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9 Appendix

H. Hashemi Farzaneh and U. Lindemann, *A Practical Guide to Bio-inspired Design*, https://doi.org/10.1007/978-3-662-57684-7

9.1 Collections of Biological Inspirations

Author/ Editor	Title	Year	Type of literature	Reference	Categories of bio-inspired design
Nachtigall, Wisser	Bionics by Examples	2015	Book	Cham: Springer	Historical examples, materials and structures, styling and design, construction and equipment, building and climatization, robotics and locomotion, sensors and neuronal control, anthropo- and biomedical technology, procedures and processes, evolution and optimization, systems and organization
Malik	Bionics-Fascination of Nature	2007	Book	Munich: MCB	316 image-text pages of examples: historical examples, robotics, locomotion, sensors, neuronal control, communication, organizational structures, self-organization, materials, structures, surfaces, evolution, optimization, intelligence and creativity
Kapsali	Biomimetics for Designers: Applying Nature's Processes & Materials in the Real World	2016	Book	London: Thames and Hudson	Historical examples, shapes, surfaces, structures, making, towards 4D designs
Xia	Biomimetic Principles and Design of Advanced Engineering Materials	2016	Book	New York: John Wiley & Sons	Material with mechanical and functional properties, surfaces and processes
Bennings	Bionics: Nature as a Model	1993	Book	Munich:Pro Futura	Image-text pages of examples in different disciplines: structures, surfaces, organizational structures, self-organisation, materials, energy supply, design, robotics, locomotion, light, sensors, manage compression, heat protection, evolution, optimization, processes, tools
Mano	Biomimetic Approaches for Biomaterials Development	2012	Edited book	Weinheim: Wiley-VCH	Material and surfaces

Author/ Editor	**Title**	**Year**	**Type of literature**	**Reference**	**Categories of bio-inspired design**
Bar-Cohen	Biomimetics: Biologically Inspired Technologies	2005	Edited book	Boca Raton: CRC Press,	Historical examples, material and surfaces, robotics and automation, evolution and optimization, strategies and mechanism, structures, sensors
Mukherjee	Biomimetics : Learning from Nature	2010	Edited book	London: InTech	Materials and surfaces, energy conversion, neuronal control, functions, chemical reactions, self-organization, robotics, locomotion, structures
Lakhtakia, Martín-Palma	Engineered Biomimicry	2013	Edited book	New York: Elsevier	Sensors, materials, robotics, fabrication, surfaces, structures, self-organization, evolution and optimization
Swiegers	Bioinspiration and Biomimicry in Chemistry: Reverse-Engineering Nature	2012	Edited book	New York: John Wiley & Sons	Self-assembled structures and systems, molecular machines, materials, chemistry, catalysis, surfaces, energy systems
Bar-Cohen, Breazeal	Biologically Inspired Intelligent Robots	2003	Edited book	Bellingham, WA: SPIE Press Monograph Vol. PM122, SPIE Publ.	Historical examples, robotics, materials, actuators, sensors, structures, functionality, control, intelligence, and autonomy
Allen	Bulletproof Feathers: How Science Uses Nature's Secrets to Design Cutting-Edge Technology	2010	Edited book	Chicago: University of Chicago Press	Marine dynamics, robotics, acoustics, cooperative behaviour, locomotion, materials and design

Author/ Editor	Title	Year	Type of literature	Reference	Categories of bio-inspired design
Gorb	Biologically-Inspired Systems	2011 2014 2015 2016 2017	Book Series	Cham: Springer	Description of different biological systems as inspiration for technical designs: Volume 1: Insect Biotechnology, Vilcinskas, 2011; Volume 2: Biotechnology of Silk, Asakura, Miller, 2014; Volume 3: Evolution of Lightweight Structures, Hamm, 2015; Volume 4: Biological Materials of Marine Origin, Ehrlich, 2015; Volume 5: Attachment Structures and Adhesive Secretions in Arachnids, Wolff, Gorb, 2016; Volume 6: Biomimetic Research for Architecture and Building Construction, Knippers, Nickel, Speck, 2016; Volume 7: Bio-inspired Structured Adhesives, Heepe, Xue, Gorb, 2017
Gerstman	Biological and Medical Physics, Biomedical Engineering	2012 2014 2015 2018	Book Series	Cham: Springer	Different topics of physical, chemical and biological sciences, for example: Biomedical Signals and Sensors I, Kaniusas, 2012; Bioinspiration, Liu, 2012 Mathematical Biophysics, Rubin et. al., 2014; Biomedical Signals and Sensors II, Kaniusas, 2015; Complex Fluids in Biological Systems, Spagnolie, 2015; Biomedical Signals and Sensors III, Kaniusas, 2018; Biomimetics, Bhushan, 2018
Kumar	Nanomaterials for the life science	2009 2010 2011	Book Series	Weinheim: Wiley-VCH	Volume 1: Metallic Nanomaterials, 2009; Volume 2: Nanostructured Oxides, 2009; Volume 3: Mixed Metal Nanomaterials, 2009; Volume 4: Magnetic Nanomaterials, 2009; Volume 5: Nanostructured Thin Films and Surfaces, 2010; Volume 6: Semiconductor Nanomaterials, 2010; Volume 7: Biomimetic and Bioinspired Nanomaterials, 2010; Volume 8: Nanocomposites, 2010; Volume 9: Carbon Nanomaterials, 2011; Volume 10: Polymeric Nanomaterials, 2011

Author/ Editor	Title	Year	Type of literature	Reference	Categories of bio-inspired design
Bar-Cohen	Biomimetics Series	2011 2016 2017 2018	Book Series	Boca Raton: CRC Press, Taylor & Francis Group	Volume 1: Biomimetics: Nature-based Innovation, Bar-Cohen, 2011; Volume 2: Ocean Innovation: Biomimetics Beneath the Waves, Anderson et al., 2016; Volume 3: Architecture Follows Nature-Biomimetic Principles for Innovative Design, Mazzoleni, 2017; Volume 4: Advances in Manufacturing and Processing of Materials and Structures, Bar-Cohen, 2018
Jiang, Guo, Liu	Biomimetic superoleophobic surfaces: focusing on their fabrication and applications	2014	Journal article	Journal of Materials Chemistry A, Vol.3(5), pp.1811-1827, doi: 10.1039/c4ta05582a	Superoleophobic surfaces
Vincent	Biomimetics-a review	2009	Journal article	Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine, Vol.223(8), pp.919-939, doi: 10.1243/09544119JEIM561	Material, surface structures, mechanisms, hierarchy

Author/ Editor	Title	Year	Type of literature	Reference	Categories of bio-inspired design
Bhushan	Biomimetics: lessons from nature– an overview	2009	Journal article	Philosophical Transactions Of The Royal Society A-Mathematical Physical And, Vol.367(1893), pp.1445-1486, doi: 10.1098/rsta.2009.0011	Material, surfaces, hues, adhesion, motion, aerodynamics, energy productions, sensors, hierarchical organization
Bhullar, Lala, Ramkrishna	Smart Biomaterials – A review	2014	Journal article	Reviews On Advanced Materials Science, Vol.40(3), pp.303-314, http://www.ipme.ru/e-journals/RAMS/	Material and structures, smart biomaterials, self-healing, surfaces
Naik, Stone	Integrating biomimetics	2005	Journal article	Materials Today, Vol.8(9), pp.18-26, doi: 10.1016/S1369-7021(05)71077-4	Material and surfaces, structures

Author/ Editor	Title	Year	Type of literature	Reference	Categories of bio-inspired design
Yu, Lou, Fan, Zhang	Biomimetic optical materials: Integration of nature's design for manipulation of light	2013	Journal article	Elsevier Ltd., Progress in Materials Science, Volume 58, Issue 6, 825-873, doi: 10.1016/j.pmatsci.2013.03.003	Materials and surfaces, optical structures
Eadie, Ghosh	Biomimicry in textiles: past, present and potential. An overview	2011	Journal article	Journal of the Royal Society Interface, Vol.8(59), 761-775, doi: 10.1098/rsif.2010.0487	Material and functional surfaces, structures, colours, self-healing, thermal insulation in context to textiles
Ma	Biomimetic Materials for Tissue Engineering	2008	Journal article	Advanced Drug Delivery Reviews, Vol. 60, Issue 2, 184-198, doi: 10.1016/j.addr.2007.08.041	Nano-fibrous Materials, self-assembled structures, composite and nano-composite materials, surfaces, bioactive molecule delivery
Naleway, Taylor, Porter, Meyers, McKittrick	Structure and mechanical properties of selected protective systems in marine organisms	2016	Journal article	Materials Science and Engineering C,59, 1143 - 1167, doi: 10.1016/j.msec.2015.10.033	Structure and mechanical properties of marine organisms

Author/ Editor	Title	Year	Type of literature	Reference	Categories of bio-inspired design
Leong	Biomaterials	1980-present	Journal	ISSN: 0142-9612	Materials
Full	Bioinspiration & biomimetics : learning from nature	2006-present	Journal	ISSN: 1748-3190	Examples of different discplines
Anderson	Journal of Biomedical Materials Research Part A	1996-present	Journal	ISSN: 1552-4965	Materials
Gilbert	Journal of Biomedical Materials Research Part B: Applied Biomaterials	1996-present	Journal	ISSN: 1552-4981	Materials
Winnik	Langmuir	1985-present	Journal	ISSN: 0743-7463	Material and surfaces, structures, self-assembly, processes

Author/ Editor	Title	Year	Type of literature	Reference	Categories of bio-inspired design
Wagner	Acta Biomaterialia	2005-present	Journal	ISSN: 1742-7061	Material, surfaces and structures
Syngellakis	The International Journal of Design & Nature	2006-present	Journal	ISSN: 1755-7437	Design in nature, Nature and architectural design, Thermodynamics in nature, Evolutionary thermodynamics, Eco-informatics, Natural materials in engineering, Mechanics in nature, Dynamic modelling and ecosystems (etc.)
Boblan, Bannasch	First International Industrial Conference Bionik 2004	2004	Proceedings		Architecture, Design & Systematics; Biological Paradigms for Optimisation; Biomechatronics and Robotics; Fluid Dynamics; Functional Surfaces; Materials & Surfaces; Sensorics and Information Processing
	IEEE International Conference on Robotics and Biomimetics (ROBIO)	yearly	Conference		Robotics
	International Conference on Biomimetic and Biohybrid Systems, Living Machines	yearly	Conference		Living machines, robotics and locomotion, self-regulation, learning, memory, architecture, sensors
	International Conference on Intelligent Robotics and Applications (ICIRA)	yearly	Conference		Robotics, automation and intelligent systems

9.2 Catalogs/Databases of Biological Principles (Examples)

Functions (aggregated)	Sub group	Functions (of author)	Biological systems (examples)	Description	Source (database)
Move or stay put	Attach	Principles of joining	Suckers of octopus	Octopus possess different numbers and arrangement of suckers, which allow them to attach temporarily at an object	4)
		Attach permanently	Eggs of the asparagus beetle	Asparagus beetles attach their eggs permanently on plant surfaces	1)
	Move	Locomotion principles	Resilin of insects	Flying insects are able to move in/through gases due to the presence of resilin, an extremely elastic protein that stores the kinetic energy	4)
		Move (solids)	Organisms	Movement of organisms in/through liquids, gases or solids	3)
Protect from physical harm	Protect from living threats	Protection systems	Resolution of body contours	Some organisms disguise themselves by a color scheme matching the environment so that the body contours dis-solve to protect themselves from animals	4)
		Protect from plants/ microbes	White rock shell snail	The egg s urface of the white rock shell snail has special properties that protect the shell from microbial foul-ing	1)
	Protect from non-living threats	Protection systems	Lotus plants	Some plants, such as the lotus plant, have surfaces with wax layers that protect from dirt deposits	4)
	Manage structural forces	Shock absorption	Footpads of dog	Dogs have their own natural shock absorber - footpads - which manage structural forces like compression	4)
	Regulate physiol. processes	Regulate reproduction or growth	Cells of the freshwater common pond snail	Freshwater common pond snail regulates reproduction or growth by a clever mechanism of the cells to preserve vital resources	1)

Functions (aggregated)	Sub group	Functions (of author)	Biological systems (examples)	Description	Source (database)
Protect from physical harm	Prevent structural failure	Support/carry material	Insect trachea	Through spiral reinforcement the insect trachea prevents deformation with minimized material expenditure	2)
		Preserve	Plants	Plant resin prevents fracture/ rupture	3)
		Prevent buckling	Quills of porcupines	The thin walled quills of porcupines are built and optimized to prevent buckling	1)
Maintain community	Coordinate	Coordinate activities, coordinate systems, optimize shape/materials	Human skin	Human skin serves multiple functions such as to coordinate activities and systems	1)
	Cooperate	Cooperate within (eco)systems, co-operate/ compete between different species	Mutualism	In nature, there is a cooperation between different species of biological systems, for example some organism creating habitat for other species	1)
	Provide ecosystem services	Regulate climate, chemically break down inorganic compounds	Ants	Ants positively affect the properties of the soil and thereby reduce the carbon dioxide in the atmosphere which contributes to the regulation of the climate	1)

Functions (aggregated)	Sub group	Functions (of author)	Biological systems (examples)	Description	Source (database)
Modify	Modify physical state	Modify buoyancy	Swim bladders of fish	Swim bladders help fishes to swim with less energy in different depths by modifying their buoyancy	1)
		Deform	Insect wings	Insects modify size and shape of their wings after hatching from the cocoon	3)
		Form material	Birch leaf roller	Birch leaf rollers form a sinkhole out of birch leaves by modifying the physical state through cutting and rolling the leaves	2)
		Modify (colour)	Chameleons	Chameleons are able to change the colour of their skin rapidly	3)
	Modify chemical/ electrical state	Modify solubility (dissolving, emulsifying, precipitating, crystrallizing)	Lipid membranes in living cells	Lipid membranes in living cells have the ability to modify the solubility of fats and oils in water	1)
	Adapt/optimize	Adapt phenotype	Leaves of the Kukumakranka plant	The leaves of the Kukumakranka plant have the ability to adapt their phenotype to different climatic conditions	1)
	transform/ convert energy	Explosion mechanisms	Bombardier beetle	The bombardier beetle is able to transform thermal energy in its own combustion chamber by mixing and igniting a secretion mixture	4)
		Energy of a moving object	Muscles	Transform/ convert energy	3)

Functions (aggregated)	Sub group	Functions (of author)	Biological systems (examples)	Description	Source (database)
Make	Physically assemble	Bio-inspired architecture	Wasp's nest	The nest of wasps consists of a papery mass that helps the wasps to build a structure	4)
	Chemically assemble	Connect material	Spider silk	The silk of spiders to catch prey has a high surface tension which always keeps the silk tight	2)
	Chemically assemble	Produce	Synthesis	Chemically assembly with biochemical reactions (synthesis)	3)
Process information	Navigate	Measure/ recognize	Honeybees	Using electromagnetic waves honeybees are able to navigate through air	3)
	Send signals	Measure/ recognize	Fish	Some fishes are able to send electrical/ magnetic signals to communicate and navigate through water	3)
	Process signals	Measure/ recognize	Antennae of insects	Using their antennae, insects respond to signals	3)
	sense signals/ environmental cues	Transfer of information	Slit sensilla of spider	Spiders sense motion, sound and other vibrations with the slit sensilla that helps to stimulate the dendrites at low stresses caused by, for example, the movement of prey	2)
		Sensors	Compound eyes of insects	The temporal resolution and the wider field of view of compound eyes allow insects to sense light (visible spectrum) from the environment and thus avoid colliding with objects	4)

Functions (aggregated)	Sub group	Functions (of author)	Biological systems (examples)	Description	Source (database)
Break down	Chemically break down	Separate	Enzyme reaction	An enzyme reaction chemically breaks down polymers	3)
	Physically break down	Chopping devices	Radula of Patella limpets	The Patella limpet has one tooth, called radula, which has a special shape used for physically breaking down of living and non-living materials	4)
		Material separation	Chicken	Chicken physically break down non-living material when they use their tooth called "egg tooth" to open the eggshell	2)
Get, store, or distribute resources	Capture, absorb or filter	Distribution systems	Pigments in the oriental hornet´s cuticle	Hornets have special photovoltaic pigments in the cuticle that help them to absorb solar energy and turn it into electrical energy	4)
		Transfer of material	Tongue of woodpecker	The woodpeckers capture solids and liquids with their tongue	2)
	Store	Collect	Pelt/ feathers	The pelt and feathers of animals have the function to store thermal energy	3)
	Distribute	Distribute	Flying seeds	Some plants have seeds that are able to fly to distribute those solids (seeds) in the surrounding	3)
	Expel	Expel solids	Glands of marine birds	Marine birds are able to drink saline water of the sea because they expel the salt via glands	1)

9.3 Translation Technical/Biological Domain

Technical terms according to the Functional Basis (Hirtz et al. 2002), biological terms according to the Engineering-to-Biology-Thesaurus (Nagel et al. 2010), Biologically Meaningful Keywords (Cheong et al. 2011), and the Correlation Matrix NIST-BT (Baldussu 2014, p. 86-87, p. 226-230)

Technical Terms			**Biological Terms**			
Functional Basis			**Eng.-to-Bio. Thesaurus**	**Biologically Meaningful Keywords**	**Correlation Matrix NIST-BT**	
Class	*Secondary*	*Tertiary*	*Function Correspondents*	*Keywords (% of colloc., # of matches)*	*Group*	*Sub-Group*
Branch	Separate		Bleaching, meiosis, abscission, mitosis, segment, electrophoresis, dialysis, denature, free, detach, release	Speciate (%68,#66), Diverge (%44, #39), Segregate (%35, #34), Furrow (%33, #9), Evolve (%18, #424), Denature (%17, #36), Grow (%16, #796), Reproduce (%14, #537), Cleave (%14, #80), Surround (%11, #209), Stimulate (%9, #289), Contract (%3, #226), Activate (%2, #256), Retract (%14, #7), Bend (%12, #33), Fold (%8, #74)		
		Divide	Division, prophase, metaphase, anaphase, cleave, cytokinesis		Break Down	Chemically break down, Physically break down
		Extract		Collect (%11, #72), Extract (%10, #61), Trap (%8, #49), Delete (%7, #43), Degrade (%6, #36), Beat (%5, #39), Separate (%3, #308)	Get, store, or distribute resources	Capture, absorb, or filter
		Remove	Deoxygenate, filtrate, liberate, expulsion, evacuate		Get, store, or distribute resources	Capture, absorb, or filter
	Distribute		Circulate, diffuse, exchange, disperse, scatter, spread, spray	Hydrolyze (%41, #75), Burst (%32, #31), Discharge (%29, #14), Stimulate (%26, #289), Circulate (%26, #164), Fuse (%23, # 120), Secrete (%21, #232), Concentrate (%21, #58), Pass through (%20, #139), Break down (%20, #125), Diffuse (%15, #238), Stretch (%15, #89), Bind (%14, #483), Segregate (%12, #34), Change shape (%9, #71), Lyse (%26, #23), Decompose (%13, #31), Condensate (%6, #16), Fold (%5, #74)	Get, store, or distribute resources	Distribute

Technical Terms			Biological Terms			
Functional Basis			Eng.-to-Bio. Thesaurus	Biologically Meaningful Keywords	Correlation Matrix NIST-BT	
Class	*Secondary*	*Tertiary*	*Function Correspondents*	*Keywords (% of colloc., # of matches)*	*Group*	*Sub-Group*
Channel	Import		Absorb, attract, consume, inhale, intake	Osmose (%16, #31), Pass through (%15, #139), Squeeze (%14, #21), Diffuse (%7, #238), Insert (%5, #132), Release (%4, #508), Secrete (%3, #232), Transport (%3, #283), Fold (%1, #74)		
	Export		Bind, block, breakdown, excrete, inactivate, repel	Contract (%1, #266), Inactivate (%6, #52), Denature (%6, #36), Attach (%3, #200), Break down (%2, #125), Bind (%1, #483), Cleave (%1, #80), Excrete (%1, #111), Fuse (%1, #120)	Get, store, or distribute resources	Expel
	Transfer		Migrate, transfer	Conjugate (%60, #32), Beat (%41, #39), Transport (%27, #283), Couple (%22, #58), Break (%8, #196), Pollinate (%7, #74), Bind (%6, #483), Attract (%3, #96), Change shape (%52, #71), Organize (%10, #134) Shift (%7, #67)	Process information	Navigate
		Transport	Circulate, conduct, diffuse, pump, shift, displace, fly, swim, jump, bounce	Transport (%19, #283), Transduce (%10, #99), Communicate (%6, #109), Bind (%6, #483), Extend (%3, #95), Collect (%3, #72), Stimulate (%2, #289), Contract (%1, #226), Pollinate (%9, #74), Disperse (%4, #123)	Move or Stay Put	Move
		Transmit	Communicate, transduce	Contract (%12, #226), Transduce (%8, #99), Communicate (%6, #109), Conduct (%1, #106)		

Technical Terms			Biological Terms			
Functional Basis			**Eng.-to-Bio. Thesaurus**	**Biologically Meaningful Keywords**	**Correlation Matrix NIST-BT**	
Class	*Secondary*	*Tertiary*	*Function Correspondents*	*Keywords (% of colloc., # of matches)*	*Group*	*Sub-Group*
Channel	Guide		Orient, position, slide, tunnel	Communicate (%6, #109), Extend (%3, #95), Transport (%3, #283), Arrange (%3, #112), Hold (%2, #124)		
		Translate	Synthesize, transcribe	Transcribe (%27, #347), Synthesize (%12, #310)		
		Rotate	Oscillate, spin, turn, swivel, roll	Wind (%4, #26)		
		Allow DOF	Articulate			
Connect	Couple		Recombination, mate, build, phosphorylate, bond, synthesis, latch, lock, extend, link, overlap	Extend (%15, #95), Project (%14, #50), Hold (%14, #124), Stretch (%13, #89), Overlap (%10, #29), Activate (%7, #256), Bind (%4, #483)		
		Join	Bind, adhere, bond, fuse		Make	Physically assemble
		Link	Clamp, activate, bind, project		Move or Stay Put	Attach

Technical Terms			Biological Terms			
Functional Basis			Eng.-to-Bio. Thesaurus	Biologically Meaningful Keywords	Correlation Matrix NIST-BT	
Class	*Secondary*	*Tertiary*	*Function Correspondents*	*Keywords (% of colloc., # of matches)*	*Group*	*Sub-Group*
Connect	Mix		Blend, contract, exchange, fragment	Fragment (%26, #127), Exchange (%10, #220), Cleave (%9, #80), Bind (%6, #483), Break down (%4, #125), Contract (%1, #226), Cross over (%65, #34), Degrade (%8, #36)	Make	Chemically assemble
Control magnitude	Actuate		Activate, induce, trigger	Change shape (%11, #71), Bind (%9, #483), Stick (%6, #53), Activate (%5, #256), Change structure (%4, #53), Regulate (%3, #401), Absorb (%2, #172), Adapt (%7, #286), Evolve (%4, #424), Excite (%1, #69)		
	Regulate		Electrophoresis, gate, organogenesis, respire, sustain, preserve, remain, stabilize, maintain, regulate	Kill (%10, #102), Protect (%9, #161),		
		Increase	Hyperpolarize, pinocytosis, grow, expand, multiply, replicate	Relax (%29, #42), Stimulate (%18, #289), Activate (%14, #256), Contact (%10, #226), Project (%10, #50), Grow (%7, #786), Molt (%7, #44), Develop (%3, #843), Fold (%3, #74)	Maintain Physical Integrity	Regulate Physiological Processes
		Decrease	Compress, coil, divide, fold, shorten, wrap	Hyperpolarize (%21, #29), Oppose (%20, #15), Constrict (%8, #39), Stimulate (%3, #289), Inhibit (%3, #190), Narrow (%2, #47), Bind (%1, #483), Bulge (%6, #17)		

Technical Terms			Biological Terms			
Functional Basis			Eng.-to-Bio. Thesaurus	Biologically Meaningful Keywords	Correlation Matrix NIST-BT	
Class	*Secondary*	*Tertiary*	*Function Correspondents*	*Keywords (% of colloc., # of matches)*	*Group*	*Sub-Group*
Control magnitude	Change		Pinocytosis, degrade, alter, bind, catalyse, contract, hydrolysis, twist, mutate, radiate, charged, slip, acclimatize, alternate, fluctuate	Evolve (%7, #424), Specialize (%6, #164) Adapt (%1, #286)	Modify	Modify physical state Modify chemical/ electrical state
		Increment		Relax (%29, #42), Stimulate (%18, #289), Activate (%14, #256), Contact (%10, #226), Project (%10, #50), Grow (%7, #786), Molt (%7, #44), Develop (%3, #843), Fold (%3, #74)		
		Decrement	Decarboxylation, constrict	Hyperpolarize (%21, #29), Oppose (%20, #15), Constrict (%8, #39), Stimulate (%3, #289), Inhibit (%3, #190), Narrow (%2, #47), Bind (%1, #483), Bulge (%6, #17)		
		Shape	Elongate, stretch, attach, spread	Coil (%10, #30), Enlarge (%3, #33), Contract (%2, #226),		
		Condition	Osmosis, constrict			Adapt/ Optimize

Technical Terms			Biological Terms			
Functional Basis			Eng.-to-Bio. Thesaurus	Biologically Meaningful Keywords	Correlation Matrix NIST-BT	
Class	*Secondary*	*Tertiary*	*Function Correspondents*	*Keywords (% of colloc., # of matches)*	*Group*	*Sub-Group*
Control magnitude	Stop		Clog, extinguish, halt, interphase, seal, suspend	Lyse (%9, #23), Cut (%5, #134), Inhibit (%2, #190), Activate (%2, #256), Bind (%1, #483)		
		Prevent	Constrain, obstruct	Cover (%17, #121), Bind (%14, #483), Destroy (%10, #68), Stimulate (%9, #289), Surround (%9, #209), Inhibit (%7, #190), Release (%7, #508)	Maintain Physical Integrity	Manage structural forces
						Prevent structural failure
		Inhibit	Cover, destroy, inhibit, repress, surround		Maintain Physical Integrity	Protect from Biotic factors
						Protect from Abiotic factors
						Manage structural forces
Convert	Convert		Polymerize, synthesize, burn, gluconeogenesis, metabolize, grow, transduction, fermentation, glycolysis, hydrolysis, respiration, ionize, decompose, degrade, develop, mutate, photosynthesize	Specialize (%48, #164), Cut (%26, #134), Recombine (%26, #135), Transduce (%23, #99), Degrade (%14, #36), Synthesize (%14, #310), Photosynthesize (%13, #205), Stimulate (%13, #289), Transcribe (%12, #347), Fuse (%12, #120), Contract (%11, #226), Divide (%10, #277), Decompose (%10, #31), Break down (%9, #125), Activate (%8, #256), Mutate (%7, #299), Reproduce (%6, #537), Transpire (%37, #27), Coil (%10, #30)	Make	Generate/ convert energy
					Process information	Encode/ Decode

Technical Terms			Biological Terms			
Functional Basis			Eng.-to-Bio. Thesaurus	Biologically Meaningful Keywords	Correlation Matrix NIST-BT	
Class	*Secondary*	*Tertiary*	*Function Correspondents*	*Keywords (% of colloc., # of matches)*	*Group*	*Sub-Group*
Provision	Store		Conserve, hold, convert, deposit, photosynthesize	Concentrate (%16, #58), Convert (%12, #146), Photosynthesize (%12, #205), Deposit (%10, #49), Dissolve (%7, #69)	Get, store, or distribute resources	Store
		Contain	Absorb	Enclose (%46, #78), Swell (%17, #35), Surround (%15, #209), Extend (%5, #95), Grow (%5, #786), Develop (%4, #843)		
		Collect	Absorb, catch, break-down, concentrate, Digest., reduce	Digest (%30, #267), Break down (%18, #125), Convert (%10, #146), Reduce (%9, #312), Feed (%9, #183), Cleave (%10, #80)	Get, store, or distribute resources	Capture, absorb, or filter
	Supply		Feed, lactate	Nurture (%17, #6), Break down (%5, #125), Convert (%4, #146), Degrade (%3, #36)	Maintain Community	Provide Ecosystem services
Signal	Sense			Receptor (%34, #503), Receive (%20, #172), Be stimulated (%14, #217), Bind (%14, #483), Curl (%50, #2), Protrude (%12, #17), Encounter (%4, #55)	Process information	Sense signal/ environment cues
		Detect	Detect, locate, see, small			
		Measure	Observe, monitor, gauge, watch	Emit (%48, #33), Recognize (%18, #203) Isolate (%9, #137)	Process information	Navigate Sense signal/ environment cues

Technical Terms			Biological Terms			
Functional Basis			**Eng.-to-Bio. Thesaurus**	**Biologically Meaningful Keywords**	**Correlation Matrix NIST-BT**	
Class	*Secondary*	*Tertiary*	*Function Correspondents*	*Keywords (% of colloc., # of matches)*	*Group*	*Sub-Group*
Signal	Indicate		Fluoresce, communicate, react, mark	Signal (%3, #399), Communicate (%4, #109)		
		Track				
		Display		Convey (%20, #10), Behave (%12, #374), Change shape (%8, #71), Signal (%8, #399), Bind (%5, #483), Stick out (%43, #7), Unwind (%17, #12), Denature (%14, #36), Change structure (%6, #53), Break down (%1, #125), Convert (%2, #146)	Process information	Send signal
	Process		Learn		Process information	Process signals Compute
Support			Develop, wrap	Anchor (%21, #24), Connect (%20, #167), Wrap (%13, #15), Divide (%3, #277), Bind (%2, #483), Develop (%2, #843)		
	Stabilize		Homeostasis, cling, hold, bind, connect			
	Secure		Surround, envelope			
	Position					

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H. Hashemi Farzaneh and U. Lindemann, *A Practical Guide to Bio-inspired Design*, https://doi.org/10.1007/978-3-662-57684-7