

~~WHAT IS CLAIMED IS:~~

1. A system for quantifying a health capacity of a biological system, comprising:
at least one sensor configured to measure an emergent factor of the biological system and generate measured data based on the emergent factor; and
a processing system comprising a processor and an interface for receiving the measured data from the at least one sensor and determining one or more factors that quantify the health capacity of the biological system based on the measured data.
2. The system of Claim 1, wherein the processor computes a solution for maximizing the health capacity of the biological system according to machine readable instructions.
- ~~3. The system of Claim 2, wherein the biological system is an organism.~~
- ~~4. The system of Claim 3, wherein the biological system is selected from an animal, a plant, and a single cell organism.~~
- ~~5. The system of Claim 3, wherein the biological system is an industrial biology system or a synthetic biology system.~~
- ~~6~~3. The system of Claim ~~3~~2, wherein the ~~organism~~biological system is a human.
- ~~7~~4. The system of Claim 1, further comprising a storage component in communication with the processing system and for storing the measured data.
- ~~8~~5. The system of Claim 1, wherein the measured data is a energy budget of the biological system.
- ~~9~~6. The system of Claim 1, wherein processing system comprises a plurality of transmitters configured to transmit the measured data as data streams optimized with respect to properties of the at least one sensor and the emergent factors to be reported.
- ~~10~~7. The system of Claim ~~9~~6, wherein the processor makes pre-symptomatic detection of a disease state of the biological system based on the health metrics, according to machine readable instructions.
- ~~11~~8. The system of Claim ~~10~~7, wherein the processor makes pre-symptomatic detection of the disease state of the biological system using a supervised learning algorithm according to machine readable instructions with a collection of health metrics reported from a plurality of other objects.

~~12~~9. The system of Claim ~~11~~ 8, wherein the disease state is selected from aging, sepsis, cardiovascular disease, and infectious disease.

~~13. The system of Claim 11, wherein the disease state is an infectious disease.~~

~~14. The system of Claim 13, wherein the infectious disease is caused by a viral infection.~~

~~15. The system of Claim 14, wherein the viral infection is selected from a respiratory infection, a gastrointestinal tract infection, a liver infection, a nervous system infection, and a skin infection.~~

~~16. The system of Claim 15, wherein the viral infection is a coronavirus.~~

~~17. The system of Claim 16, wherein the viral disease is COVID-19.~~

~~18. The system of Claim 1, wherein the at least one sensor is a thermodynamic sensor, an electrochemical sensor, a structural sensor, a tensile sensor, a motion sensor, or a combination thereof.~~

~~19~~10. The system of Claim 1, wherein the at least one sensor comprises a plurality of wearable devices for sensing data comprising at least one of heat flux data, calorimetry data, osmometry data, and physiometry data.

~~20~~11. The system of Claim 1, wherein the at least one sensor is an implanted device.

~~21~~12. The system of Claim 1, wherein the interface transmits the measured data via wireless communication.

~~22~~13. The system of Claim 1, wherein the processing system further comprises:

an application program interface that controls storage of the measured data, access to the measured data, security configurations, user inputs, and output of any results.

~~23~~14. A system for quantifying a health capacity of a biological system, comprising:

a plurality of measuring devices, wherein at least one measuring device measures a thermodynamic property of the biological system.

~~24~~15. The system of ~~any~~ Claims ~~22~~ 13, wherein the output includes a solution for intercepting a disease state.

~~25. A method for quantifying a health capacity of a biological system, comprising:~~

sensing at least one emergent factors of the biological system,
generating measured data relating to the at least one emergent factor, and
determining, based on the measured data, one or more stimuli that influence the
health capacity of the biological system.

26. The method of Claim 25, further comprising generating a solution for
maximizing the health capacity by modifying one or more stimuli that influence the health
capacity of the biological system, wherein the stimuli are selected from sleep patterns, sleep
durations, nutritional intakes, and exercise regimens.

27. A system for determining an energy signature of a non-biological system,
comprising:

at least one sensor configured to measure an emergent factor of the system and
generate measured data based on the emergent factor; and

a processing system comprising a processor and an interface for receiving the
measured data from the at least one sensor and determining one or more factors that quantify
an energy budget of the non-biological system based on the measured data.

28. The system of Claim 1, comprising at least one thermodynamic sensor and at
least one motion sensor.

29. The system of Claim 28, wherein the at least one thermodynamic sensor
comprises a plurality of wearable devices for sensing surface temperature of the biological
system over time, and wherein the at least one motion sensor comprises at least one
accelerometer for sensing physical activity of the biological system over time.

30. The method of Claim 25, wherein the measured data comprise surface
temperature and physical activity of the biological system over time.

31. The method of Claim 30, further comprising:

estimating heat elimination of the biological system over time based on
differential surface temperature;

estimating heat production of the biological system over time based on physical
activity; and

estimating a basal metabolic status of the biological system based on temporal
alignment of heat elimination and heat production.

32. The method of Claim 30, further comprising:

~~obtaining a quasiperiodic rhythm of the biological system based on the measured data, wherein the quasiperiodic rhythm is of seconds timescale, of minutes timescale, ultradian, circadian, circalunar, or of yearly timescale.~~

~~33. The method of Claim 32, further comprising:~~

~~obtaining a variability of the quasiperiodic rhythm across a predetermined amount of time; and~~

~~determining the health capacity based on the variability of the quasiperiodic rhythm.~~

~~34. The method of Claim 32, further comprising:~~

~~estimating heat elimination of the biological system over time based on differential surface temperature;~~

~~estimating heat production of the biological system over time based on physical activity;~~

~~estimating a basal metabolic status of the biological system based on temporal alignment of heat elimination and heat production; and~~

~~determining the health capacity by applying a time dependent function to the estimated basal metabolic status, wherein the time dependent function is derived from the quasiperiodic rhythm of the biological system.~~

~~35. The system of Claim 28, wherein the processing system is further configured to analyze a quasiperiodic rhythm and activity levels of the biological system based on the measured data, wherein the quasiperiodic rhythm is of seconds timescale, of minutes timescale, ultradian, circadian, circalunar, or of yearly timescale.~~

~~36. The system of Claim 35, wherein the processing system is further configured to actuate the sensors based on the analyzed quasiperiodic rhythm and activity levels of the biological system.~~

~~37. The method of Claim 25, wherein the measured data comprises exhaust streams of the biological system.~~

~~38. The method of Claim 37, wherein the exhaust streams comprise heat, one or more low energy chemical species, or any combination thereof.~~

~~39. The method of Claim 37, wherein the measured data comprises total energy expenditure of the biological system in real time.~~

- ~~40. The method of Claim 37, further comprising:
analyzing functional aspects of thermoregulation in the biological system based on the measured data.~~
- ~~41. The method of Claim 40, further comprising:
generating and outputting indicators for understanding, improving, modulating, repurposing, or any combination thereof, one or more functions of the biological system.~~
- ~~42. The method of Claim 41, wherein the indicators are used to manage weight, blood pressure, circadian rhythm, sleep quality, sleep duration, or any combination thereof, of the biological system.~~
- ~~43. The system of Claim 1, comprising at least one heat sensor and at least one chemical sensor configured to measure exhaust streams of the biological system.~~
- ~~44. The system of Claim 43, wherein the exhaust streams comprise heat, one or more low energy chemical species, or any combination thereof.~~
- ~~45. The system of Claim 43, wherein the sensors are configured to directly measure total energy expenditure of the biological system in real time.~~
- ~~46. The system of Claim 43, wherein the processing system is configured to analyze functional aspects of thermoregulation in the biological system based on the measured data.~~
- ~~47. The system of Claim 46, wherein the processing system is configured based on a input training set, and further configured to generate and output indicators for understanding, improving, modulating, repurposing, or any combination thereof, one or more functions of the biological system.~~
- ~~48. The system of Claim 47, wherein the indicators are used to manage weight, blood pressure, circadian rhythm, sleep quality, sleep duration, or any combination thereof, of the biological system.~~
- ~~49. The system of Claim 47, wherein at least one indicator suggests automatically administering suitable amounts of one or more: decoupling agents, modulators of the oxidative phosphorylation pathway, modulators of transmembrane ionic gradients, or any combination thereof.~~
- ~~50. The system of Claim 47, wherein at least one indicator suggests control of the external environment to influence the biological system's thermoregulatory functions or physiological aspects relating to thermoregulation.~~

~~51. The system of Claim 50, wherein the biological system's thermoregulatory functions or physiological aspects relating to thermoregulation comprise cardiovascular parameters, circadian parameters, cognitive parameters, emotional parameters, or any combination thereof.~~

~~52. The system of Claim 50, wherein control of the external environment comprises adjusting interior air temperature, pressure, humidity, or any combination thereof.~~

~~53. The system of Claim 50, wherein control of the external environment comprises providing auditory stimuli, olfactory stimuli, visual stimuli, or any combination thereof.~~

~~54. The system of Claim 47, wherein at least one indicator suggests to the biological system to take predefined actions.~~

~~55. The system of Claim 54, wherein the biological system is a human being, and wherein the predefined actions comprise: change clothes, go inside, go outside, eat a specific food, drink water, do certain exercises, go to sleep, or any combination thereof.~~

~~56. The system of Claim 27, comprising at least one heat sensor and at least one chemical sensor configured to measure exhaust streams of the biological system.~~

~~57. The system of Claim 56, wherein the exhaust streams comprise heat, one or more low energy chemical species, or any combination thereof.~~

~~58. The system of Claim 56, wherein the sensors are configured to directly measure total energy expenditure of the biological system in real time.~~

~~59. The system of Claim 56, wherein the processing system is configured to automatically analyze emergent properties of thermoregulation in the biological system based on the measured data.~~

~~60. The system of Claim 59, wherein the processing system is further configured to automatically generate and output indicators for understanding, improving, modulating, repurposing, or any combination thereof, one or more emergent properties of the biological system.~~

~~61. The system of Claim 60, wherein the indicators are used to manage weight, pressure, rhythm, or any combination thereof, of the biological system.~~

~~62. The method of Claim 25, wherein the measured data comprises heat flux data.~~

~~63. The method of Claim 62, wherein:~~

~~at least one health capacity is a basal metabolic status, and~~

~~at least one emergent factor is the temporal alignment of heat production and heat elimination.~~

~~64. The method of Claim 63, wherein the temporal alignment is related to at least one quasiperiodic rhythm of the biological system.~~

~~65. The method of Claim 64, wherein the at least one quasiperiodic rhythm is a circadian rhythm.~~

~~66. The method of Claim 25, further comprising the step of further comprising:
generating and outputting at least one indicator for improving or modulating the temporal alignment of heat production and heat elimination of the biological system.~~

~~67. The method of Claim 66, wherein the indicator suggests to the biological system to perform to at least one predefined action selected from the group of actions comprises: change clothes, go inside, go outside, eat a specific food, drink a specified beverage, perform certain exercises, go to sleep, or any combination thereof.~~

~~68. The method of Claims 64, further comprising the step of recommending at least one predetermined action to improve or modulate the temporal alignment of heat production and heat elimination of the biological system.~~

~~69. The method of Claim 68, wherein the action manages circadian rhythm.~~

~~70. The system of Claim 1, wherein the measured data comprises heat flux data.~~

~~71. The system of Claim 70, wherein:~~

~~at least one health capacity is a basal metabolic status, and~~

~~at least one emergent factor is the temporal alignment of heat production and heat elimination of the biological system.~~

~~72. The system of Claim 71, wherein the temporal alignment is related to at least one quasiperiodic rhythm of the biological system.~~

~~73. The system of Claim 72, wherein the quasiperiodic rhythm is a circadian rhythm.~~

~~74. The system of Claim 71, wherein the processing system is further configured to generate and output at least one indicator for improving or modulating the temporal alignment of heat production and heat elimination of the biological system.~~

~~75. The system of Claim 74, wherein the indicator suggests to the biological system to perform to at least one predefined action selected from the group of actions comprises:~~

~~change clothes, go inside, go outside, eat a specific food, drink a specified beverage, perform certain exercises, go to sleep, or any combination thereof.~~

~~76. The system of Claim 72, wherein the at least one indicator suggests automatically administering suitable amounts of one or more of the following: a decoupling agent, a modulator of the oxidative phosphorylation pathway, a modulator of transmembrane ionic gradients, or any combination thereof.~~

~~77. The system of Claim 74, wherein the indicators are used to manage circadian rhythm.~~

7816 A system for quantifying and improving a metabolic status of a human, comprising:

at least one wearable thermodynamic sensor configured to:

measure an emergent factor of the human, wherein the emergent factor is the temporal alignment of heat production and heat elimination of the human, the temporal alignment relating to the circadian rhythm of the human, and

based on the emergent factor, generate measured data comprising heat flux data over time; and

a processing system comprising a processor and an interface, the processing system configured to:

receive the measured data from the at least one wearable thermodynamic sensor,

based on the measured data, quantify a metabolic status of the human relating to the heat production and heat elimination,

based on the measured data, determine one or more stimuli that influence the metabolic status of the human,

compute a solution for maximizing the metabolic status of the human, and

generate and output at least one indicator for improving the metabolic status of the human by modulating the heat production and heat elimination of the human.

~~79. A method for quantifying and improving a metabolic status of a human, comprising:~~

~~sensing at least one emergent factors of the human, wherein the emergent factor is the temporal alignment of heat production and heat elimination of the human, the temporal alignment relating to the circadian rhythm of the human;~~

~~generating measured data relating to the at least one emergent factor, the measured data comprising heat flux data over time;~~

~~based on the measured data, quantifying a metabolic status of the human relating to the heat production and heat elimination;~~

~~based on the measured data, determining one or more stimuli that influence the metabolic status of the human;~~

~~computing a solution for maximizing the metabolic status of the human; and~~

~~generating and outputting at least one indicator for improving the metabolic status of the human by modulating the heat production and heat elimination of the human.~~

~~80~~17. The system of Claim ~~78~~ 16, wherein quantifying a metabolic status of the human is based on determining the mean, variance, min and/or max of the heat production and/or heat elimination over at least one circadian cycle.

~~81~~18. The system of Claim ~~78~~ 16, wherein quantifying a metabolic status of the human is based on determining the inter-day stability and/or intraday variability of the heat production and/or heat elimination over at least one circadian cycle.

~~82~~19. The system of Claim ~~78~~ 16, wherein quantifying a metabolic status of the human is based on comparing the mean, variance, min and/or max of the heat production and/or heat elimination over a particular circadian cycle to the historical value for the human.

~~83~~20. The system of Claim ~~78~~ 16, wherein quantifying a metabolic status of the human is based on comparing the inter-day stability and/or intraday variability of the heat production and/or heat elimination over a particular circadian cycle to the historical value for the human.