**Biosensor**

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Jump to: [navigation](http://en.wikipedia.org/wiki/Biosensor#mw-navigation), [search](http://en.wikipedia.org/wiki/Biosensor#p-search)

A **biosensor** is an analytical device, used for the detection of an [analyte](http://en.wikipedia.org/wiki/Analyte), that combines a biological component with a physicochemical detector.[[1]](http://en.wikipedia.org/wiki/Biosensor#cite_note-1)[[2]](http://en.wikipedia.org/wiki/Biosensor#cite_note-2)

* the *sensitive biological element* (e.g. tissue, microorganisms, organelles, cell receptors, [enzymes](http://en.wikipedia.org/wiki/Enzyme), [antibodies](http://en.wikipedia.org/wiki/Antibody), [nucleic acids](http://en.wikipedia.org/wiki/Nucleic_acid), etc.), a biologically derived material or biomimetic component that interacts (binds or recognizes) the analyte under study. The biologically sensitive elements can also be created by [biological engineering](http://en.wikipedia.org/wiki/Biological_engineering).
* the *transducer* or the *detector element* (works in a physicochemical way; optical, piezoelectric, electrochemical, etc.) that transforms the signal resulting from the interaction of the analyte with the biological element into another signal (i.e., transduces) that can be more easily measured and quantified;
* biosensor reader device with the associated electronics or signal processors that are primarily responsible for the display of the results in a user-friendly way.[[3]](http://en.wikipedia.org/wiki/Biosensor#cite_note-3) This sometimes accounts for the most expensive part of the sensor device, however it is possible to generate a user friendly display that includes transducer and sensitive element(see [Holographic Sensor](http://en.wikipedia.org/wiki/Holographic_Sensor)). The readers are usually custom-designed and manufactured to suit the different working principles of biosensors. Known manufacturers of biosensor electronic readers include PalmSens, Gwent Biotechnology Systems and Rapid Labs.

**Contents**

 [[hide](http://en.wikipedia.org/wiki/Biosensor)]

* [1 Examples and applications](http://en.wikipedia.org/wiki/Biosensor#Examples_and_applications)
* [2 The biosensor system](http://en.wikipedia.org/wiki/Biosensor#The_biosensor_system)
* [3 Bioreceptors](http://en.wikipedia.org/wiki/Biosensor#Bioreceptors)
* [4 Surface attachment of the biological elements](http://en.wikipedia.org/wiki/Biosensor#Surface_attachment_of_the_biological_elements)
* [5 Biotransducer](http://en.wikipedia.org/wiki/Biosensor#Biotransducer)
	+ [5.1 Electrochemical](http://en.wikipedia.org/wiki/Biosensor#Electrochemical)
	+ [5.2 Ion channel switch](http://en.wikipedia.org/wiki/Biosensor#Ion_channel_switch)
	+ [5.3 Others](http://en.wikipedia.org/wiki/Biosensor#Others)
* [6 Placement of biosensors](http://en.wikipedia.org/wiki/Biosensor#Placement_of_biosensors)
* [7 Applications](http://en.wikipedia.org/wiki/Biosensor#Applications)
	+ [7.1 Glucose monitoring](http://en.wikipedia.org/wiki/Biosensor#Glucose_monitoring)
	+ [7.2 Interferometric Reflectance Imaging Sensor](http://en.wikipedia.org/wiki/Biosensor#Interferometric_Reflectance_Imaging_Sensor)
	+ [7.3 Food analysis](http://en.wikipedia.org/wiki/Biosensor#Food_analysis)
	+ [7.4 DNA biosensors](http://en.wikipedia.org/wiki/Biosensor#DNA_biosensors)
	+ [7.5 Microbial biosensors](http://en.wikipedia.org/wiki/Biosensor#Microbial_biosensors)
* [8 See also](http://en.wikipedia.org/wiki/Biosensor#See_also)
* [9 References](http://en.wikipedia.org/wiki/Biosensor#References)
* [10 External links](http://en.wikipedia.org/wiki/Biosensor#External_links)

**Examples and applications[[edit](http://en.wikipedia.org/w/index.php?title=Biosensor&action=edit&section=1" \o "Edit section: Examples and applications)]**

A common example of a commercial biosensor is the [blood glucose](http://en.wikipedia.org/wiki/Blood_glucose) biosensor, which uses the enzyme [glucose oxidase](http://en.wikipedia.org/wiki/Glucose_oxidase) to break blood glucose down. In doing so it first oxidizes glucose and uses two electrons to reduce the FAD (a component of the enzyme) to FADH2. This in turn is oxidized by the electrode in a number of steps. The resulting current is a measure of the concentration of glucose. In this case, the electrode is the transducer and the enzyme is the biologically active component.

Recently, arrays of many different detector molecules have been applied in so called [electronic nose](http://en.wikipedia.org/wiki/Electronic_nose) devices, where the pattern of response from the detectors is used to fingerprint a substance.[[4]](http://en.wikipedia.org/wiki/Biosensor#cite_note-4) In the [Wasp Hound](http://en.wikipedia.org/wiki/Wasp_Hound) odor-detector, the mechanical element is a video camera and the biological element is five parasitic wasps who have been conditioned to swarm in response to the presence of a specific chemical.[[5]](http://en.wikipedia.org/wiki/Biosensor#cite_note-scicentr-5) Current commercial electronic noses, however, do not use biological elements.

A [canary in a cage](http://en.wikipedia.org/wiki/Domestic_Canary#Miner.27s_canary), as used by miners to warn of gas, could be considered a biosensor. Many of today's biosensor applications are similar, in that they use organisms which respond to [toxic](http://en.wikipedia.org/wiki/Toxic) substances at a much lower concentrations than humans can detect to warn of their presence. Such devices can be used in environmental monitoring, trace gas detection and in water treatment facilities.

Many optical biosensors are based on the phenomenon of [surface plasmon resonance](http://en.wikipedia.org/wiki/Surface_plasmon_resonance) (SPR) techniques.[[6]](http://en.wikipedia.org/wiki/Biosensor#cite_note-6) This utilises a property of and other materials; specifically that a thin layer of gold on a high refractive index glass surface can absorb laser light, producing electron waves (surface plasmons) on the gold surface. This occurs only at a specific angle and wavelength of incident light and is highly dependent on the surface of the gold, such that binding of a target analyte to a receptor on the gold surface produces a measurable signal.

Surface plasmon resonance sensors operate using a sensor chip consisting of a plastic cassette supporting a glass plate, one side of which is coated with a microscopic layer of gold. This side contacts the optical detection apparatus of the instrument. The opposite side is then contacted with a microfluidic flow system. The contact with the flow system creates channels across which reagents can be passed in solution. This side of the glass sensor chip can be modified in a number of ways, to allow easy attachment of molecules of interest. Normally it is coated in [carboxymethyl dextran](http://en.wikipedia.org/w/index.php?title=Carboxymethyl_dextran&action=edit&redlink=1) or similar compound.

Light of a fixed wavelength is reflected off the gold side of the chip at the angle of total internal reflection, and detected inside the instrument. The angle of incident light is varied in order to match the evanescent wave propagation rate with the propagation rate of the surface plasmon plaritons.[[7]](http://en.wikipedia.org/wiki/Biosensor#cite_note-7) This induces the evanescent wave to penetrate through the glass plate and some distance into the liquid flowing over the surface.

The refractive index at the flow side of the chip surface has a direct influence on the behaviour of the light reflected off the gold side. Binding to the flow side of the chip has an effect on the refractive index and in this way biological interactions can be measured to a high degree of sensitivity with some sort of energy. The refractive index of the medium near the surface changes when biomolecules attach to the surface, and the SPR angle varies as a function of this change.

Other evanescent wave biosensors have been commercialised using waveguides where the propagation constant through the waveguide is changed by the absorption of molecules to the waveguide surface. One such example, [Dual Polarisation Interferometry](http://en.wikipedia.org/wiki/Dual_Polarisation_Interferometry) uses a buried waveguide as a reference against which the change in propagation constant is measured. Other configurations such as the [Mach-Zehnder](http://en.wikipedia.org/wiki/Mach-Zehnder) have reference arms lithographically defined on a substrate. Higher levels of integration can be achieved using resonator geometries where the resonant frequency of a ring resonator changes when molecules are absorbed.[[8]](http://en.wikipedia.org/wiki/Biosensor#cite_note-8)[[9]](http://en.wikipedia.org/wiki/Biosensor#cite_note-9)

Other optical biosensors are mainly based on changes in absorbance or fluorescence of an appropriate indicator compound and do not need a total internal reflection geometry. For example, a fully operational prototype device detecting casein in milk has been fabricated. The device is based on detecting changes in absorption of a gold layer.[[10]](http://en.wikipedia.org/wiki/Biosensor#cite_note-10) A widely used research tool, the micro-array, can also be considered a biosensor.

Nanobiosensors use an immobilized bioreceptor probe that is selective for target analyte molecules. Nanomaterials are exquisitely sensitive chemical and biological sensors. Nanoscale materials demonstrate unique properties. Their large surface area to volume ratio can achieve rapid and low cost reactions, using a variety of designs.[[11]](http://en.wikipedia.org/wiki/Biosensor#cite_note-11)

Biological biosensors often incorporate a genetically modified form of a native protein or enzyme. The protein is configured to detect a specific analyte and the ensuing signal is read by a detection instrument such as a fluorometer or luminometer. An example of a recently developed biosensor is one for detecting [cytosolic](http://en.wikipedia.org/wiki/Cytosol) concentration of the analyte cAMP (cyclic adenosine monophosphate), a second messenger involved in cellular signaling triggered by ligands interacting with receptors on the cell membrane.[[12]](http://en.wikipedia.org/wiki/Biosensor#cite_note-12) Similar systems have been created to study cellular responses to native ligands or xenobiotics (toxins or small molecule inhibitors). Such "assays" are commonly used in drug discovery development by pharmaceutical and biotechnology companies. Most cAMP assays in current use require lysis of the cells prior to measurement of cAMP. A live-cell biosensor for cAMP can be used in non-lysed cells with the additional advantage of multiple reads to study the kinetics of receptor response.

**The biosensor system[[edit](http://en.wikipedia.org/w/index.php?title=Biosensor&action=edit&section=2" \o "Edit section: The biosensor system)]**





Biosensor system

A biosensor typically consists of a bio-recognition component, biotransducer component, and [electronic system](http://en.wikipedia.org/wiki/Electronic_system) which include a signal amplifier, processor, and display. Transducers and electronics can be combined, e.g., in CMOS-based microsensor systems.[[13]](http://en.wikipedia.org/wiki/Biosensor#cite_note-A1-13)[[14]](http://en.wikipedia.org/wiki/Biosensor#cite_note-A2-14) The recognition component, often called a bioreceptor, uses biomolecules from organisms or receptors modeled after biological systems to interact with the analyte of interest. This interaction is measured by the biotranducer which outputs a measurable signal proportional to the presence of the target analyte in the sample. The general aim of the design of a biosensor is to enable quick, convenient testing at the point of concern or care where the sample was procured.[[15]](http://en.wikipedia.org/wiki/Biosensor#cite_note-15)

**Bioreceptors[**[**edit**](http://en.wikipedia.org/w/index.php?title=Biosensor&action=edit&section=3)**]**