

Display Settings: Abstract

[Exp Physiol](#). 2008 Jan;93(1):16-26. Epub 2007 Oct 19.**Claude Bernard, the first systems biologist, and the future of physiology.**[Noble D.](#)**Author information****Abstract**

The first **systems** analysis of the functioning of an organism was Claude Bernard's concept of the constancy of the internal environment (le milieu intérieur), since it implied the existence of control processes to achieve this. He can be regarded, therefore, as the first **systems** biologist. The new vogue for **systems biology** today is an important development, since it is time to complement reductionist molecular **biology** by integrative approaches. Claude Bernard foresaw that this would require the application of mathematics to **biology**. This aspect of Claude Bernard's work has been neglected by physiologists, which is why we are not as ready to contribute to the development of **systems biology** as we should be. In this paper, I outline some general principles that could form the **basis** of **systems biology** as a truly multilevel approach from a physiologist's standpoint. We need the insights obtained from higher-level analysis in order to succeed even at the lower levels. The reason is that higher levels in biological **systems** impose boundary conditions on the lower levels. Without understanding those conditions and their effects, we will be seriously restricted in understanding the logic of living **systems**. The principles outlined are illustrated with examples from various aspects of physiology and biochemistry. Applying and developing these principles should form a major part of the future of physiology.

PMID:17951329[PubMed - indexed for MEDLINE] [Free full text](#)**Publication Types, MeSH Terms, Substances, Personal Name as Subject****LinkOut - more resources****PubMed Commons**[PubMed Commons home](#)

0 comments

[How to join PubMed Commons](#)

Shortcut Text	Internet Address
NCBI	<a href="http://www.ncbi.nlm.nih.gov/">http://www.ncbi.nlm.nih.gov/</a>
Skip to main content	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#maincontent">http://www.ncbi.nlm.nih.gov/pubmed/17951329#maincontent</a>
Skip to navigation	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#navcontent">http://www.ncbi.nlm.nih.gov/pubmed/17951329#navcontent</a>
Resources	<a href="http://www.ncbi.nlm.nih.gov/static/header_footer_ajax/submenu/#resources">http://www.ncbi.nlm.nih.gov/static/header_footer_ajax/submenu/#resources</a>
All Resources	<a href="http://www.ncbi.nlm.nih.gov/guide/all/">http://www.ncbi.nlm.nih.gov/guide/all/</a>
Chemicals & Bioassays	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#chemicals-bioassays">http://www.ncbi.nlm.nih.gov/pubmed/17951329#chemicals-bioassays</a>
BioSystems	<a href="http://www.ncbi.nlm.nih.gov/biosystems/">http://www.ncbi.nlm.nih.gov/biosystems/</a>
PubChem BioAssay	<a href="http://www.ncbi.nlm.nih.gov/pcassay">http://www.ncbi.nlm.nih.gov/pcassay</a>
PubChem Compound	<a href="http://www.ncbi.nlm.nih.gov/pccompound">http://www.ncbi.nlm.nih.gov/pccompound</a>
PubChem Structure Search	<a href="http://pubchem.ncbi.nlm.nih.gov/search/search.cgi">http://pubchem.ncbi.nlm.nih.gov/search/search.cgi</a>
PubChem Substance	<a href="http://www.ncbi.nlm.nih.gov/pcsubstance">http://www.ncbi.nlm.nih.gov/pcsubstance</a>
All Chemicals & Bioassays Resources...	<a href="http://www.ncbi.nlm.nih.gov/guide/chemicals-bioassays/">http://www.ncbi.nlm.nih.gov/guide/chemicals-bioassays/</a>
DNA & RNA	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#dna-rna">http://www.ncbi.nlm.nih.gov/pubmed/17951329#dna-rna</a>
BLAST (Basic Local Alignment Search Tool)	<a href="http://blast.ncbi.nlm.nih.gov/Blast.cgi">http://blast.ncbi.nlm.nih.gov/Blast.cgi</a>
BLAST (Stand-alone)	<a href="http://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Web&amp;PAGE_TYPE=BlastDocs&amp;DOC_TYPE=Download">http://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Web&amp;PAGE_TYPE=BlastDocs&amp;DOC_TYPE=Download</a>
E-Utilities	<a href="http://www.ncbi.nlm.nih.gov/books/NBK25501/">http://www.ncbi.nlm.nih.gov/books/NBK25501/</a>
GenBank	<a href="http://www.ncbi.nlm.nih.gov/genbank/">http://www.ncbi.nlm.nih.gov/genbank/</a>
GenBank: BankIt	<a href="http://www.ncbi.nlm.nih.gov/WebSub/?tool=genbank">http://www.ncbi.nlm.nih.gov/WebSub/?tool=genbank</a>
GenBank: Sequin	<a href="http://www.ncbi.nlm.nih.gov/projects/Sequin/">http://www.ncbi.nlm.nih.gov/projects/Sequin/</a>
GenBank: tbl2asn	<a href="http://www.ncbi.nlm.nih.gov/genbank/tbl2asn2/">http://www.ncbi.nlm.nih.gov/genbank/tbl2asn2/</a>
Genome Workbench	<a href="http://www.ncbi.nlm.nih.gov/tools/gbench/">http://www.ncbi.nlm.nih.gov/tools/gbench/</a>
Influenza Virus	<a href="http://www.ncbi.nlm.nih.gov/genomes/FLU/">http://www.ncbi.nlm.nih.gov/genomes/FLU/</a>
Nucleotide Database	<a href="http://www.ncbi.nlm.nih.gov/nucleotide">http://www.ncbi.nlm.nih.gov/nucleotide</a>
PopSet	<a href="http://www.ncbi.nlm.nih.gov/popset">http://www.ncbi.nlm.nih.gov/popset</a>
Primer-BLAST	<a href="http://www.ncbi.nlm.nih.gov/tools/primer-blast/">http://www.ncbi.nlm.nih.gov/tools/primer-blast/</a>
ProSplign	<a href="http://www.ncbi.nlm.nih.gov/sutils/static/prosplign/prosplign.html">http://www.ncbi.nlm.nih.gov/sutils/static/prosplign/prosplign.html</a>
Reference Sequence (RefSeq)	<a href="http://www.ncbi.nlm.nih.gov/refseq/">http://www.ncbi.nlm.nih.gov/refseq/</a>
RefSeqGene	<a href="http://www.ncbi.nlm.nih.gov/refseq/rsg/">http://www.ncbi.nlm.nih.gov/refseq/rsg/</a>
Sequence Read Archive (SRA)	<a href="http://www.ncbi.nlm.nih.gov/Traces/sra/sra.cgi?">http://www.ncbi.nlm.nih.gov/Traces/sra/sra.cgi?</a>
Splign	<a href="http://www.ncbi.nlm.nih.gov/sutils/splign/">http://www.ncbi.nlm.nih.gov/sutils/splign/</a>
Trace Archive	<a href="http://www.ncbi.nlm.nih.gov/Traces/trace.cgi">http://www.ncbi.nlm.nih.gov/Traces/trace.cgi</a>
UniGene	<a href="http://www.ncbi.nlm.nih.gov/uniGene">http://www.ncbi.nlm.nih.gov/uniGene</a>
UniSTS	<a href="http://www.ncbi.nlm.nih.gov/unists">http://www.ncbi.nlm.nih.gov/unists</a>
All DNA & RNA Resources...	<a href="http://www.ncbi.nlm.nih.gov/guide/dna-rna/">http://www.ncbi.nlm.nih.gov/guide/dna-rna/</a>
Data & Software	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#data-software">http://www.ncbi.nlm.nih.gov/pubmed/17951329#data-software</a>
Cn3D	<a href="http://www.ncbi.nlm.nih.gov/Structure/CN3D/cn3d.shtml">http://www.ncbi.nlm.nih.gov/Structure/CN3D/cn3d.shtml</a>
Conserved Domain Search Service (CD Search)	<a href="http://www.ncbi.nlm.nih.gov/Structure/cdd/wrpsb.cgi">http://www.ncbi.nlm.nih.gov/Structure/cdd/wrpsb.cgi</a>
Genome ProtMap	<a href="http://www.ncbi.nlm.nih.gov/sutils/protmap.cgi">http://www.ncbi.nlm.nih.gov/sutils/protmap.cgi</a>
SNP Submission Tool	<a href="http://www.ncbi.nlm.nih.gov/projects/SNP/">http://www.ncbi.nlm.nih.gov/projects/SNP/</a>
Vector Alignment Search Tool (VAST)	<a href="http://www.ncbi.nlm.nih.gov/Structure/VAST/vast.html">http://www.ncbi.nlm.nih.gov/Structure/VAST/vast.html</a>
All Data & Software Resources...	<a href="http://www.ncbi.nlm.nih.gov/guide/data-software/">http://www.ncbi.nlm.nih.gov/guide/data-software/</a>
Domains & Structures	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#domains-structures">http://www.ncbi.nlm.nih.gov/pubmed/17951329#domains-structures</a>
Conserved Domain Database (CDD)	<a href="http://www.ncbi.nlm.nih.gov/cdd">http://www.ncbi.nlm.nih.gov/cdd</a>
Structure (Molecular Modeling Database)	<a href="http://www.ncbi.nlm.nih.gov/structure/">http://www.ncbi.nlm.nih.gov/structure/</a>
All Domains & Structures Resources...	<a href="http://www.ncbi.nlm.nih.gov/guide/domains-structures/">http://www.ncbi.nlm.nih.gov/guide/domains-structures/</a>
Genes & Expression	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#genes-expression">http://www.ncbi.nlm.nih.gov/pubmed/17951329#genes-expression</a>
Database of Genotypes and Phenotypes (dbGaP)	<a href="http://www.ncbi.nlm.nih.gov/gap">http://www.ncbi.nlm.nih.gov/gap</a>
Gene	<a href="http://www.ncbi.nlm.nih.gov/gene">http://www.ncbi.nlm.nih.gov/gene</a>
Gene Expression Omnibus (GEO)	<a href="http://www.ncbi.nlm.nih.gov/geo/">http://www.ncbi.nlm.nih.gov/geo/</a>

Shortcut Text	Internet Address
Database	
Gene Expression Omnibus (GEO) Datasets	<a href="http://www.ncbi.nlm.nih.gov/gds">http://www.ncbi.nlm.nih.gov/gds</a>
Gene Expression Omnibus (GEO) Profiles	<a href="http://www.ncbi.nlm.nih.gov/geo/profiles/">http://www.ncbi.nlm.nih.gov/geo/profiles/</a>
HomoloGene	<a href="http://www.ncbi.nlm.nih.gov/homologene">http://www.ncbi.nlm.nih.gov/homologene</a>
Map Viewer	<a href="http://www.ncbi.nlm.nih.gov/mapview/">http://www.ncbi.nlm.nih.gov/mapview/</a>
Online Mendelian Inheritance in Man (OMIM)	<a href="http://www.ncbi.nlm.nih.gov/omim">http://www.ncbi.nlm.nih.gov/omim</a>
All Genes & Expression Resources...	<a href="http://www.ncbi.nlm.nih.gov/guide/genes-expression/">http://www.ncbi.nlm.nih.gov/guide/genes-expression/</a>
Genetics & Medicine	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#genetics-medicine">http://www.ncbi.nlm.nih.gov/pubmed/17951329#genetics-medicine</a>
Bookshelf	<a href="http://www.ncbi.nlm.nih.gov/books">http://www.ncbi.nlm.nih.gov/books</a>
Genetic Testing Registry	<a href="http://www.ncbi.nlm.nih.gov/gtr/">http://www.ncbi.nlm.nih.gov/gtr/</a>
PubMed	<a href="http://www.ncbi.nlm.nih.gov/pubmed">http://www.ncbi.nlm.nih.gov/pubmed</a>
PubMed Central (PMC)	<a href="http://www.ncbi.nlm.nih.gov/pmc/">http://www.ncbi.nlm.nih.gov/pmc/</a>
PubMed Clinical Queries	<a href="http://www.ncbi.nlm.nih.gov/pubmed/clinical">http://www.ncbi.nlm.nih.gov/pubmed/clinical</a>
All Genetics & Medicine Resources...	<a href="http://www.ncbi.nlm.nih.gov/guide/genetics-medicine/">http://www.ncbi.nlm.nih.gov/guide/genetics-medicine/</a>
Genomes & Maps	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#genomes-maps">http://www.ncbi.nlm.nih.gov/pubmed/17951329#genomes-maps</a>
Database of Genomic Structural Variation (dbVar)	<a href="http://www.ncbi.nlm.nih.gov/dbvar">http://www.ncbi.nlm.nih.gov/dbvar</a>
Genome	<a href="http://www.ncbi.nlm.nih.gov/sites/genome">http://www.ncbi.nlm.nih.gov/sites/genome</a>
Genome Project	<a href="http://www.ncbi.nlm.nih.gov/bioproject/">http://www.ncbi.nlm.nih.gov/bioproject/</a>
All Genomes & Maps Resources...	<a href="http://www.ncbi.nlm.nih.gov/guide/genomes-maps/">http://www.ncbi.nlm.nih.gov/guide/genomes-maps/</a>
Homology	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#homology">http://www.ncbi.nlm.nih.gov/pubmed/17951329#homology</a>
BLAST Link (BLink)	<a href="http://www.ncbi.nlm.nih.gov/sutils/blink.cgi?mode=query">http://www.ncbi.nlm.nih.gov/sutils/blink.cgi?mode=query</a>
Protein Clusters	<a href="http://www.ncbi.nlm.nih.gov/proteinclusters">http://www.ncbi.nlm.nih.gov/proteinclusters</a>
All Homology Resources...	<a href="http://www.ncbi.nlm.nih.gov/guide/homology/">http://www.ncbi.nlm.nih.gov/guide/homology/</a>
Literature	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#literature">http://www.ncbi.nlm.nih.gov/pubmed/17951329#literature</a>
Journals in NCBI Databases	<a href="http://www.ncbi.nlm.nih.gov/nlmcatalog/journals">http://www.ncbi.nlm.nih.gov/nlmcatalog/journals</a>
MeSH Database	<a href="http://www.ncbi.nlm.nih.gov/mesh">http://www.ncbi.nlm.nih.gov/mesh</a>
NCBI Handbook	<a href="http://www.ncbi.nlm.nih.gov/books/NBK143764/">http://www.ncbi.nlm.nih.gov/books/NBK143764/</a>
NCBI Help Manual	<a href="http://www.ncbi.nlm.nih.gov/books/NBK3831/">http://www.ncbi.nlm.nih.gov/books/NBK3831/</a>
NCBI News	<a href="http://www.ncbi.nlm.nih.gov/books/NBK1969/">http://www.ncbi.nlm.nih.gov/books/NBK1969/</a>
PubMed Health	<a href="http://www.ncbi.nlm.nih.gov/pubmedhealth/">http://www.ncbi.nlm.nih.gov/pubmedhealth/</a>
All Literature Resources...	<a href="http://www.ncbi.nlm.nih.gov/guide/literature/">http://www.ncbi.nlm.nih.gov/guide/literature/</a>
Proteins	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#proteins">http://www.ncbi.nlm.nih.gov/pubmed/17951329#proteins</a>
Protein Database	<a href="http://www.ncbi.nlm.nih.gov/protein">http://www.ncbi.nlm.nih.gov/protein</a>
All Proteins Resources...	<a href="http://www.ncbi.nlm.nih.gov/guide/proteins/">http://www.ncbi.nlm.nih.gov/guide/proteins/</a>
Sequence Analysis	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#sequence-analysis">http://www.ncbi.nlm.nih.gov/pubmed/17951329#sequence-analysis</a>
All Sequence Analysis Resources...	<a href="http://www.ncbi.nlm.nih.gov/guide/sequence-analysis/">http://www.ncbi.nlm.nih.gov/guide/sequence-analysis/</a>
Taxonomy	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#taxonomy">http://www.ncbi.nlm.nih.gov/pubmed/17951329#taxonomy</a>
Taxonomy	<a href="http://www.ncbi.nlm.nih.gov/taxonomy">http://www.ncbi.nlm.nih.gov/taxonomy</a>
Taxonomy Browser	<a href="http://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Root">http://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Root</a>
Taxonomy Common Tree	<a href="http://www.ncbi.nlm.nih.gov/Taxonomy/CommonTree/wwwcmt.cgi">http://www.ncbi.nlm.nih.gov/Taxonomy/CommonTree/wwwcmt.cgi</a>
All Taxonomy Resources...	<a href="http://www.ncbi.nlm.nih.gov/guide/taxonomy/">http://www.ncbi.nlm.nih.gov/guide/taxonomy/</a>
Training & Tutorials	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#training-tutorials">http://www.ncbi.nlm.nih.gov/pubmed/17951329#training-tutorials</a>
NCBI Education Page	<a href="http://www.ncbi.nlm.nih.gov/education/">http://www.ncbi.nlm.nih.gov/education/</a>
All Training & Tutorials Resources...	<a href="http://www.ncbi.nlm.nih.gov/guide/training-tutorials/">http://www.ncbi.nlm.nih.gov/guide/training-tutorials/</a>
Variation	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#variation">http://www.ncbi.nlm.nih.gov/pubmed/17951329#variation</a>
Database of Single Nucleotide	<a href="http://www.ncbi.nlm.nih.gov/snp">http://www.ncbi.nlm.nih.gov/snp</a>

Shortcut Text	Internet Address
Polymorphisms (dbSNP)	
All Variation Resources...	<a href="http://www.ncbi.nlm.nih.gov/guide/variation/">http://www.ncbi.nlm.nih.gov/guide/variation/</a>
How To	<a href="http://www.ncbi.nlm.nih.gov/static/header_footer_ajax/submenu/#howto">http://www.ncbi.nlm.nih.gov/static/header_footer_ajax/submenu/#howto</a>
All How To	<a href="http://www.ncbi.nlm.nih.gov/guide/all/#howtos">http://www.ncbi.nlm.nih.gov/guide/all/#howtos</a>
Chemicals & Bioassays	<a href="http://www.ncbi.nlm.nih.gov/guide/chemicals-bioassays/#howtos">http://www.ncbi.nlm.nih.gov/guide/chemicals-bioassays/#howtos</a>
DNA & RNA	<a href="http://www.ncbi.nlm.nih.gov/guide/dna-rna/#howtos">http://www.ncbi.nlm.nih.gov/guide/dna-rna/#howtos</a>
Data & Software	<a href="http://www.ncbi.nlm.nih.gov/guide/data-software/#howtos">http://www.ncbi.nlm.nih.gov/guide/data-software/#howtos</a>
Domains & Structures	<a href="http://www.ncbi.nlm.nih.gov/guide/domains-structures/#howtos">http://www.ncbi.nlm.nih.gov/guide/domains-structures/#howtos</a>
Genes & Expression	<a href="http://www.ncbi.nlm.nih.gov/guide/genes-expression/#howtos">http://www.ncbi.nlm.nih.gov/guide/genes-expression/#howtos</a>
Genetics & Medicine	<a href="http://www.ncbi.nlm.nih.gov/guide/genetics-medicine/#howtos">http://www.ncbi.nlm.nih.gov/guide/genetics-medicine/#howtos</a>
Genomes & Maps	<a href="http://www.ncbi.nlm.nih.gov/guide/genomes-maps/#howtos">http://www.ncbi.nlm.nih.gov/guide/genomes-maps/#howtos</a>
Homology	<a href="http://www.ncbi.nlm.nih.gov/guide/homology/#howtos">http://www.ncbi.nlm.nih.gov/guide/homology/#howtos</a>
Literature	<a href="http://www.ncbi.nlm.nih.gov/guide/literature/#howtos">http://www.ncbi.nlm.nih.gov/guide/literature/#howtos</a>
Proteins	<a href="http://www.ncbi.nlm.nih.gov/guide/proteins/#howtos">http://www.ncbi.nlm.nih.gov/guide/proteins/#howtos</a>
Sequence Analysis	<a href="http://www.ncbi.nlm.nih.gov/guide/sequence-analysis/#howtos">http://www.ncbi.nlm.nih.gov/guide/sequence-analysis/#howtos</a>
Taxonomy	<a href="http://www.ncbi.nlm.nih.gov/guide/taxonomy/#howtos">http://www.ncbi.nlm.nih.gov/guide/taxonomy/#howtos</a>
Training & Tutorials	<a href="http://www.ncbi.nlm.nih.gov/guide/training-tutorials/#howtos">http://www.ncbi.nlm.nih.gov/guide/training-tutorials/#howtos</a>
Variation	<a href="http://www.ncbi.nlm.nih.gov/guide/variation/#howtos">http://www.ncbi.nlm.nih.gov/guide/variation/#howtos</a>
About NCBI Accesskeys	<a href="http://www.ncbi.nlm.nih.gov/guide/browsers/#accesskeys">http://www.ncbi.nlm.nih.gov/guide/browsers/#accesskeys</a>
	<a href="http://www.ncbi.nlm.nih.gov/account/settings/">http://www.ncbi.nlm.nih.gov/account/settings/</a>
My NCBI	<a href="http://www.ncbi.nlm.nih.gov/myncbi/">http://www.ncbi.nlm.nih.gov/myncbi/</a>
Sign in to NCBI	<a href="http://www.ncbi.nlm.nih.gov/account/?back_url=http%3A%2F%2Fwww.ncbi.nlm.nih.gov%2Fpubmed%2F17951329">http://www.ncbi.nlm.nih.gov/account/?back_url=http%3A%2F%2Fwww.ncbi.nlm.nih.gov%2Fpubmed%2F17951329</a>
Sign Out	<a href="http://www.ncbi.nlm.nih.gov/account/signout/?back_url=http%3A%2F%2Fwww.ncbi.nlm.nih.gov%2Fpubmed%2F17951329">http://www.ncbi.nlm.nih.gov/account/signout/?back_url=http%3A%2F%2Fwww.ncbi.nlm.nih.gov%2Fpubmed%2F17951329</a>
US National Library of Medicine	<a href="http://www.nlm.nih.gov/">http://www.nlm.nih.gov/</a>
National Institutes of Health	<a href="http://www.nih.gov/">http://www.nih.gov/</a>
	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17951329#">http://www.ncbi.nlm.nih.gov/pubmed/17951329#</a>
Advanced	<a href="http://www.ncbi.nlm.nih.gov/pubmed/advanced">http://www.ncbi.nlm.nih.gov/pubmed/advanced</a>
Help	<a href="http://www.ncbi.nlm.nih.gov/books/NBK3827/">http://www.ncbi.nlm.nih.gov/books/NBK3827/</a>
"SPAM" filtering software notice	<a href="http://www.ncbi.nlm.nih.gov/corehtml/query/MyNCBI/exquery/spam_note.html">http://www.ncbi.nlm.nih.gov/corehtml/query/MyNCBI/exquery/spam_note.html</a>
Noble D	<a href="http://www.ncbi.nlm.nih.gov/pubmed?term=Noble%20D%5BAuthor%5D&amp;cauthor=true&amp;cauthor_uid=17951329">http://www.ncbi.nlm.nih.gov/pubmed?term=Noble%20D%5BAuthor%5D&amp;cauthor=true&amp;cauthor_uid=17951329</a>
Blackwell Publishing	<a href="http://onlinelibrary.wiley.com/resolve/openurl?genre=article&amp;sid.nlm:pubmed&amp;issn=0958-0670&amp;date=2008&amp;volume=93&amp;issue=1&amp;spage=16">http://onlinelibrary.wiley.com/resolve/openurl?genre=article&amp;sid.nlm:pubmed&amp;issn=0958-0670&amp;date=2008&amp;volume=93&amp;issue=1&amp;spage=16</a>
HighWire	<a href="http://ep.physoc.org/cgi/pmidlookup?view=long&amp;pmid=17951329">http://ep.physoc.org/cgi/pmidlookup?view=long&amp;pmid=17951329</a>
EBSCO	<a href="http://openurl.ebscohost.com/linksvc/linking.aspx?genre=article&amp;sid=PubMed&amp;issn=0958-0670&amp;title=Exp%20Physiol&amp;volume=93&amp;issue=1&amp;spage=16&amp;atitle=Claude%20Bernard,%20the%20first%20systems%20biologist,%20and%20the%20future%20of%20physiology.&amp;aulast=Noble&amp;date=2008">http://openurl.ebscohost.com/linksvc/linking.aspx?genre=article&amp;sid=PubMed&amp;issn=0958-0670&amp;title=Exp%20Physiol&amp;volume=93&amp;issue=1&amp;spage=16&amp;atitle=Claude%20Bernard,%20the%20first%20systems%20biologist,%20and%20the%20future%20of%20physiology.&amp;aulast=Noble&amp;date=2008</a>
Ovid Technologies, Inc.	<a href="http://ovidsp.ovid.com/ovidweb.cgi?T=JS&amp;PAGE=linkout&amp;SEARCH=17951329.ui">http://ovidsp.ovid.com/ovidweb.cgi?T=JS&amp;PAGE=linkout&amp;SEARCH=17951329.ui</a>
COS Scholar Universe	<a href="http://www.scholaruniverse.com/ncbi-linkout?id=17951329">http://www.scholaruniverse.com/ncbi-linkout?id=17951329</a>
Labome Researcher Resource - ExactAntigen/Labome	<a href="http://www.labome.org/expert/uk/university/noble/d-noble-1214548.html">http://www.labome.org/expert/uk/university/noble/d-noble-1214548.html</a>
PubMed Commons home	<a href="http://www.ncbi.nlm.nih.gov/pubmedcommons/">http://www.ncbi.nlm.nih.gov/pubmedcommons/</a>
How to join PubMed Commons	<a href="http://www.ncbi.nlm.nih.gov/pubmedcommons/help/join/">http://www.ncbi.nlm.nih.gov/pubmedcommons/help/join/</a>
Add to Favorites	<a href="http://www.ncbi.nlm.nih.gov/myncbi/collections/">http://www.ncbi.nlm.nih.gov/myncbi/collections/</a>
Prologue: mind over molecule: activating biological demons.	<a href="http://www.ncbi.nlm.nih.gov/pubmed/18375570">http://www.ncbi.nlm.nih.gov/pubmed/18375570</a>
[The formation and background of Claude Bernard's general physiology].	<a href="http://www.ncbi.nlm.nih.gov/pubmed/21330780">http://www.ncbi.nlm.nih.gov/pubmed/21330780</a>
Claude Bernard and an introduction to the study of experimental medicine: "physical vitalism," dialectic, and epistemology.	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17576723">http://www.ncbi.nlm.nih.gov/pubmed/17576723</a>
Review Search for organising principles: understanding in systems biology.	<a href="http://www.ncbi.nlm.nih.gov/pubmed/17052112">http://www.ncbi.nlm.nih.gov/pubmed/17052112</a>

Shortcut Text	Internet Address
Review 'Integrative Physiology 2.0': integration of systems biology into physiology and its application to cardiovascular homeostasis.	<a href="http://www.ncbi.nlm.nih.gov/pubmed/21224228">http://www.ncbi.nlm.nih.gov/pubmed/21224228</a>
See reviews...	<a href="http://www.ncbi.nlm.nih.gov/pubmed/?linkname=pubmed_pubmed_reviews&amp;from_uid=17951329">http://www.ncbi.nlm.nih.gov/pubmed/?linkname=pubmed_pubmed_reviews&amp;from_uid=17951329</a>
See all...	<a href="http://www.ncbi.nlm.nih.gov/pubmed/?linkname=pubmed_pubmed&amp;from_uid=17951329">http://www.ncbi.nlm.nih.gov/pubmed/?linkname=pubmed_pubmed&amp;from_uid=17951329</a>
Extreme Physiology & Medicine: a new journal focussed on integrative human physiology under stress.	<a href="http://www.ncbi.nlm.nih.gov/pubmed/23849731">http://www.ncbi.nlm.nih.gov/pubmed/23849731</a>
A theory of biological relativity: no privileged level of causation.	<a href="http://www.ncbi.nlm.nih.gov/pubmed/23386960">http://www.ncbi.nlm.nih.gov/pubmed/23386960</a>
Ten challenges for systems medicine.	<a href="http://www.ncbi.nlm.nih.gov/pubmed/23060899">http://www.ncbi.nlm.nih.gov/pubmed/23060899</a>
See all...	<a href="http://www.ncbi.nlm.nih.gov/pubmed/?linkname=pubmed_pubmed_citedin&amp;from_uid=17951329">http://www.ncbi.nlm.nih.gov/pubmed/?linkname=pubmed_pubmed_citedin&amp;from_uid=17951329</a>
Related Citations	<a href="http://www.ncbi.nlm.nih.gov/pubmed/?LinkName=pubmed_pubmed&amp;from_uid=17951329">http://www.ncbi.nlm.nih.gov/pubmed/?LinkName=pubmed_pubmed&amp;from_uid=17951329</a>
Compound (MeSH Keyword)	<a href="http://www.ncbi.nlm.nih.gov/pccompound?LinkName=pubmed_pccompound_mesh&amp;from_uid=17951329">http://www.ncbi.nlm.nih.gov/pccompound?LinkName=pubmed_pccompound_mesh&amp;from_uid=17951329</a>
MedGen	<a href="http://www.ncbi.nlm.nih.gov/medgen?LinkName=pubmed_medgen&amp;from_uid=17951329">http://www.ncbi.nlm.nih.gov/medgen?LinkName=pubmed_medgen&amp;from_uid=17951329</a>
Substance (MeSH Keyword)	<a href="http://www.ncbi.nlm.nih.gov/pcsubstance?LinkName=pubmed_pcsubstance_mesh&amp;from_uid=17951329">http://www.ncbi.nlm.nih.gov/pcsubstance?LinkName=pubmed_pcsubstance_mesh&amp;from_uid=17951329</a>
Cited in PMC	<a href="http://www.ncbi.nlm.nih.gov/pmc/articles/pmid/17951329/citedby/?tool=pubmed">http://www.ncbi.nlm.nih.gov/pmc/articles/pmid/17951329/citedby/?tool=pubmed</a>
Clear	javascript:historyDisplayState('ClearHT')
Turn Off	javascript:historyDisplayState('HTOff')
Turn On	javascript:historyDisplayState('HTOn')
Claude Bernard, the first systems biologist, and the future of physiology.	<a href="http://www.ncbi.nlm.nih.gov/portal/utills/pageresolver.fcgi?recordid=1395526540592377">http://www.ncbi.nlm.nih.gov/portal/utills/pageresolver.fcgi?recordid=1395526540592377</a>
Attractor metabolic networks.	<a href="http://www.ncbi.nlm.nih.gov/portal/utills/pageresolver.fcgi?recordid=1395526465380218">http://www.ncbi.nlm.nih.gov/portal/utills/pageresolver.fcgi?recordid=1395526465380218</a>
The metabolic core and catalytic switches are fundamental elements in the self-r...	<a href="http://www.ncbi.nlm.nih.gov/portal/utills/pageresolver.fcgi?recordid=1395526350337645">http://www.ncbi.nlm.nih.gov/portal/utills/pageresolver.fcgi?recordid=1395526350337645</a>
Philosophical basis and some historical aspects of systems biology: from Hegel t...	<a href="http://www.ncbi.nlm.nih.gov/portal/utills/pageresolver.fcgi?recordid=1395526305563159">http://www.ncbi.nlm.nih.gov/portal/utills/pageresolver.fcgi?recordid=1395526305563159</a>
philosophical basis AND systems biology (5)	<a href="http://www.ncbi.nlm.nih.gov/portal/utills/pageresolver.fcgi?recordid=1395526296804682">http://www.ncbi.nlm.nih.gov/portal/utills/pageresolver.fcgi?recordid=1395526296804682</a>
See more...	<a href="http://www.ncbi.nlm.nih.gov/sites/myncbi/recentactivity">http://www.ncbi.nlm.nih.gov/sites/myncbi/recentactivity</a>
NCBI	<a href="http://www.ncbi.nlm.nih.gov/guide/">http://www.ncbi.nlm.nih.gov/guide/</a>
Write to the Help Desk	<a href="http://www.ncbi.nlm.nih.gov/sites/ehelp?&amp;Ncbi_App=entrez&amp;Db=pubmed&amp;Page=abstract&amp;Snapshot=/projects/entrez/pubmed/PubMedGroup@1.47&amp;Time=2014-03-22T18:15:40-04:00&amp;Host=portal104&amp;Data=+NCBI_Phid:+CE8B076232E0B6C10000000000D4E57;+PageURL:+http://www.ncbi.nlm.nih.gov/pubmed/17951329;">http://www.ncbi.nlm.nih.gov/sites/ehelp?&amp;Ncbi_App=entrez&amp;Db=pubmed&amp;Page=abstract&amp;Snapshot=/projects/entrez/pubmed/PubMedGroup@1.47&amp;Time=2014-03-22T18:15:40-04:00&amp;Host=portal104&amp;Data=+NCBI_Phid:+CE8B076232E0B6C10000000000D4E57;+PageURL:+http://www.ncbi.nlm.nih.gov/pubmed/17951329;</a>
PubMed	<a href="http://www.ncbi.nlm.nih.gov/pubmed/">http://www.ncbi.nlm.nih.gov/pubmed/</a>
Bookshelf	<a href="http://www.ncbi.nlm.nih.gov/books/">http://www.ncbi.nlm.nih.gov/books/</a>
Nucleotide	<a href="http://www.ncbi.nlm.nih.gov/nucleotide/">http://www.ncbi.nlm.nih.gov/nucleotide/</a>
Genome	<a href="http://www.ncbi.nlm.nih.gov/genome/">http://www.ncbi.nlm.nih.gov/genome/</a>
SNP	<a href="http://www.ncbi.nlm.nih.gov/snp/">http://www.ncbi.nlm.nih.gov/snp/</a>
Gene	<a href="http://www.ncbi.nlm.nih.gov/gene/">http://www.ncbi.nlm.nih.gov/gene/</a>
Protein	<a href="http://www.ncbi.nlm.nih.gov/protein/">http://www.ncbi.nlm.nih.gov/protein/</a>
PubChem	<a href="http://pubchem.ncbi.nlm.nih.gov/">http://pubchem.ncbi.nlm.nih.gov/</a>
Human Genome	<a href="http://www.ncbi.nlm.nih.gov/genome/guide/human/">http://www.ncbi.nlm.nih.gov/genome/guide/human/</a>
Mouse Genome	<a href="http://www.ncbi.nlm.nih.gov/genome/guide/mouse/">http://www.ncbi.nlm.nih.gov/genome/guide/mouse/</a>
Sequence Read Archive	<a href="http://www.ncbi.nlm.nih.gov/Traces/sra/">http://www.ncbi.nlm.nih.gov/Traces/sra/</a>
About NCBI	<a href="http://www.ncbi.nlm.nih.gov/About/">http://www.ncbi.nlm.nih.gov/About/</a>
Research at NCBI	<a href="http://www.ncbi.nlm.nih.gov/research/">http://www.ncbi.nlm.nih.gov/research/</a>
NCBI News	<a href="http://www.ncbi.nlm.nih.gov/news/">http://www.ncbi.nlm.nih.gov/news/</a>
NCBI FTP Site	<a href="http://www.ncbi.nlm.nih.gov/Ftp/">http://www.ncbi.nlm.nih.gov/Ftp/</a>

Shortcut Text	Internet Address
NCBI on Facebook	<a href="https://www.facebook.com/ncbi.nlm">https://www.facebook.com/ncbi.nlm</a>
NCBI on Twitter	<a href="https://twitter.com/ncbi">https://twitter.com/ncbi</a>
NCBI on YouTube	<a href="http://www.youtube.com/ncbinlm">http://www.youtube.com/ncbinlm</a>
privacy policy	<a href="http://www.nlm.nih.gov/privacy.html">http://www.nlm.nih.gov/privacy.html</a>
DHHS	<a href="http://www.dhhs.gov/">http://www.dhhs.gov/</a>
USA.gov	<a href="http://www.usa.gov/">http://www.usa.gov/</a>
Copyright	<a href="http://www.ncbi.nlm.nih.gov/About/disclaimer.html">http://www.ncbi.nlm.nih.gov/About/disclaimer.html</a>
Disclaimer	<a href="http://www.ncbi.nlm.nih.gov/About/disclaimer.html#disclaimer">http://www.ncbi.nlm.nih.gov/About/disclaimer.html#disclaimer</a>
Browsers	<a href="http://www.ncbi.nlm.nih.gov/guide/browsers/">http://www.ncbi.nlm.nih.gov/guide/browsers/</a>
Accessibility	<a href="http://www.nlm.nih.gov/accessibility.html">http://www.nlm.nih.gov/accessibility.html</a>
Contact	<a href="http://www.ncbi.nlm.nih.gov/About/glance/contact_info.html">http://www.ncbi.nlm.nih.gov/About/glance/contact_info.html</a>