génera

open letter

Généra. Open letter
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— *Φύσις κρύπτεσθαι φιλεῖ*
Nature loves to hide
Ἡράκλειτος

But sometimes, we are the ones who bury it.

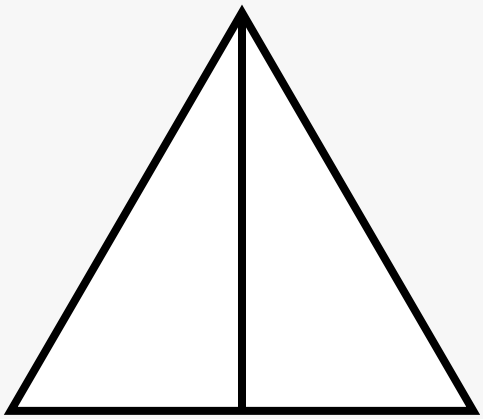
Tissue engineering is at a stalemate. It has become increasingly apparent that its initial promises were only partially fulfilled, falling short of their ultimate goals. While technologies like bioprinting and organoid development have profoundly impacted areas such as prosthesis creation, organ replacements, artificial meat production, and drug testing, their development trajectory has notably deviated from the initial promise of solving the organ generation issue.

The initial conceptual clarity has to be bracketed. Philosophers often invent new concepts by using common language in a specific way. The starting **structural mantra** that tissue is a mere collection of cells and ECM has led us into an epistemological pit with barely any chance to escape. The rope to the surface is to pose an ultimate question in tissue studies — on tissue and its identity.

Essence is not something what descends to us. It is what philosophers craft using language in a specific way. Therefore, the **main difference between tissue and tissue engineering** is what to be raised and nurtured all the way to its philosophical maturity.

In our situation we literally have to run away from our preconceptions on tissue engineering. The TE fortress has to be abandoned for a while, so we can come back with a new knowledge.

A=A?
Tissue = Tissue?



It is almost a truism and a platitude now to assert that we are on the verge of something new. The »**shifting of paradigms**« has become a ***modus operandi*** of modern thought. We are always promised that this »new« is the newest and the best one.

However, after the revolution begins, it frequently transforms into the very thing it aimed to change, becoming a caricature of itself. This ironic transformation results in a dilution of its original intent and essence, leading to a situation where the revolutionary ideals are subtly undermined by their own achievements.

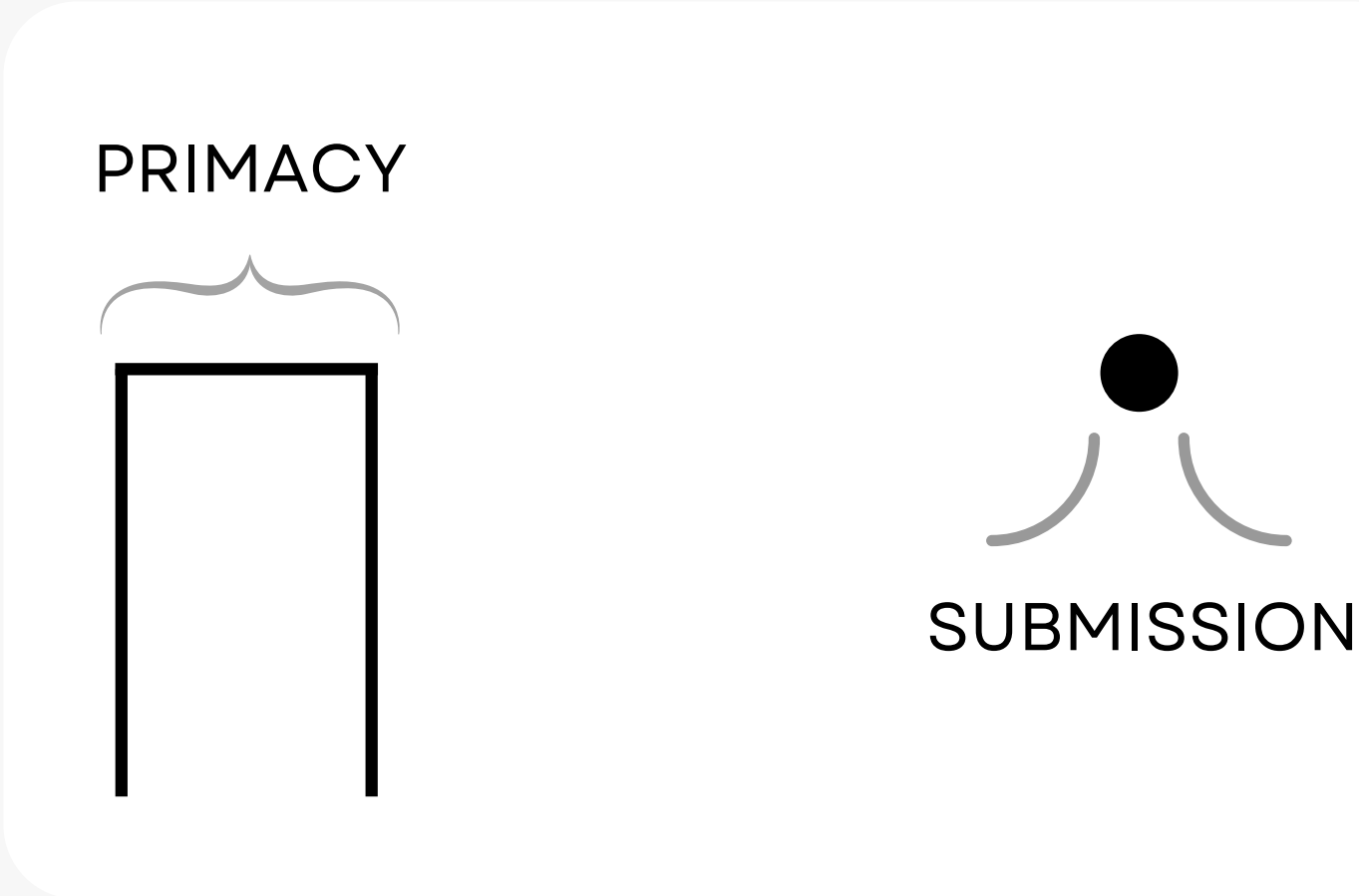
After scrutinizing some of the crucial »revolutions« in tissue engineering development, I began to notice how some fundamental concepts have crystallized through the texture of TE and, most importantly, why it's essential to discern and collect these crystals.

I have spotted the thought pattern that has recently begun to engulf the scientific community, and which can be easily traced back throughout the XX century. We started off with mechanical organs, then transitioned to the decellularization process, and ultimately resided at the Active Matter venue.

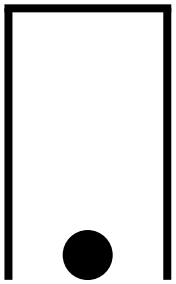
In philosophy, we always deal with something primary and secondary:

- Substance and Accident (Aristotle)
- Essence and Existence
- Cause and Effect
- Noumena and Phenomena (Kant)

For our analysis of TE, we can consider the categories of **Form and Matter** as members of this dichotomy. In an attempt to visualize what I mean, I will resort to schematic representations of the concepts discussed. The bottom of a figure will be reserved for Matter and the top for Form by default, but their significance will change. A small black circle means »submission,« and the open rectangle symbolizes »primacy.«

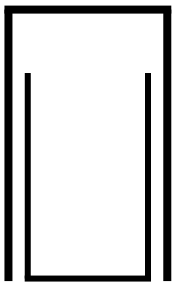


Using these simple elements, we can craft a quick yet elegant classification of conceptual TE (Tissue Engineering) approaches to work with.



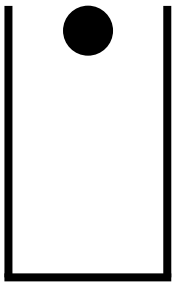
Morphism

Artificial mechanical and transplant organs prioritize form over matter, echoing early biomedical engineering attempts that focused on replicating organ structures, often at the expense of intricate biochemical functionalities.



Hylomorphism

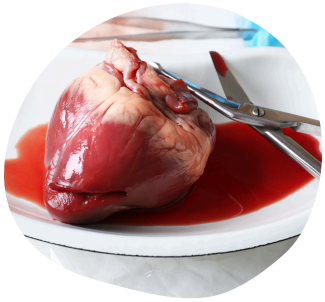
This highlights artificial living organs where form and matter, reflecting Aristotle's hylomorphism, are melded holistically in tissue engineering, underscoring their equal importance in crafting a functional organ.



Hylism

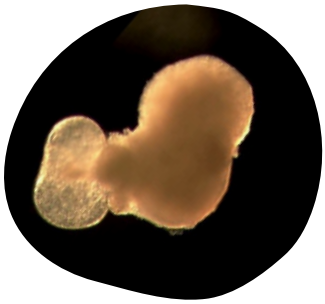
This signifies self-assembling organoids where matter leads and form follows. Rooted in Hylozoism, it implies with the right components (matter), the desired structure (form) will spontaneously emerge, mirroring advanced methods like organoid culture.

Our TE approaches can be straightforwardly related to these concepts and explained in their terms. For the sake of simplicity, I have chosen the heart as a test subject here.



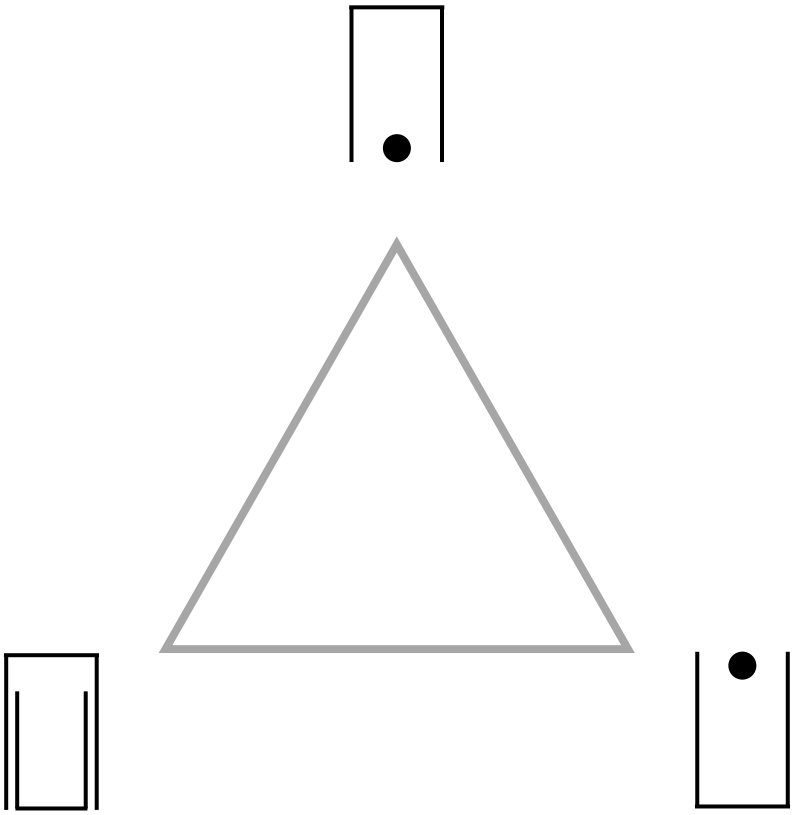
In both mechanical and living heart transplants, the overriding principle is the dominance of the donor's form. This form, whether artificial or biological, supersedes the recipient's matter, imposing its own cellular architecture and operational mechanisms.

A recellularized heart bridges the realms of biology and engineering. A normal heart is decellularized to retain only an empty scaffold (form), which is then repopulated with the patient's own cells (matter), blending biological authenticity with engineered precision.



In scenarios where form is secondary, heart organoids emerge. Cells, acting as active matter, autonomously assemble into heart components or even an entire heart, showcasing a blend of self-organization and biological intricacy.

It seems that conceptualization often comprises three elements, possibly because we find comfort in smaller numbers like 3 (*Plato, Hegel, Kant*) or 4 (*Aristotle, Heidegger*). Following this common affinity for the number »3,« we can introduce a new concept: the Tissue Engineering Triangle (TET).



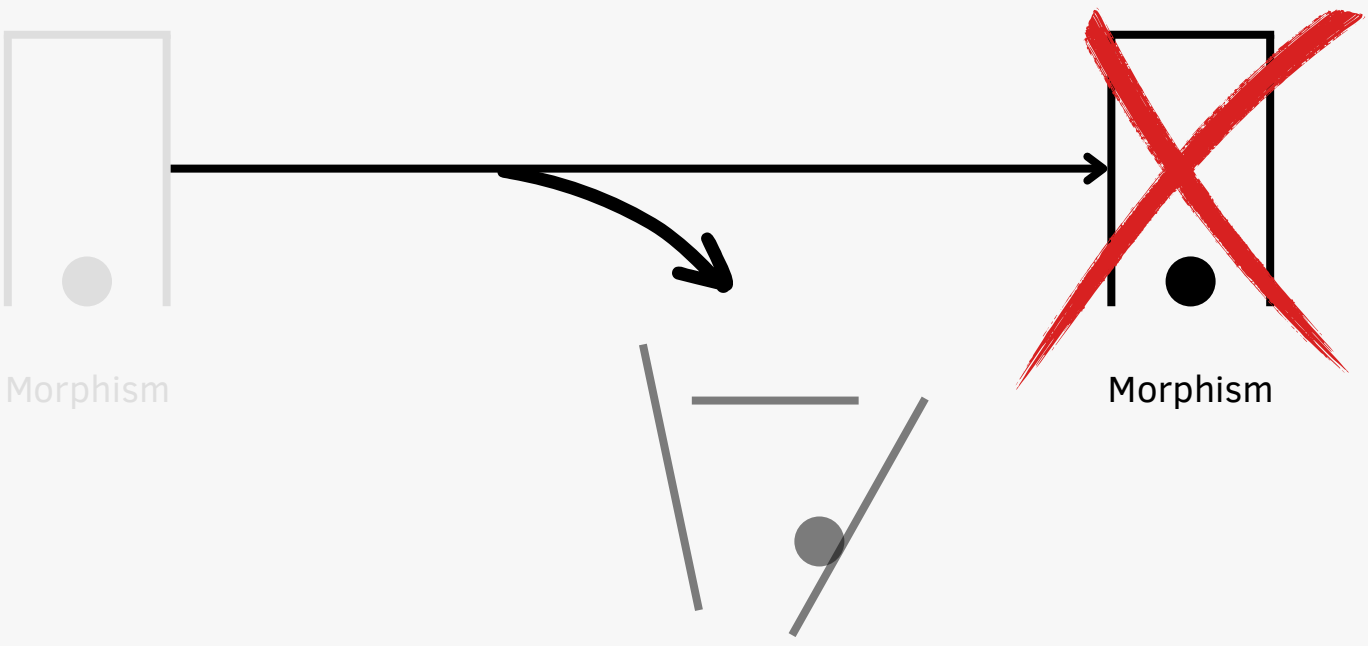
Tissue Engineering Triangle (TET)

What interests us the most in this triangle, is the **triangle itself**. How do we switch between these different modes? How can we employ this »switching« to our tissue engineering practices? Is it really a triangle and there are no other nodes?

The mode of production for textural objects starkly contrasts with that of simple technological objects. The technology required to produce a piece of tissue dramatically diverges from our household utensils. The paradoxical outcome of our thought experiment is that all corners of the TET **simultaneously fit and don't fit for tissue production**.

There's always a promise that this exact mode of tissue production will eventually yield real organs, yet the revolution halts near its end. This resonates with the accelerationism movement, where ever-new innovations must emerge for the sake of these innovations, simply to accelerate the capitalistic machinery.

Aporetical choice between form and matter is not a choice of either. Maybe just choosing to be *aporetical* is what is necessary. A random navigation through the constellation of methods is not feasible though. What is to be achieved is a roadmap with establishment of basic differences in TE concepts, which leads us to a basic **Periodic Table of Tissue Engineering**. My proposal is for us to **seize this pivotal moment to establish standards in this domain**



Discursive Horizons

The Liminality of Tissue. Liminality, a phase of transition, in tissue engineering refers to the state where matter is active yet not yet a functional tissue or organ. Analyzing these liminal states could shed light on the recurrent stagnation in the tissue engineering, and how the revolution can achieve its anticipated culmination

Bioprinted Meat: The Unfinished Hylomorphic Revolution. The anticipated bioprinting upheaval has been commodified to produce an unfinished textural rite—artificial meat. This half-dead, half-alive matter is not a byproduct of bioprinting; rather, it's its *ultimate product* and the logical conclusion of the revolution. It's time to *revolve the revolution.*

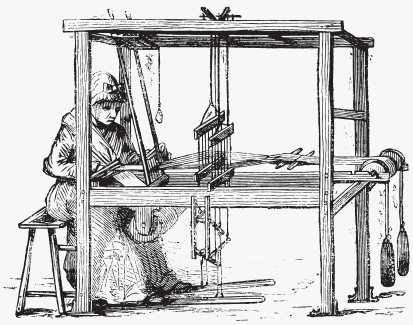
Tissue Engineering Periodic Table. The conceptual evolution of tissue engineering propels us towards a lucrative realization—there are myriad such conceptualizations. To avoid getting lost in these intellectual rainforests, a navigational blueprint is imperative. Only then will the *textural Holzwege* transform into a straight path.

At the end of the day, the Tissue Engineering revolution has to be completed. And there is a conceptual machine, which can do exactly that. For the sake of our discussion, let's call it **Généra**, the first machine to be able to weave the tissues.

We have to be careful though not to let another »*new method*« to occupy this realm just for the reason of this method being new. This machine is a major result of the tissue engineering periodization and finding an empty spot, which is to be replaced with another machine, but which will fit in the overall organization of this table.

We don't want to risk inventing a new method, but not from our fear. There is simply **too little risk in the risk itself**. To truly advance the revolution in tissue engineering, we must seize control of its essential components, seize the »a) telephones, b) telegraphs, c) railway stations« of tissue engineering to bring the revolution to its end.

This mission cannot be achieved through the efforts of tissue engineers alone; professionals from diverse fields of science and culture are invited to contribute their expertise to unravel this old puzzle, the enigma of tissue **génération**.



générate