiki/International_unit) (IU). Although it is true that 1 U = 1 IU[[5]](https://en.wikipedia.org/wiki/Enzyme_unit%22%20%5Cl%20%22cite_note-isbn_9783527606054-5) (because, for many enzymes, the existing U was adopted as the later IU), international units can be defined for the biologic activity of many other kinds of substance besides enzymes (for example, vitamins and hormones).

### Specific activity

The specific activity of an enzyme is another common unit. This is the activity of an enzyme per milligram of total protein (expressed in μmol min−1 mg−1). Specific activity gives a measurement of enzyme purity in the mixture. It is the micro moles of product formed by an [enzyme](https://en.wikipedia.org/wiki/Enzyme) in a given amount of time (minutes) under given conditions per milligram of total proteins. Specific activity is equal to the rate of reaction multiplied by the volume of reaction divided by the mass of total protein. The SI unit is katal/kg, but a more practical unit is μmol/mgmin.

Specific activity is a measure of *enzyme processivity* (the capability of enzyme to be processed), at a specific (usually saturating) [substrate](https://en.wikipedia.org/wiki/Enzyme_substrate) concentration, and is usually constant for a pure enzyme.

An active site titration process can be done for the elimination of errors arising from differences in cultivation batches and/or misfolded enzyme and similar issues. This is a measure of the amount of active enzyme, calculated by e.g. titrating the amount of active sites present by employing an irreversible inhibitor. The specific activity should then be expressed as μmol min−1 mg−1 active enzyme. If the molecular weight of the enzyme is known, the [turnover number](https://en.wikipedia.org/wiki/Turnover_number), or μmol product per second per μmol of active enzyme, can be calculated from the specific activity. The turnover number can be visualized as the number of times each enzyme molecule carries out its catalytic cycle per second.

Highlights Enzymes II

1. A "substrate" is a molecule bound by an enzyme which it catalyzes a reaction upon. Substrates bind specific binding sites on enzymes that resemble their structure. An "active site" of an enzyme is a site on an enzyme where the reaction it catalyzes occurs.

2. There are two models for enzyme action relevant for our consideration. The "lock and key" model proposes that enzymes act like a "lock" that only certain keys (substrates) fit. This model works well for describing the binding of substrates, but is not helpful (or accurate) for describing the mechanism of catalysis.

3. The "induced fit" model of enzyme action proposes that enzymes change in response to binding of substrate and that change is at least partly responsible for the catalysis that occurs on the substrate. Thus, the induced fit model says that enzymes change substrates (by catalysis) and that substrates change enzymes (enabling catalysis).

4. It is important to note that after catalysis occurs, the product is released and the enzyme is returned to its original state.

5. As one increases the amount of substrate for an enzymatic reaction, the velocity of the reaction (concentratioin of product made per time) increases. If one uses more enzyme, one produces a faster velocity.

6. An enzymatic reaction's maximum velocity (Vmax) is the limit (maximum) of a plot of the velocity versus the substrate concentration. Enzymatic reactions reach maximum velocity when the enzyme is saturated with substrate. Plots of enzyme velocities versus substrate concentration are called hyperbolic.

7. Some enzymes have their ability to catalyze a reaction affected by the presence of another molecule. If that molecule is the substrate, one obtains a sigmoidal plot like that of hemoglobin binding to oxygen. This type of plot is is evidence that the enzyme's activity is affected by the substrate. When the activity of an enzyme is affected by binding a small molecule, the enzyme is described as allosteric. Allosterism specifically means that binding of a small molecule to an enzyme affects the enzyme's activity.

8. A very important number that does NOT vary according to the quantity of enzyme used (that is to say that it is a constant for a given enzyme) is the Km (the Michaelis constant). Km turns out to be the concentration of substrate required to get an enzymatic reaction to half maximum velocity (slide 12). Km is a constant for any given enzyme and provides a measure of an enzyme's "affinity" for its substrate. An enzyme with a high Km has a low affinity for its substrate. An enzyme with a low Km has a high affinity for its substrate. Note that Km is NOT Vmax/2. Instead, it is the substrate concentration required to get a reaction to Vmax/2.

9. Another important parameter of enzymes is called Kcat (also called turnover number). In [enzymology](https://en.wikipedia.org/wiki/Enzymology%22%20%5Co%20%22Enzymology), turnover number (also termed ***k*cat**) is defined as the maximum number of chemical conversions of  [substrate](https://en.wikipedia.org/wiki/Substrate_%28biochemistry%29)  molecules per second that a single [catalytic site](https://en.wikipedia.org/wiki/Catalytic_site) will execute for a given [enzyme](https://en.wikipedia.org/wiki/Enzyme) concentration {\displaystyle [E\_{T}]} for enzymes with two or more active sites. . Kcat is equal to Vmax/[Enzyme]. Because the concentration of enzyme is taken into account in this equation, Kcat does NOT vary with the amount of enzyme used and is therefore a constant for an enzyme. Kcat is equal to the number of molecules of product made per enzyme per unit time. A Kcat of 5/second means that that enzyme makes five molecules of product per molecule of enzyme per second.