ANABIONTICS II

The Navigation of Biological State

Hiram Dunn
AstroBiota
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Anabiontics I defined a persistence-governing role within coupled biological systems. Catabiontic activity is disproportionately associated with throughput, while anabiontic activity is associated with the regulation, repair, buffering, interface management, and material signaling through which a coupled state remains viable or becomes recoverable. The defining unit of analysis is relational: system, role, material, and effect on persistence.

That framework immediately raises a second problem. If anabiontic signals and structures influence whether a biological partnership persists, they must also influence which states that partnership can enter. A redox signal can change metabolism. A hormone can alter development. A conditioned interface can permit a previously unstable interaction. A polymer or extracellular matrix can change diffusion, attachment, hydration, and the behavior of every organism that encounters it. In each case, persistence-governing material also changes the set of trajectories available to the system.

Anabiontics therefore cannot end with maintenance. Its second problem is state accessibility: how a biological system moves from one organized condition to another, which transitions are available from a given starting state, and how prior material history changes what becomes possible next.

The purpose of this essay is to develop that consequence without abandoning the narrower foundation of Part I. An anabiontic remains defined by its role in a coupled system. The new question is what happens when persistence-governing signals, structures, or interfaces do more than preserve an existing relationship and instead alter the trajectory of the relationship itself.

1. Possible State and Accessible State

A biological system can possess more than one possible state without having equal access to all of them. Genetic capacity does not specify a single phenotype, community structure, metabolic organization, or symbiotic configuration. The state that appears depends on the condition of the system entering the event: its prior exposures, existing interfaces, redox balance, developmental history, neighboring organisms, structural environment, and regulatory state.

This creates a necessary distinction between a possible state and an accessible state. A state may be physically and genetically possible while remaining inaccessible from the system's present organization. The inability to observe that state does not necessarily mean the system cannot occupy it. It may mean that the transition required to reach it has not occurred.

This distinction is especially important in coupled biology. A partnership does not form simply because compatible components are present. The components must enter a configuration in which signaling, interface conditions, metabolism, and structure become mutually compatible. The path into that configuration may matter as much as the final composition.

Anabiontics provides a material language for this problem because persistence-governing outputs alter the conditions under which later interactions occur. A redox signal can prime one partner before contact with another. A secreted metabolite can alter compatibility. A polymer can create an interface on which attachment becomes stable. A previous stress response can change the meaning of a later signal. The same participants may therefore produce different outcomes depending on the sequence of states through which the coupled system arrived.

The observed biological system may represent only one accessible region within a larger possibility space. The experimental problem is not simply to list what states exist. It is to determine the histories through which those states become reachable.

2. State Access and State Maintenance

State access and state maintenance are related but distinct functions. A material signal may help a system enter a new state without being required to maintain that state indefinitely. Another material may stabilize the new organization after it

appears. A structural output may then preserve the relevant interface through subsequent turnover. These functions can occur through different mechanisms or through the same mechanism at different stages.

This distinction prevents anabiontics from becoming a simple theory of persistent exposure. The persistence of a state does not require permanent presence of the material that initiated it. A transient redox or hormonal signal can alter gene expression, partner behavior, developmental trajectory, extracellular structure, or metabolic organization. Once these changes occur, the coupled system may begin producing its own persistence conditions.

The strongest anabiontic transition is therefore not one in which an external material must remain continuously present. It is one in which the initial intervention changes the coupled system enough that persistence becomes increasingly endogenous. Regulation transfers from the initiating condition into the biological organization itself.

This can be tested experimentally. After a candidate anabiontic condition establishes a new coupled state, the initiating signal can be withdrawn. The system can then be observed for maintenance, drift, collapse, or reconstruction. A state that immediately disappears was externally maintained. A state that remains coordinated after withdrawal has acquired some degree of internal persistence. A state that can be disturbed and later reconstruct itself demonstrates a stronger form of persistence still.

The distinction between access and maintenance is therefore central to Part II. It separates the event that opens a trajectory from the processes that make the resulting state durable.

3. Ordered Material Histories

Biological state transitions are often path-dependent. If a system can occupy states A, B, C, and D, it does not follow that A can transition directly to D. State B may establish the redox condition required for C. State C may produce an interface required for D. Under those circumstances, reproducing the final environment while omitting the intermediate states may fail because the system itself has not been prepared to occupy the final condition.

The order of anabiontic signals can therefore matter. Exposure to signal X followed by signal Y may produce a different result from Y followed by X. The molecules may be identical in both experiments, but the receiving system is not. The second signal always encounters a state already modified by the first.

This is particularly relevant to biological partnership because compatibility is frequently constructed rather than simply present. A first interaction may alter immune tolerance, redox tone, membrane state, extracellular chemistry, attachment behavior, or spatial organization. A later interaction then occurs at a different interface. What appears to be the effect of the second signal may actually depend on the history created by the first.

Anabiontic engineering should therefore treat sequence as an experimental variable. Duration, repetition, withdrawal, spacing between exposures, starting state, partner order, environmental context, and recovery interval can all determine the resulting trajectory.

This changes the basic screening question. Conventional screening often asks what compound X does to system A. A state-centered anabiontic experiment can ask what becomes possible after X, what becomes possible after X then Y, whether the order can be reversed, whether the resulting state persists after withdrawal, and whether the system responds differently when X is encountered again.

The object of engineering is no longer only a material. It can be a material history.

4. State Omega

Once state access and path dependence are distinguished, a more ambitious objective becomes definable. Consider a coupled biological system in State A and another state, Omega, that the system has not previously occupied under its normal history. Omega need not require a new genome or a new organism. It may already lie within the biological possibility space of the existing system while remaining inaccessible from its present organization.

State Omega is not defined as a universal optimum. It is a system-relative target state: an organization selected because it displays a desired combination of persistence, compatibility, recoverability, or function. The term describes an engineering objective, not an intrinsic biological good.

The task is therefore to determine whether a trajectory from A to Omega can be constructed through anabiontic regulation. One signal may alter redox state. Another may change interface behavior. A structural condition may stabilize the partnership. Repetition may entrain a response. Withdrawal may reveal whether the system has internalized the new organization.

The important test is not whether Omega can be produced while every external condition remains fixed. The stronger test is whether the system begins to maintain or reconstruct Omega after the initiating conditions are relaxed.

This makes recovery more informative than immobility. Biological systems turn over continuously. Molecules disappear. Cells divide and die. Extracellular structures are remodeled. Partners fluctuate in abundance. A persistent state cannot be defined by permanent retention of every component. It must be defined by a tendency to reconstruct a recognizable organization through ordinary disturbance.

A meaningful Omega state is therefore an attractor in a practical, operational sense: after displacement, the coupled system preferentially returns toward that organization rather than toward its previous historical state. The central experimental question becomes not whether the state remains perfectly unchanged, but what state the system rebuilds after it has been perturbed.

5. Anabiontic Recall

Path dependence creates another testable possibility. Suppose a candidate anabiontic signal X participates in establishing Omega and is then removed. The system later experiences sufficient disturbance to move away from Omega. If X is introduced again, the second encounter does not occur in the original system. It occurs in a system with a history of having previously occupied Omega.

If the later encounter with X preferentially facilitates reconstruction of Omega, then the biological meaning of X has become history-dependent. The molecule or material has not necessarily changed. The receiving biology has.

I call this proposed phenomenon anabiontic recall.

Anabiontic recall does not require symbolic storage. Prior state can persist through altered regulatory architecture, extracellular structure, redox setpoints, immune populations, microbial composition, spatial organization, receptor expression, developmental changes, or other physical traces of previous coupling. The important criterion is that the first encounter changes how the system responds to the later encounter.

This distinguishes recall from ordinary repeated exposure. If X produces the same immediate effect each time because the same mechanism is repeatedly activated, the phenomenon requires no new category. The stronger case occurs when prior occupation of a state changes the later response to X and biases reconstruction toward that previously established organization.

Anabiontic recall therefore provides a direct experimental bridge between persistence and biological memory. It asks whether a persistence-governing signal can acquire different system-level meaning because the coupled system has been changed by its own history.

6. State Delta and the Direction of Persistence

Nothing in anabiontics implies that persistence is beneficial. A coupled system can become better at reconstructing an undesirable state. Pathological inflammation can acquire memory. Microbial communities can stabilize into configurations that resist restoration. A symbiotic relationship can become exploitative while remaining persistent. A material history can increase sensitivity rather than resilience.

I use State Delta for a system-relative region of state space that is persistent or accessible but undesirable relative to the objective of the experiment. Delta is not a moral property of biology. It is a directional classification imposed by the defined system and goal.

This distinction is necessary because anabiontic behavior is defined by persistence function, not by benefit. A signal that preserves one biological partnership may destabilize another. A material that maintains fungal state may provoke an undesirable immune state in an animal. A persistent response can therefore be an engineering success in one system and a failure in another.

Sensitization illustrates the logic clearly. A first exposure can alter the receiving system so that a later exposure produces a different and stronger response. The material need not remain between encounters. What persists is the changed biological organization through which the later encounter is interpreted.

Within the language developed here, that is movement through state space with history-dependent consequence. If the resulting state is undesirable, the trajectory is toward Delta rather than Omega.

The objective of anabiontic engineering is therefore not persistence alone. It is directed persistence: identifying which trajectories are being opened, which states are being stabilized, and whether recovery after disturbance returns the system toward the intended region.

7. Experimental Navigation of State

A state-centered experimental program follows directly from the framework. The first requirement is to define the coupled system and identify the persistence-governing role established in Part I. Only then should a candidate signal, material, or structure be tested as an anabiontic.

The second requirement is to specify the starting state. Because history matters, a material cannot be interpreted independently of the condition of the system receiving it. Baseline redox state, developmental stage, partner composition, previous exposures, structural organization, and recovery history may all be relevant.

The third requirement is to separate immediate effect from trajectory. Measurements should distinguish transient activation from persistent reorganization. A candidate intervention should be followed through withdrawal, recovery, disturbance, and re-exposure whenever possible.

The fourth requirement is to test sequence. If two signals are involved, both X-then-Y and Y-then-X may need to be examined. If a structural condition emerges between exposures, it should be treated as part of the causal sequence rather than as background.

The fifth requirement is to test reconstruction. A state that appears once under highly controlled conditions may be interesting, but a state that reappears after disturbance demonstrates a stronger form of organization. Recovery assays therefore become central to anabiontic state engineering.

These experiments produce a different kind of biological map. Instead of asking only which molecules cause which effects, they ask which histories move a coupled system between stable or recoverable states.

8. From Persistence Governance to State Engineering

Anabiontics I argued that biological partnership requires persistence governance and that this governance is executed through signals, materials, structures, interfaces, and feedback. Anabiontics II extends that claim by recognizing that the same persistence-governing mechanisms also alter the trajectories available to the coupled system.

The central consequence is that biological possibility is partly historical. A genome constrains what a system can do, but the state actually reached depends on the path taken through signaling, structure, interaction, and material environment. Some states may remain inaccessible not because they are genetically impossible, but because the system has never encountered the sequence of conditions required to construct them.

Anabiontic engineering therefore asks four linked questions. What state is the coupled system in now? What anabiontic conditions can open access to another state? What allows the new organization to maintain itself after the initiating condition is removed? What allows that organization to reconstruct after disturbance?

This framework preserves the relational discipline of Part I. Anabiontics is not a synonym for any molecule that changes phenotype. The relevant material must be interpreted within a defined coupled system and a persistence-governing role. Part II adds only that persistence governance has a directional consequence: it changes where the system can go.

The resulting frontier is not simply the discovery of new organisms, genes, or compounds. It is the systematic discovery of states and trajectories already latent within biological systems we possess.

The theory therefore moves from a question of continuity to a question of navigation. Part I asks who governs persistence and through what material means. Part II asks what states become reachable when that governance is deliberately altered.

If the framework is correct, some of the most important biological diversity still undiscovered may not be taxonomic diversity at all. It may be state diversity: stable or recoverable organizations that existing biological systems can occupy but that their ordinary histories never reveal.