

# Stoffwechsel

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## Übergeordnet

Biologischer Prozess

## Untergeordnet

Biosynthese

Katabolismus

Transport

## Gene Ontology

QuickGO <sup>[1]</sup>

Der **Stoffwechsel** oder der **Metabolismus** (griechisch μεταβολισμός, *metabolismós* „Stoffwechsel“, mit lateinischer Endung versehen) ist die Gesamtheit der chemischen Prozesse im Organismus, die als Folge zur Umwandlung von Stoffen führt und steht damit für die Aufnahme, den Transport und die chemische Umwandlung von Stoffen in einem Organismus sowie die Abgabe von Stoffwechselendprodukten an die Umgebung. Alle beteiligten Stoffe werden als *Metaboliten* bezeichnet.

Diese biochemischen Vorgänge (zum Beispiel innere und äußere Atmung, Transportvorgänge, Ernährung) dienen dem Aufbau und der Erhaltung der Körpersubstanz (Baustoffwechsel) sowie der Energiegewinnung (Energiestoffwechsel) und damit der Aufrechterhaltung der Körperfunktionen. Wesentlich für den Stoffwechsel sind Enzyme, die chemische Reaktionen katalysieren.

Der gesamte Stoffwechsel kann eingeteilt werden in katabole Reaktionen, welche, durch den Abbau von chemisch komplexen Nahrungsstoffen zu einfacheren Stoffen, Energie liefern, und anabole Reaktionen, welche unter Energieverbrauch körpereigene Stoffe aus einfachen Bausteinen aufbauen. Der gesamte Stoffwechsel ist jedoch ein komplexes Netzwerk von einzelnen Reaktionen, die zusammen Stoffwechselwege bilden. Diese können linear (z.B. Glycolyse) oder zyklisch (z.B. Citratzyklus) sein. Die meisten Stoffwechselwege sind amphibol: Sie laufen in verschiedenen Schritten katabol wie anabol ab. Auch wenn Stoffwechselwege in vielen Einzelschritten reversibel sind, sind sie als Gesamtes immer irreversibel, da mindestens ein Reaktionsschritt nur in anabole oder katabole Richtung verläuft.

Werden von außen aufgenommene, fremde Stoffe umgesetzt, so spricht man auch von Fremdstoffmetabolismus.

Die Erforschung des Stoffwechsels erfolgt vor allem mit Methoden der Physiologie und Biochemie.

Den Stoffwechsel kann man auch als Austausch von freier Energie oder Ordnung verstehen. Lebewesen erhöhen in sich die Ordnung (Abnahme der Entropie) auf Kosten der Erhöhung von Unordnung, also von Entropie, in der Umgebung. Man hat Lebewesen deshalb auch als Negentropen bezeichnet.

Erwin Schrödinger hat darauf hingewiesen, dass der Ausdruck *Stoffwechsel* leicht missverstanden werden kann. Man könne meinen, es handele sich um einen *Austausch* von Stoffen („Jedes Atom Stickstoff, Sauerstoff, Schwefel usw. ist ebenso viel wert wie jedes andere seiner Art; was ließe sich durch ihren Austausch gewinnen?“<sup>[2]</sup>). Tatsächlich ist aber eine *chemische Veränderung* von Stoffen gemeint.

## Reaktionstypen

### Enzymatisch katalysierte Reaktionen

Nach dem IUPAC/IUBMB Enzym-Klassifikationssystem gibt es sechs Hauptgruppen von Enzymreaktionen.<sup>[3]</sup> Dadurch kann auch der Stoffwechsel, in dem Reaktionen durch Enzyme katalysiert werden, ebenfalls in sechs Gruppen von Reaktionen unterteilt werden, nämlich in Redoxreaktionen, Gruppenübertragungsreaktionen, Hydrolysereaktionen, Lyase-Reaktionen (Addition, Hydratisierung), Isomerisierungsreaktionen und Ligationsreaktionen.

→ *Hauptartikel: Enzym#Klassifikation*

### Transport

Der Transport von Stoffen durch Transportproteine kann innerhalb von Zellkompartimenten, außerhalb von Zellen, oder über Kompartimentgrenzen (Biomembrane) hinweg geschehen. Es kann sich um reine Diffusionsprozesse, erleichterte Diffusion oder aktiven, ATP verbrauchenden Membrantransport handeln.

Mit der Transporter Classification Database (TCDB) steht eine von der IUBMB sanktionierte Klassifikation der Transportproteine zur Verfügung, die sich zusätzlich zur Funktion an der Abstammung der Proteine orientiert. Bei dieser Definition von Transport werden allerdings alle Proteine, die Stoffe zeitweilig nur binden und in dieser Zeit selbst transportiert werden (beispielsweise mit dem Blutkreislauf), nicht erfasst. Die Hauptgruppen in der TCDB sind Porine und Ionenkanäle, potenzialgetriebene Transporter, primär aktive Transporter, Phosphotransferasen, Transmembran-Elektronencarrier, Hilfstransporter und andere.

→ *Hauptartikel: Transport (Biologie)*

## Stoffwechselforgänge

### Einteilung nach der Funktion der Stoffwechselreaktion im Organismus

- Energiestoffwechsel – exergone chemische Umsetzungen zum Zweck der Energiegewinnung
- Grundumsatz - Stoffwechsel eines Organismus bei völliger Ruhe
- Hungerstoffwechsel – Anpassung des Organismus an geringes Nahrungsangebot
- Baustoffwechsel – Aufbau von Stoffen, aus denen der Organismus besteht
- Assimilation – Umbau organismenfremder Stoffe in organismeneigene Stoffe
- Dissimilation – Abbau organismeneigener Stoffe, meistens zum Zweck der Energiegewinnung
- Glukose-Stoffwechsel
- Aminosäure-Stoffwechsel
- Eisenstoffwechsel
- Biotransformation – Abbau und Entfernung schädlicher organismeneigener und -fremder Stoffe

### Einteilung nach der Veränderung von Molekülen

- Stoffherstellung (Biosynthese) (Anabolismus)
- Stoffveränderung / -abbau (Katabolismus)

## Beispiele für Stoffwechselforgänge

In der Photosynthese wandeln spezifische Stoffwechselforgänge (in der Regel die des Calvin-Zyklus) unter Verwendung der Energie des Lichts Kohlenstoffdioxid (bei Landpflanzen aus der Luft stammend), Wasser und andere Ausgangsstoffe in Stoffe um, die entweder sofort dem weiteren Aufbau und Wachstum des Organismus dienen oder gespeichert werden, zum Beispiel Kohlenhydrate. Diese Reservestoffe können später im

Baustoffwechsel oder im Energiestoffwechsel verarbeitet werden.

Tiere verstoffwechseln (metabolisieren) bei ihrer Verdauung andere Organismen oder deren Speicherstoffe (etwa Kohlenhydrate, Proteine oder Fette).

## Einzelnachweise

- [1] <http://www.ebi.ac.uk/QuickGO/GTerm?id=GO:0008152>
- [2] Erwin Schrödinger: *Was ist Leben - Die lebende Zelle mit den Augen des Physikers betrachtet*. Deutschsprachige Ausgabe der englischsprachigen Originalausgabe *What is life?* von 1944, 5. Auflage. Piper Verlag, München 2001, ISBN 3-492-21134-8, S. 125.
- [3] IUPAC Enzymnomenklaturempfehlung: *Recommendations of the Nomenclature Committee of the International Union of Biochemistry and Molecular Biology on the Nomenclature and Classification of Enzymes by the Reactions they Catalyse*. (<http://www.chem.qmul.ac.uk/iubmb/enzyme/>), Stand: 24. Mai 2013, abgerufen am 26. Mai 2013.

## Weblinks

- Interactive flow chart of the major metabolic pathways (engl.) (<http://www2.ufp.pt/~pedros/bq/integration.htm>)
- Biochemistry of Metabolism (engl.) (<http://www.rpi.edu/dept/bcbp/molbiochem/MBWeb/mb1/MB1index.html>) – umfassende Informationen zu den biochemischen Aspekten des Themas Stoffwechsel
- Arbeitsgemeinschaft für Pädiatrische Stoffwechselstörungen (<http://www.aps-med.de/>) – Wissenswertes zu Erkrankungen des Stoffwechsels
- Society for the Study of Inborn Errors of Metabolism (<http://www.ssiem.org/>)
- SuperCYP: Datenbank für Cytochrom-Metabolismus (<http://bioinformatics.charite.de/supercyp/>) (engl.)
- Roche's "Biochemical Pathways" als "Landkarte" zum Navigieren ([http://www.expasy.org/cgi-bin/show\\_thumbnails.pl](http://www.expasy.org/cgi-bin/show_thumbnails.pl))

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If you have Invariant Sections without Cover Texts, or some other combination of the three, merge those two alternatives to suit the situation.

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