The text: “There have to be invented appropriate symbolic images of the relevant chemical and physical processes”

1. Images:

Images and diagrams are widely used in scientific textbooks. In the ‘village of scientists’, use of images has a clearly prominent place, but on reading the textbooks one has a definite impression that images would be seen as extras – useful for teaching and communication but not central to the work of scientists.

This would not be the view taken in the text above – ‘there have to be invented’. Such importance for images would seem strange and anomalous in the ‘village of science’. This would contrast with the central importance of the image for all areas of human enquiry in *Insight* – ‘τα μεν ουν ειδη ….’ is a quote that could not be given a more prominent place.

Early on in *Insight* this importance is put very strongly. In his inquiry into the genesis of the definition of the circle, Lonergan writes “Eliminate the image of the centre, the radii, the curve, and by the same stroke there vanishes all grasp of necessary or of impossible roundness. But it is this grasp that constitutes the insight. …. It follows that image is necessary for insight.”

The place of the image in science is put thus in *Verbum* p.29. The necessity of the image or phantasm regards “not merely the genesis but also the use of scientific grasp. …. The difference between invention or learning and use of science is that, in the first instance, phantasm has to produce the act of insight whereas, in subsequent instances, informed intellect guides the production of an appropriate phantasm; in other words, in the first instance, we are at the mercy of fortune, the subconscious, or a teacher’s skill for the emergence of an appropriate phantasm; we are in a ferment of trying to grasp we know not what; but once we have understood, then we can operate on our own, marshalling images to a habitually known end.”

2. Chemical and physical processes:

Again, in the ‘village of scientists’, one suspects that, in the study of the organism, the place of chemical and physical processes would be seen in a more or less reductionist light. Biological processes can be reduced to chemical and physical processes in a quite determinist way. This is the spectre of Laplace that would claim that if we knew all the chemical and physical happenings in the organism, then this would be all we needed to know to understand its functioning?

*Insight* would take a clear stand against this. Far from operating within the organism in a deterministic way, chemical and physical processes in the organism are the materials that biological processes use to build on to reach a higher level - biological existence. Nor are chemical and physical processes determined by the biological level. There is an autonomy of the different levels. Chemical and physical processes operate autonomously according to the laws of chemistry and physics, and from a biological point of view they operate, not in a deterministic
way, but as an autonomous random aggregate of chemical and physical events, which can be used and systematised for biological purposes. One might say that chemical and physical processes are to be viewed not deterministically but opportunistically.

In the ‘village of science’, this would not be a readily appreciated view. It would seem to go against the grain of what science is attempting to achieve. To deny that biological science can explain life in chemical and physical terms seems to run counter to a spontaneous anticipation of scientific enquiry. To link chemical and processes to biological processes, not by direct causation and reduction, but in terms of possibilities and probabilities is to be seen as a cloak for ignorance.

3. Appropriate images:

An appropriate image will be an image that gives rise to the understanding required. The clearest example of an appropriate image might be the constructions used in geometry to allow us to prove theorems. However, even an appropriate image does not determine having the insight that leads to the solution. Having the insight emerge is a probabilistic event - sometimes it happens, sometimes it does not.

In science, there are some images for aggregates of random events. There is the image from physics of a volume of gas as molecules in continuous random collision with one another. It seems a very easy and fruitful image to work with. If one increases temperature, there is the image of increased mobility of the gas molecules thus increasing pressure. Hence the gas laws are reduced to an understandable mechanism.

In the ‘science village’, one suspects, this would be the kind of appropriate image that should be sought for linking chemical and physical processes to biological processes. This however is a reductionist image, and while entirely successful and fruitful for the gas laws, is not going to bear fruit as an image for non-reductionist emergent processes.

So, what of appropriate images for emergent processes, and do we not have access to an instance of an emergent process in a very personal way? When we come to understand something, when we ponder a symbolic image in geometry and come to experience the dawning of the insight we seek, do we not personally experience an emergent probabilistic process. We ponder and we struggle, we wait and we hope. This is going on all the time in our lives, but how do we understand this process; what image of it do we have? Also, Lonergan maintains that the relationship of the higher sciences to a lower science, like the relationship of image to insight, are both instances of the matter-form couplet. So, do we have any images of the relationship of material cause to formal cause?

But is it not the case that seeking to invent such images is not actually what is being spoken of in the text above? The statement is that there have to be invented images of relevant chemical and physical processes, not images of an emergent process as such.

4. Relevant chemical and physical processes:
The reason chemical and physical processes are being mentioned in the text is that the consideration of these processes is the path forward to full explanatory science in the study of the organism. This is the third step, following on anatomy and physiology. Physiology is not seen to be an explanatory science, and only reaches a knowledge that relates the capacity-for-performance of parts to the capacities-for-performance of other parts. One wonders if this would be seen as somewhat odd and anomalous in the ‘village of science’. Indeed I wonder this myself.

Take for example the study of the heart as a pump. The capacity of the heart muscle as a pump can be related to the capacity of the nerves as control mechanisms and the capacity of the peripheral circulation as resistance against which the heart has to pump etc. And so we can get a biophysics of the heart in terms of blood pressure, heart rate, stroke volume, peripheral resistance, cardiac output etc.? But why is this not explanatory science, why is this relating capacities-for-performance of parts viewed as at the level of things-for-us and not the thing-itself?

It seems that to reach the thing-itself, it is necessary to link physiology with the underlying manifolds of chemical and physical processes. ( So, is the idea here that one has to go beyond, for example, a knowledge that stimulating the sympathetic or parasympathetic nerves increases or decreases heart rate (this, it seems, is only a capacity-for-performance related-to-us), to a knowledge how this happens – e.g. to the flows of adrenaline and acetylcholine between nerve endings and muscle receptors and even deeper into biochemistry of adrenaline, or the biophysics of active transport across cell membranes?)

In the transition of this third step, where one links physiology with biochemistry and biophysics, “there have to be grasped by insight the laws of the higher system that account for regularities beyond the range of physical and chemical explanation”. An appropriate image is needed for insight to grasp the laws of the higher system. But what are these laws?

Could one such law, for example, be a mathematically formulated law accounting for blood pressure in the cardiovascular system? It would seem not. The laws are to be used to construct ‘the flexible circle of schemes of recurrence in which the organism functions’; and it is this flexible circle of schemes that is ‘coincident with the related set of capacities-for-performance that previously was grasped in sensibly presented organs’ – i.e. physiology. So, if not ‘laws’ of physiology, what are laws of the higher system, to be grasped by insight in an appropriate image of relevant physical and chemical processes?

As we have seen, the key understanding of the relevant physical and chemical processes is that they are random aggregates of physical and chemical events operating autonomously at their own levels. This non-systematic aggregate is systematised by the laws of the higher level. I am struggling to make sense, to come up with an example, here. Since I would have a background in physiology and biophysics and not biochemistry, again I would instance transport across cell membranes. At the level of a physical process, ions and molecules will move non-systematically according to their own laws to establish distributions across membranes. The higher system on the organism will want to establish new regularities in distributions across membranes, such as those required for action potentials of the nerve cell. Is this ‘law of the action potential’ an example of a higher system law?
However, I suspect that this is not what Lonergan is advertting to when he speaks of higher laws. One has the impression that appropriate images have yet to be found and higher explanatory laws yet to be discovered.