Ontology of Sensors: Some Examples from Biology

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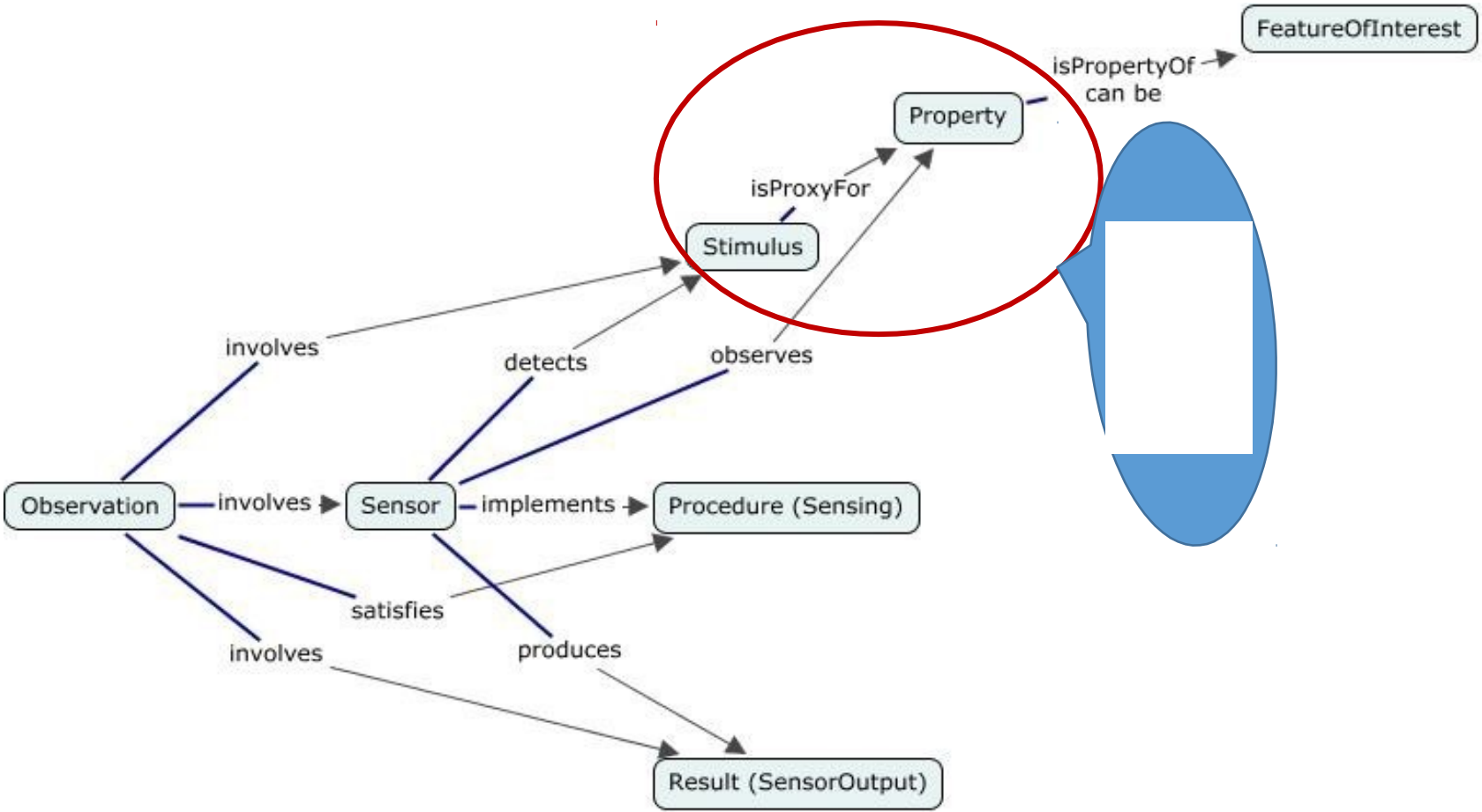
National Center for Ontological Research (NCOR)

University at Buffalo

An Introduction to "Beyond Semantic Sensor Network Ontologies (SSNO)“

Ontology Summit 2015 Track B Internet of Things: Toward Smart Networked Systems and Societies

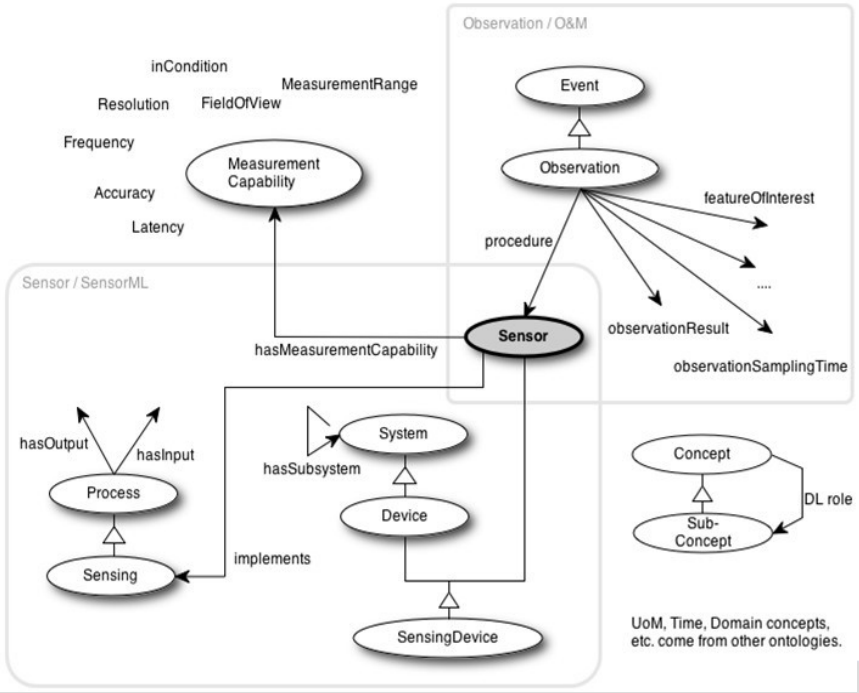
The *Stimulus-Sensor-Observation* Ontology Design Pattern



Ontology Summit 2015: Internet of Things: Toward Smart Networked Systems and Societies

Semantic Sensor Network Ontology:

Past, Present, and Future



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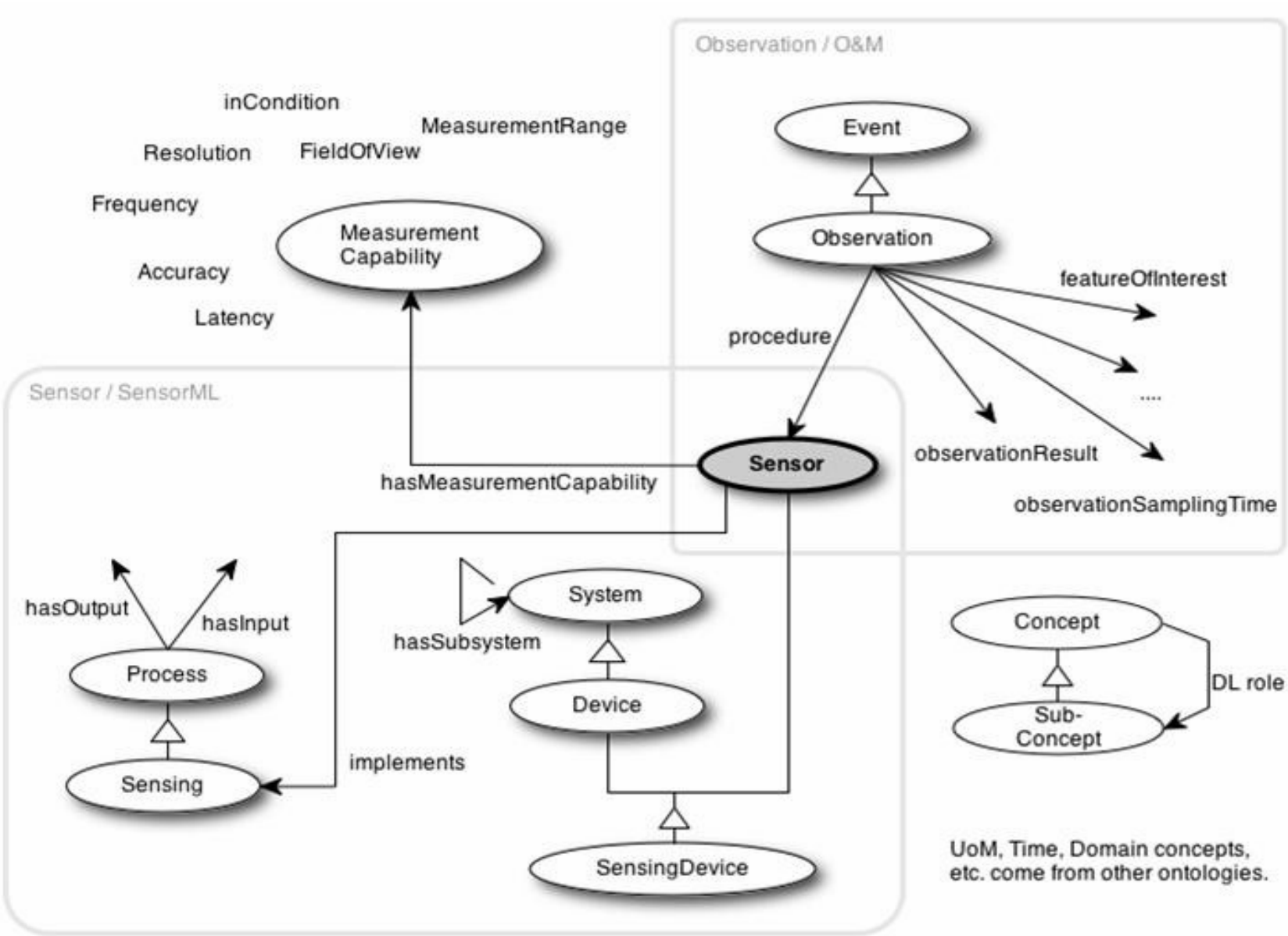
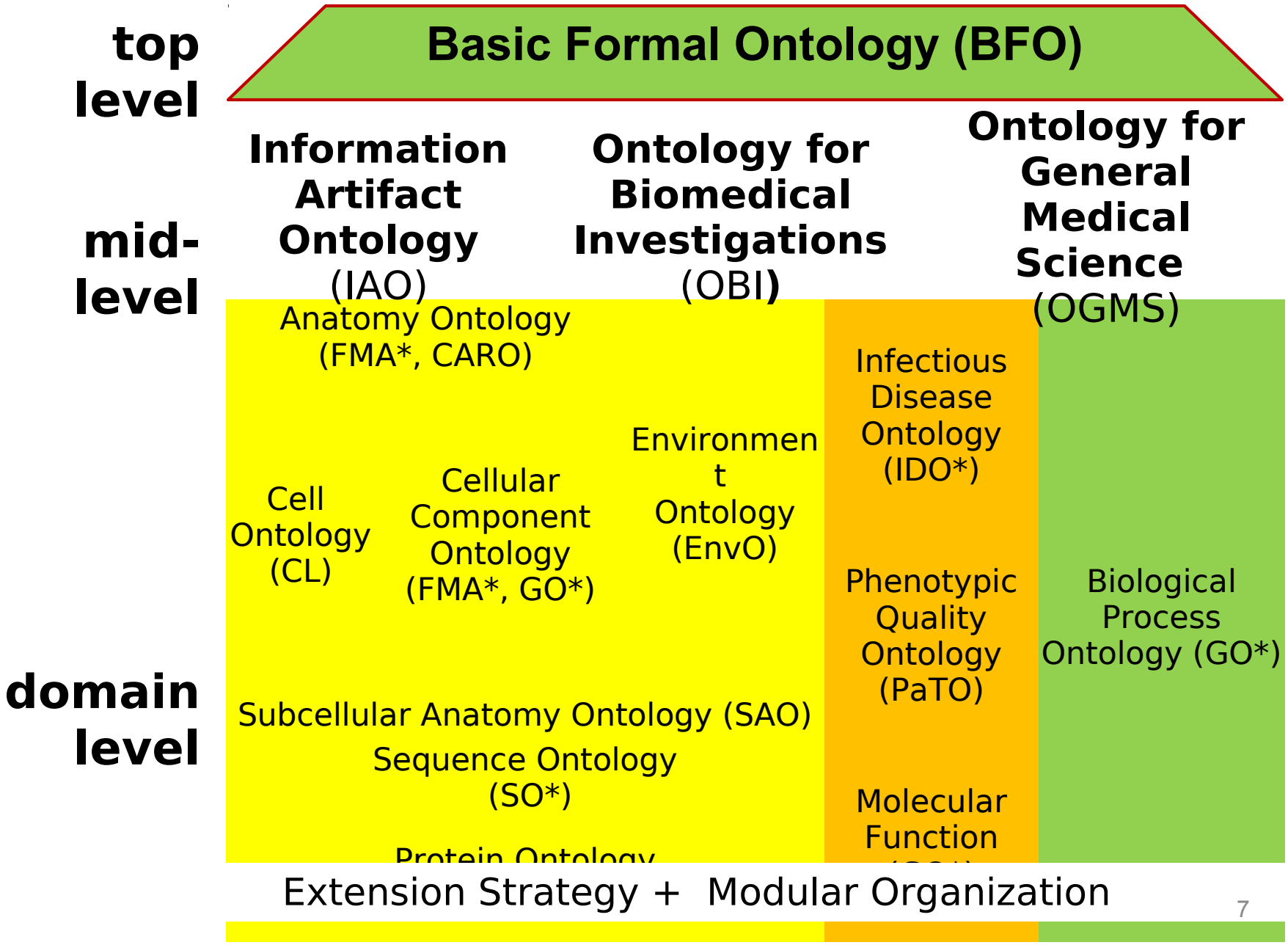
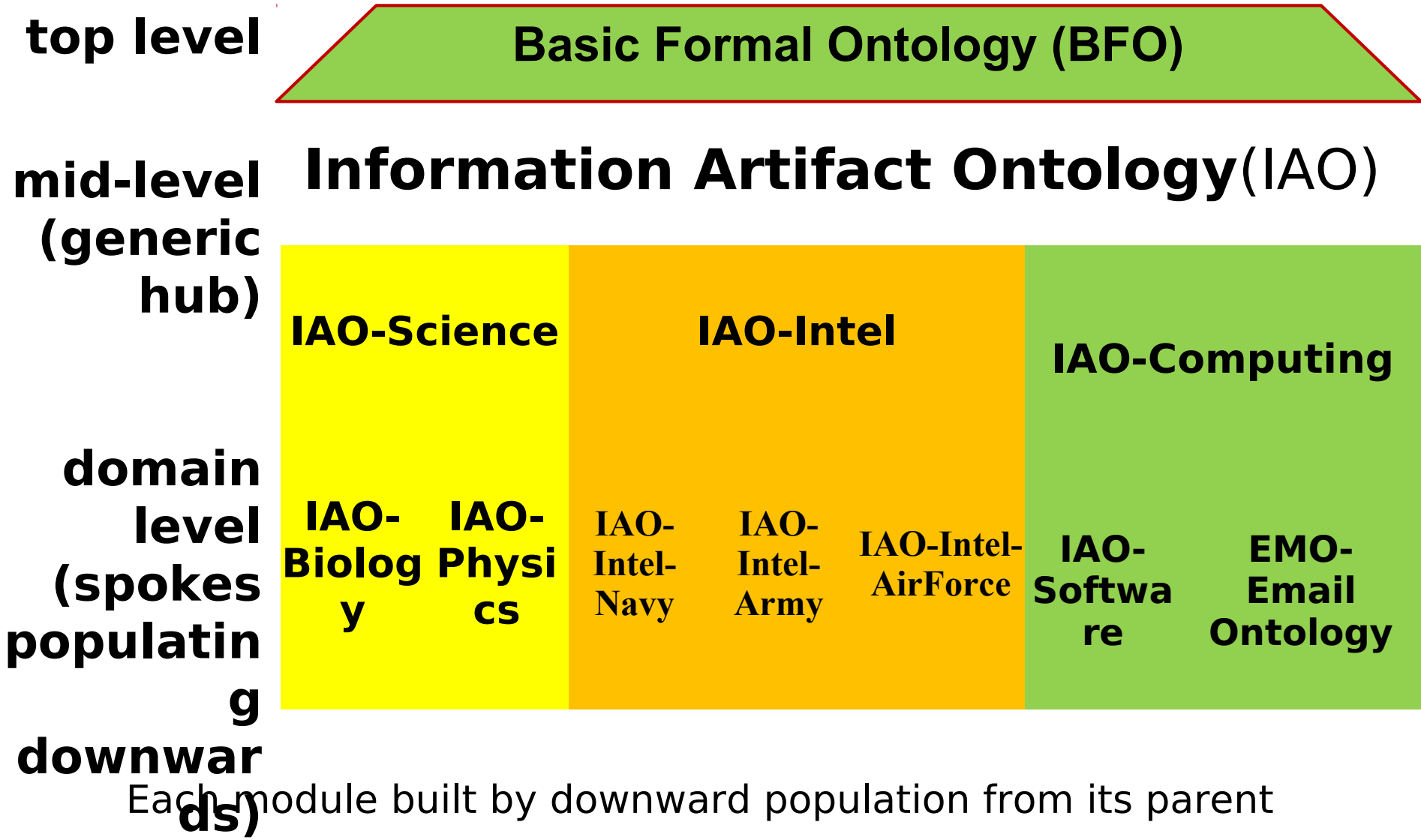

Observation / O&M
inCondition
MeasurementRange
Resolution
FieldOfView
Frequency
Measurement Capability
Accuracy
Latency
Event
Observation
featureOfInterest
procedure
....
observationResult
observationSamplingTime
Sensor / SensorML
Sensor
hasMeasurementCapability
hasOutput
hasInput
Process
Sensing
implements
System
hasSubsystem
Device
SensingDevice
Concept
DL role
Sub-Concept
UoM, Time, Domain concepts, etc. come from other ontologies.
Also adding:
physical properties, power use, connectors, lifetime, etc (of devices/systems)
mobility, availability, operational ranges, callibration, ...

RELATION TO TIME / GRANULARITY	CONTINUANT			OCCURRENT	
	INDEPENDENT		DEPENDENT		
ORGAN AND ORGANISM	Organism (NCBI Taxonomy)	Anatomical Entity (FMA, CARO)	Organ Function (FMP, CPRO)	Phenotypic Quality (PaTO)	**Biological Process** (GO)
CELL AND CELLULAR COMPONENT	Cell (CL)	**Cellular Component** (FMA, GO)	Cellular Function (GO)		
MOLECULE	Molecule (ChEBI, SO, RnaO, PrO)		**Molecular Function** (GO)		Molecular Process (GO)

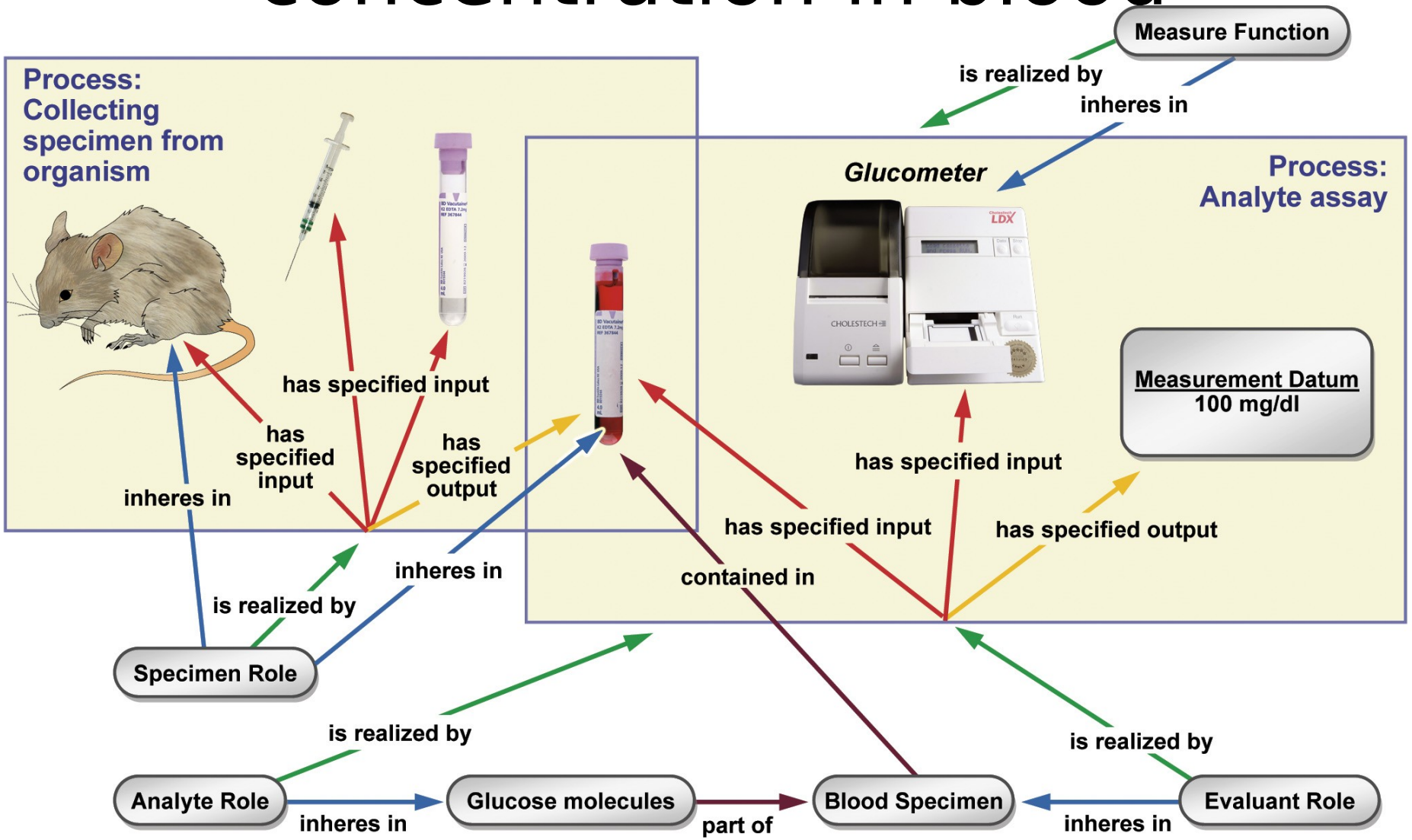
Open Biological and Biomedical Ontologies (OBO) Foundry (http://obofoundry.org)


top level
Basic Formal Ontology (BFO)
mid-level
Information Artifact Ontology (IAO)
Ontology for Biomedical Investigations (OBI)
Ontology for General Medical Science (OGMS)
domain level
Anatomy Ontology (FMA*, CARO)
Cell Ontology (CL)
Cellular Component Ontology (FMA*, GO*)
Environment Ontology (EnvO)
Infectious Disease Ontology (IDO*)
Phenotypic Quality Ontology (PaTO)
Biological Process Ontology (GO*)
Subcellular Anatomy Ontology (SAO)
Sequence Ontology (SO*)
Molecular Function
Protein Ontology
Extension Strategy + Modular Organization

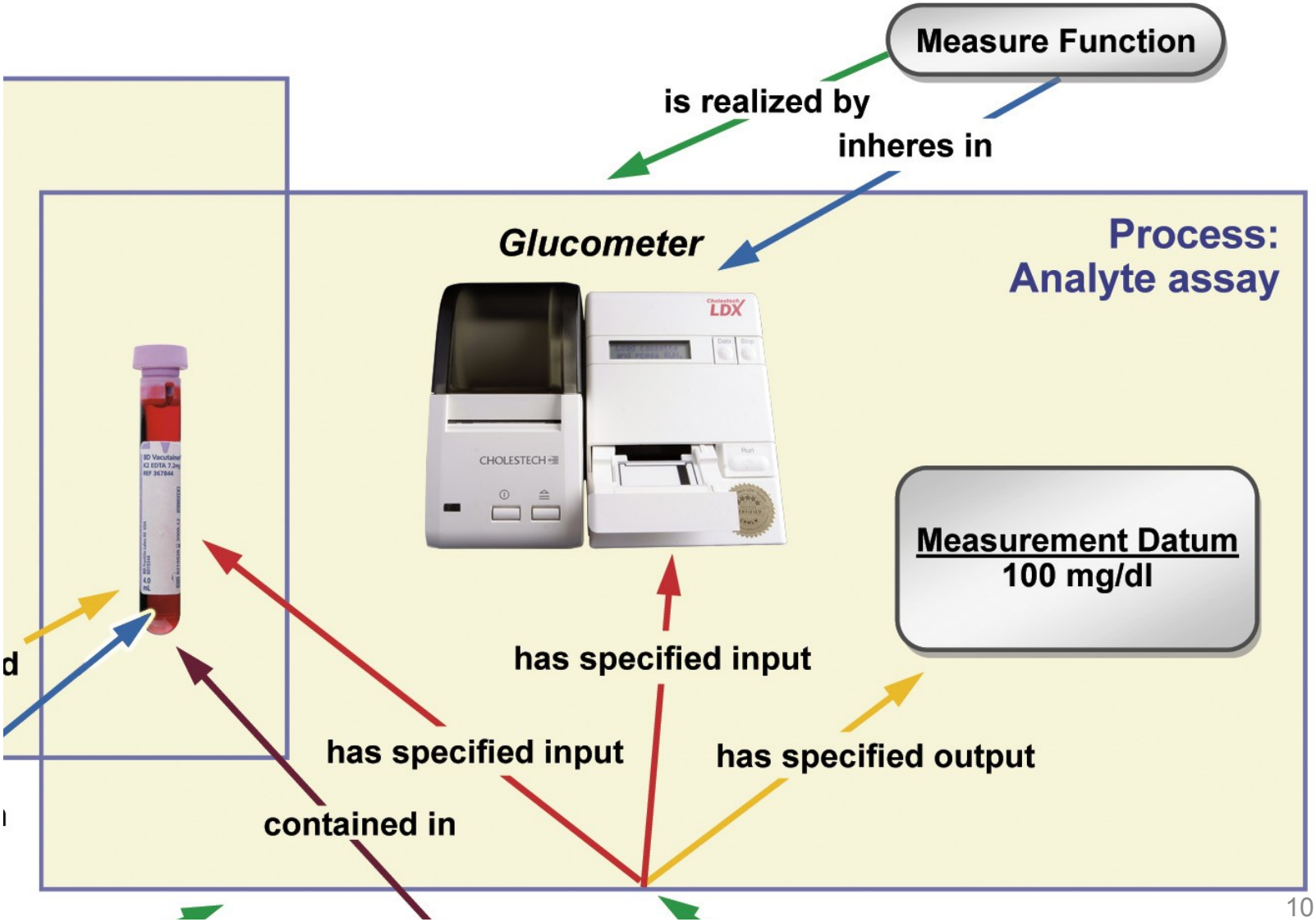


Each module built by downward population from its parent

Measuring the glucose concentration in blood



Ontology for Biomedical Investigations



Brinkman *et al. Journal of Biomedical Semantics* 2010, **1**(Suppl 1):S7
http://www.jbiomedsem.com/content/1/S1/S7

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PROCEEDINGS Open Access

Modeling biomedical experimental processes with OBI

Ryan R Brinkman[1], Mélanie Courtot[1], Dirk Derom[2], Jennifer M Fostel[3], Yongqun He[4], Phillip Lord[5], James Malone[6], Helen Parkinson[6], Bjoern Peters[7], Philippe Rocca-Serra[6], Alan Ruttenberg[8], Susanna-Assunta Sansone[6], Larisa N Soldatova[9*], Christian J Stoeckert Jr.[10], Jessica A Turner[11], Jie Zheng[10], the OBI consortium

From Bio-Ontologies 2009: Knowledge in Biology
Stockholm, Sweden. 28 June 2009

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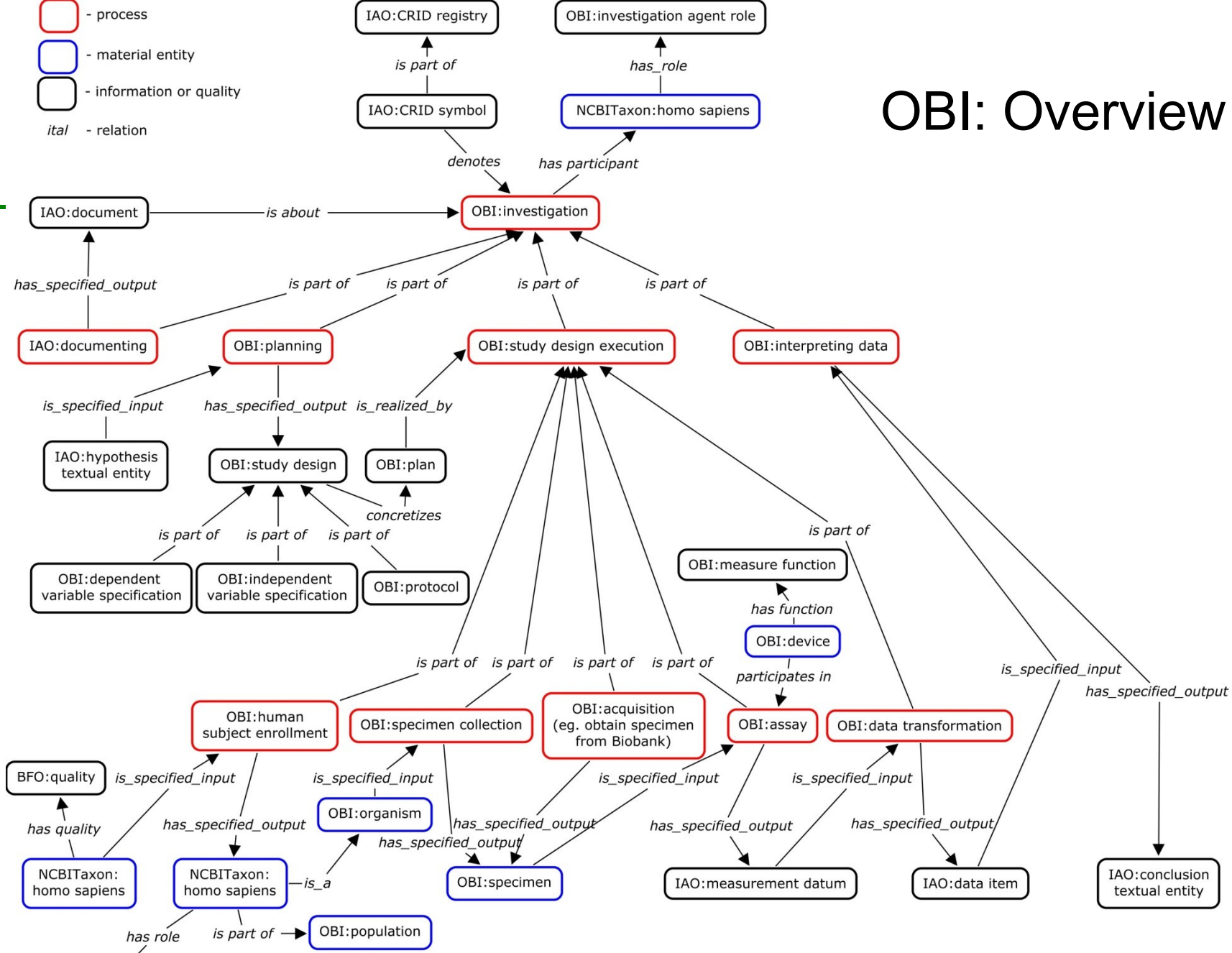
Abstract

Background: Experimental descriptions are typically stored as free text without using standardized terminology, creating challenges in comparison, reproduction and

http://www.jbiomedsem.com/content/1/S1/S7

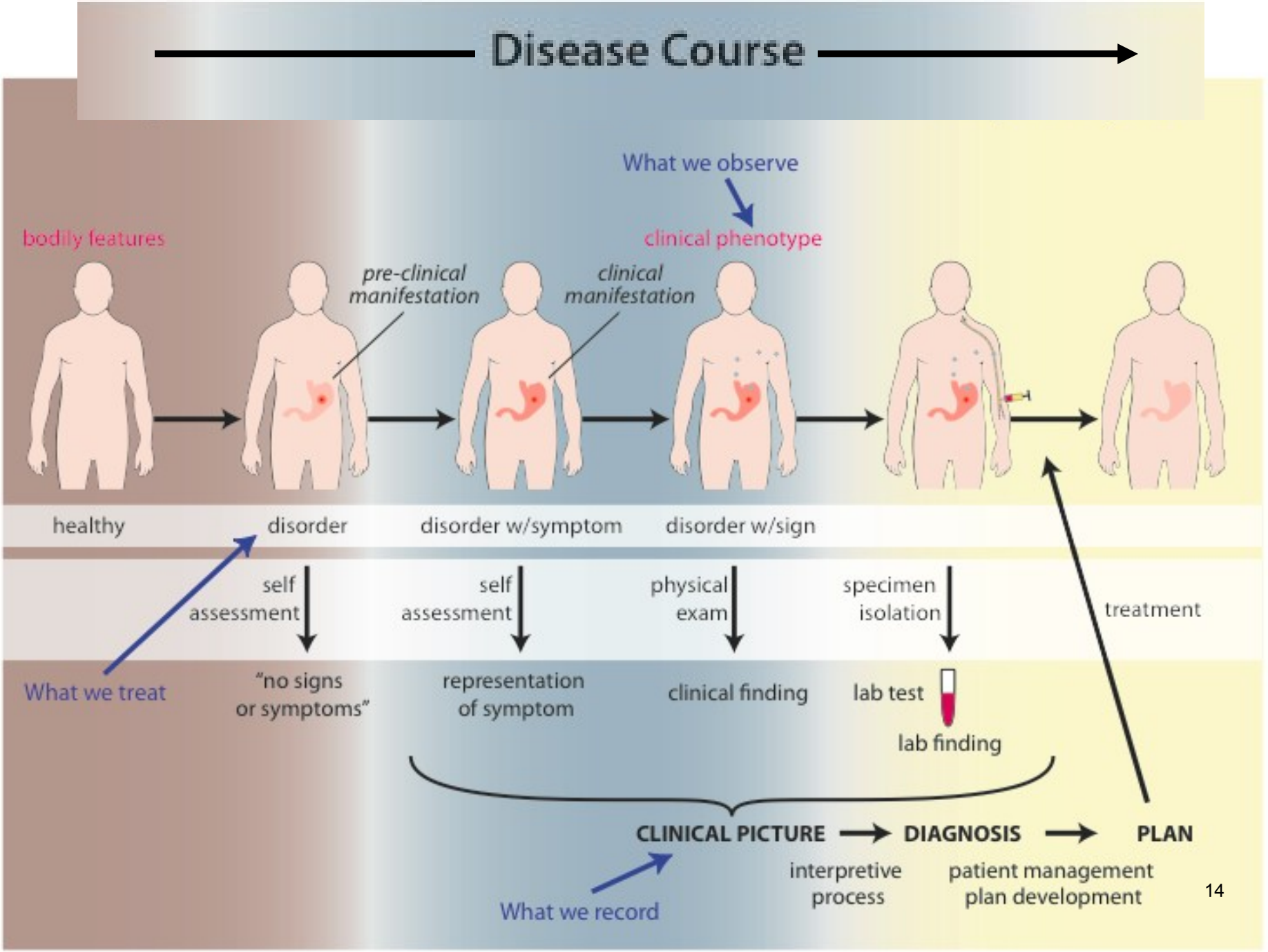
OBI: Overview



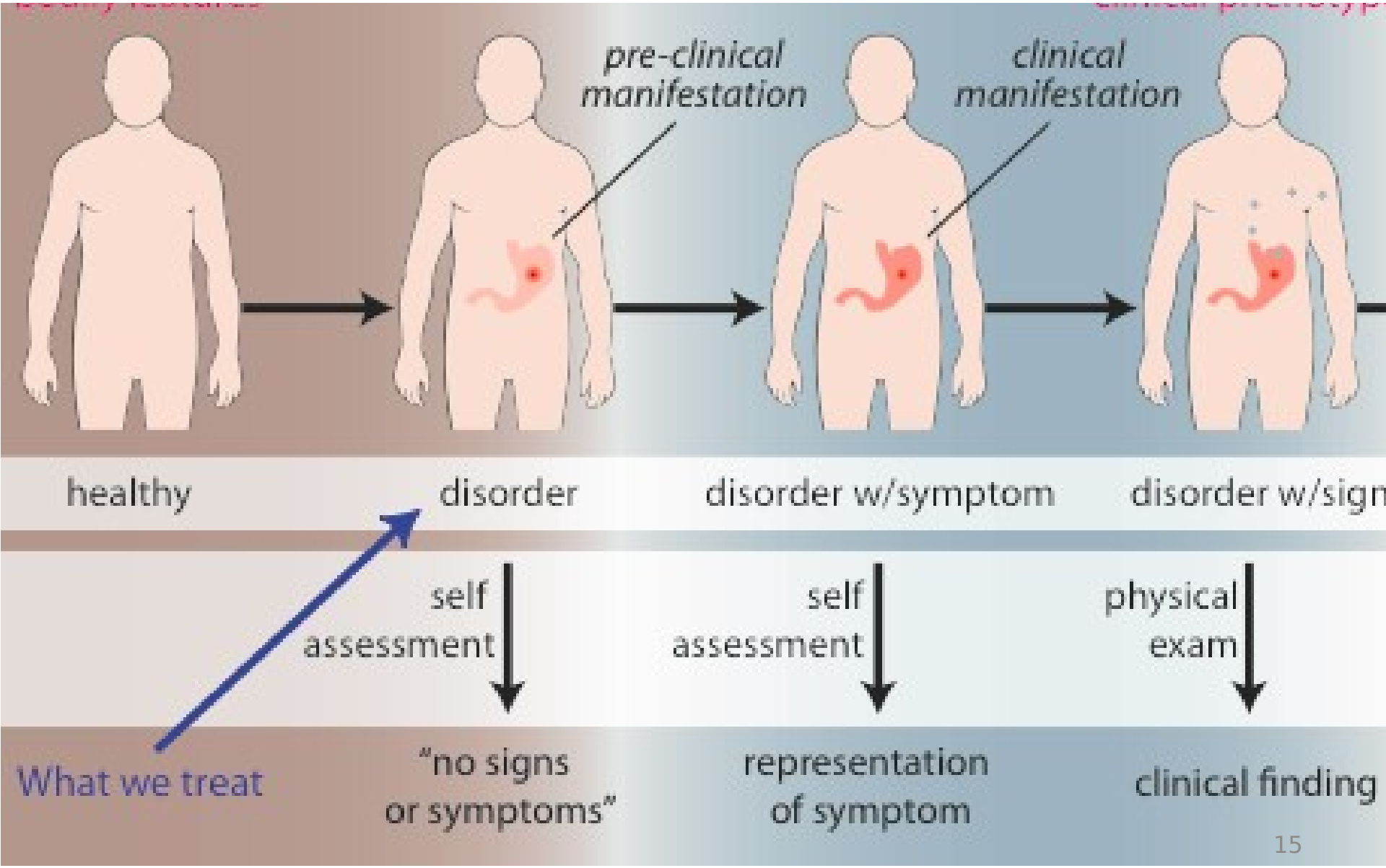
OGMS

Ontology for General Medical Science,

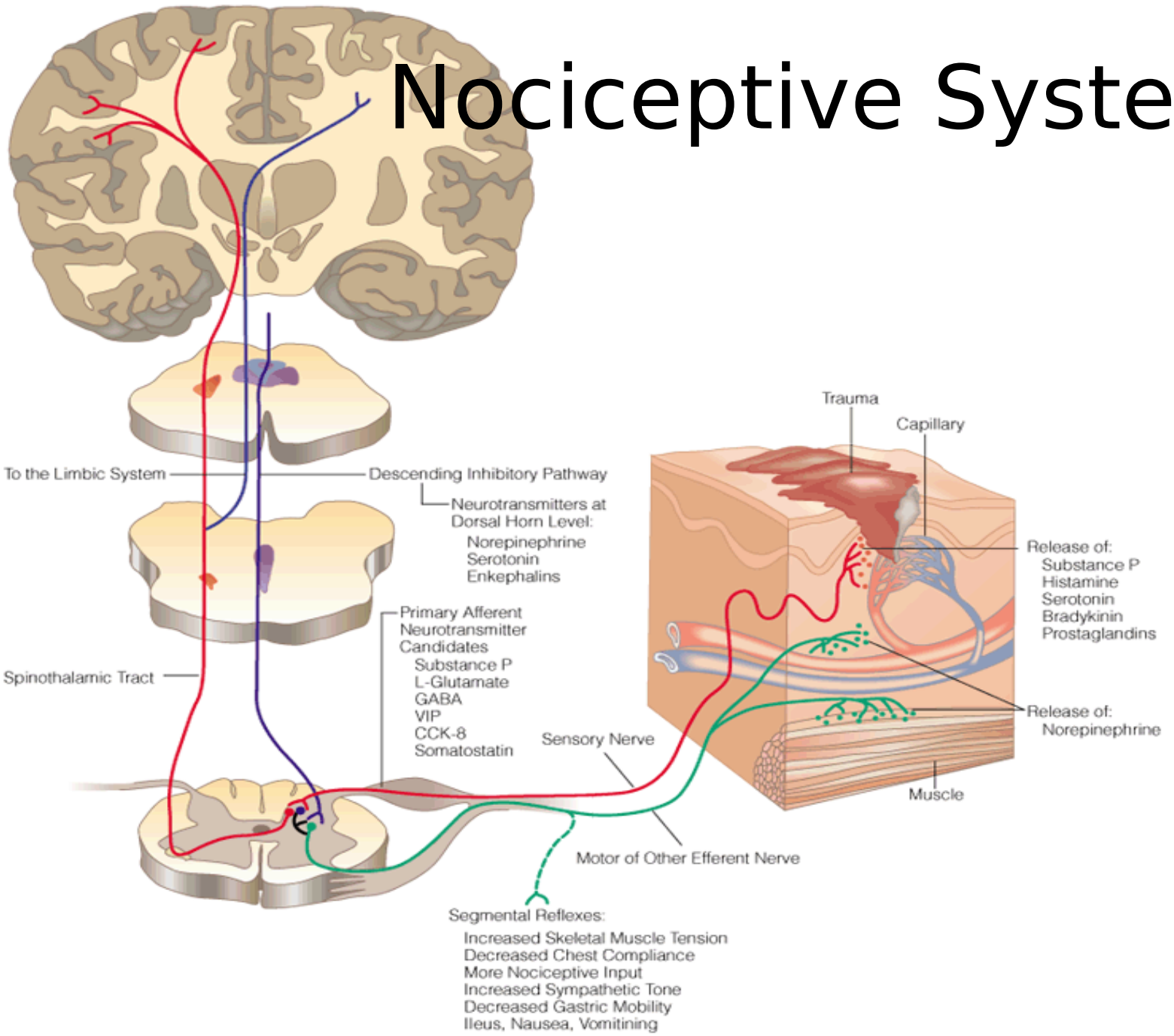
http://code.google.com/p/ogms/


Disease Course
What we observe
bodily features
clinical phenotype
pre-clinical manifestation
clinical manifestation
healthy
disorder
disorder w/symptom
disorder w/sign
self assessment
self assessment
physical exam
specimen isolation
treatment
What we treat
"no signs or symptoms"
representation of symptom
clinical finding
lab test
lab finding
CLINICAL PICTURE
DIAGNOSIS
PLAN
interpretive process
patient management plan development
What we record

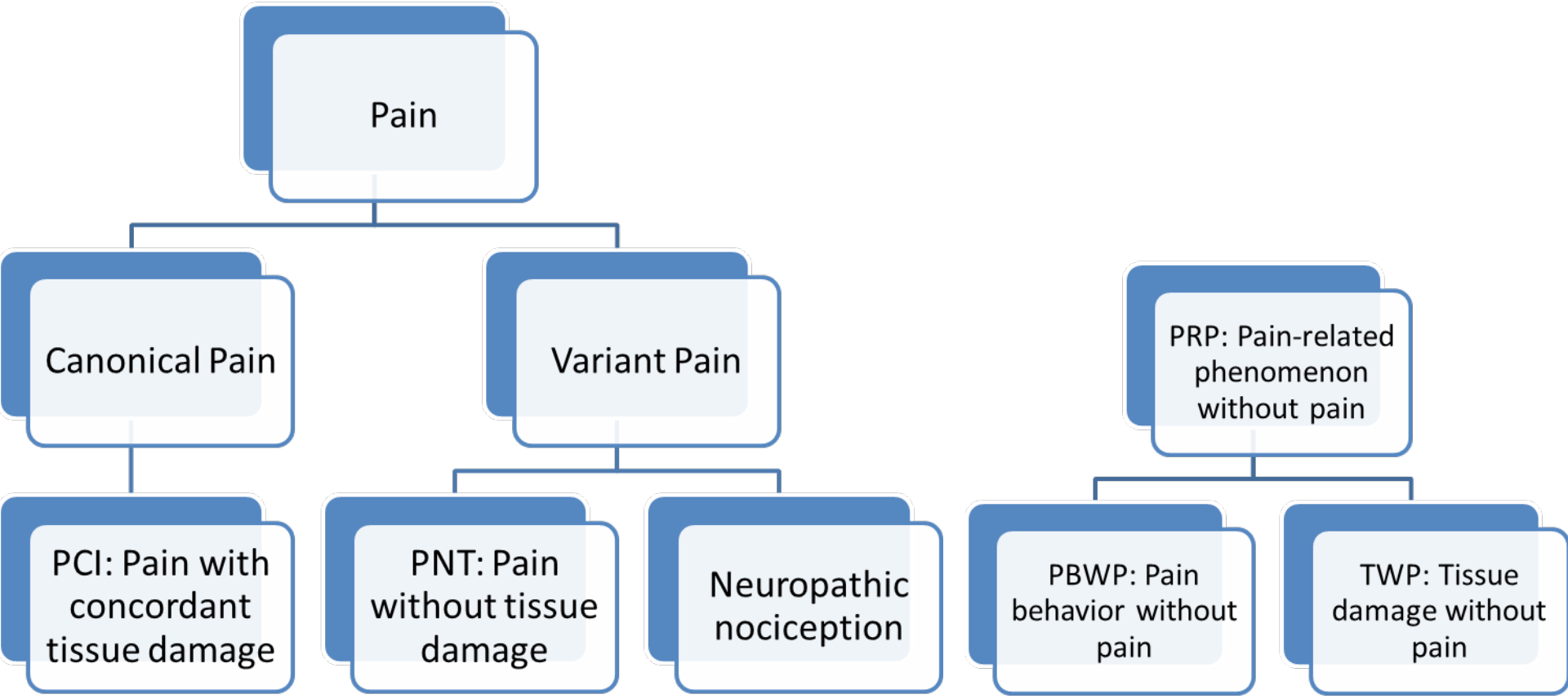
Big Picture


pre-clinical manifestation
clinical manifestation
healthy
disorder
disorder w/symptom
disorder w/sign
self assessment
self assessment
physical exam
What we treat
"no signs or symptoms"
representation of symptom
clinical finding

Nociceptive System



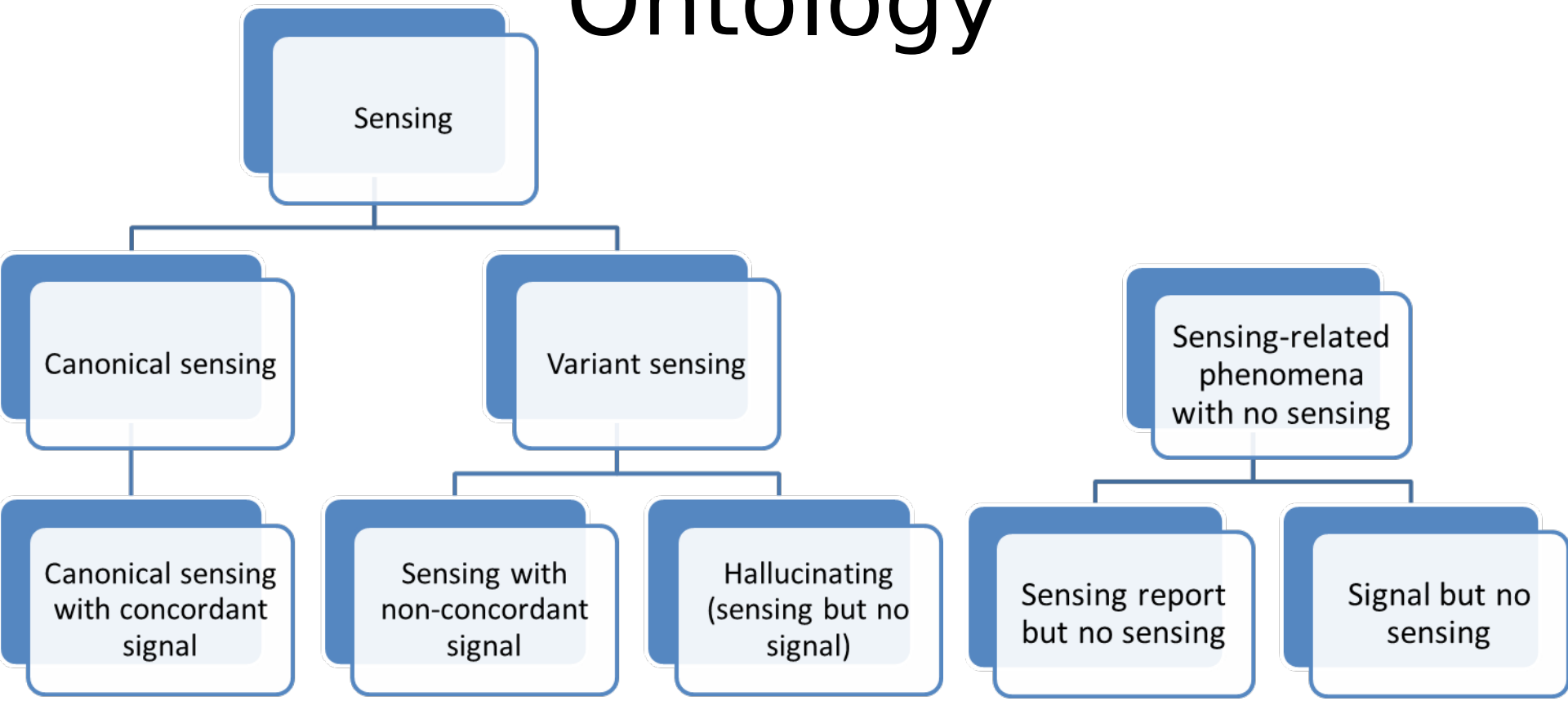
Pain Ontology



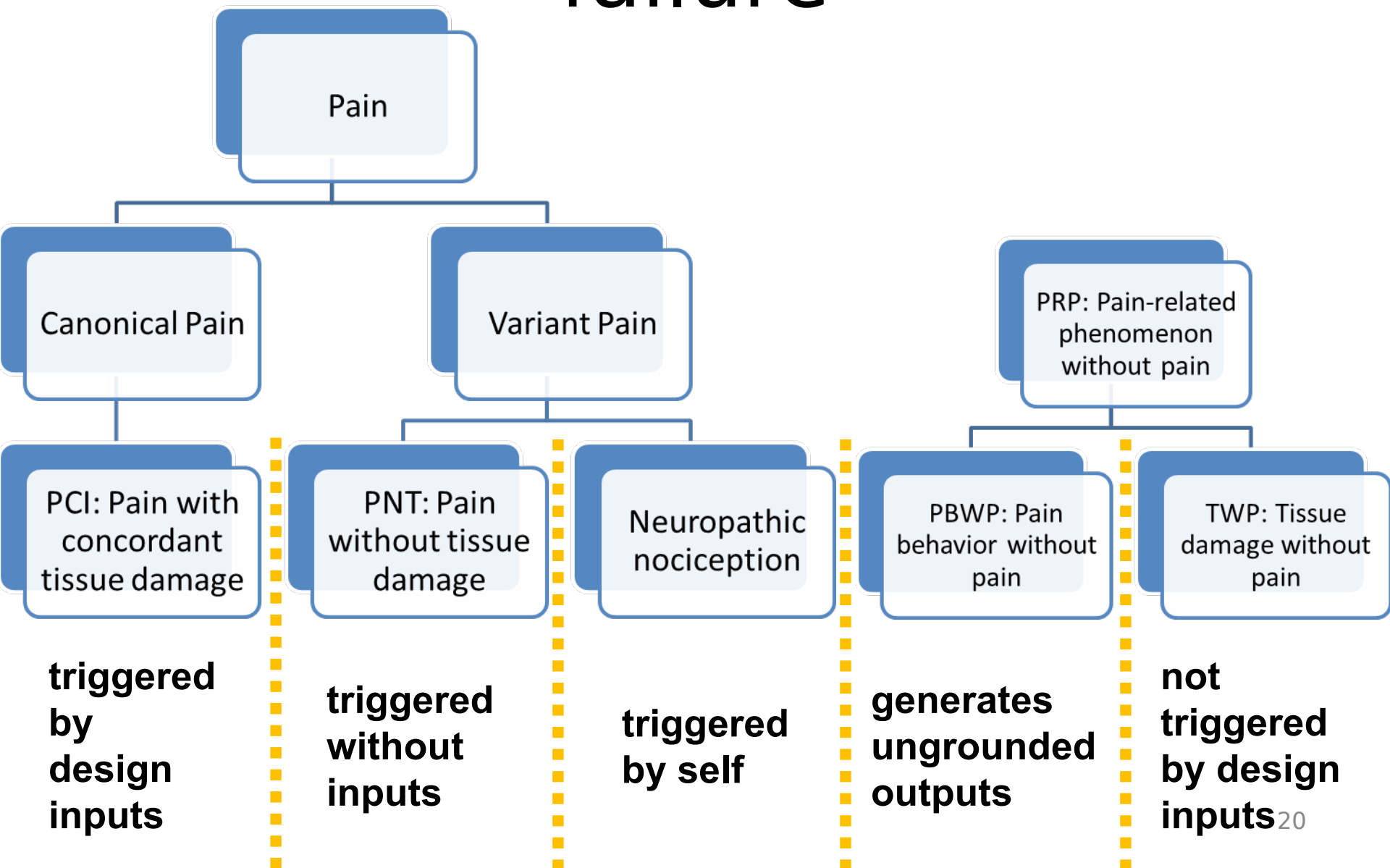
http://philpapers.org/archive/SMITAO-12.pdf

	Symptoms	Signs	Physical Basis	Examples
Canonical Pain				
PCT: Pain with concordant tissue damage	Pain	Manifestation of tissue damage Signals sent to nociceptive system Activation of emotion- generating brain centers, which can produce increased heart rate, blood pressure, galvanic skin response.	Peripheral tissue damage Intact nociceptive system	Primary sunburn Pain from strained muscle Pain from fracture Pulpitis
Variant Pain				
PNT: pain without concordant tissue damage	Pain	Manifestation of some disorder in the patient Signals sent to nociceptive system Patient reports of pain are either exaggerated or muted relative to disorder Activation of emotion generating brain centers	Physical disorder of amplitude control mechanisms associated with the nociceptive system Intact nociceptive system	Myofascial pain disorder Tension-type headache Chronic back pain
NN: neuro-pathic nociception	Pain	Neurological test confirming nerve damage	Disorder in the nociceptive system	Trigeminal neuralgia Post-herpetic neuralgia Diabetic neuropathy Central pain
PRP: Pain-Related Phenomena Without Pain				
PBWP: pain behavior without pain	Aaargh!	Report of pain Sick role behaviors accompanied by normal clinical examination Grossly exaggerated pain behaviors Identified external incentives	Mental states such as anxiety, rather than peripheral tissue locus Disordered emotional or cognitive systems misinterpreting sensory signals	Factitious pain Malingering Anxiety-induced pain report
TWP: tissue-damage without pain	No pain	Manifestation of tissue damage normally of the sort to cause pain	Suppression of pain system by one or other mechanism	Stress associated with sudden emergencies Physiological damping of the pain process caused by endorphins Placebo-induced opioid analgesia Genetic insensitivity to pain

The Pain Ontology as subtype of Sensing Ontology



Four types of (pain) sensor failure



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Research

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Foundations for a realist ontology of mental disease

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Journal of Biomedical Semantics 2010, 1:10 doi:10.1186/2041-1480-1-10