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Engels, Reductionism and Epigenetics: The Lysenko Debate

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ABSTRACT: This article has three goals: To reprise Engels' view of dialectical change; second to review how epigenetics challenges classical genetics and assess its tenets against those of Trofim Lysenko; finally, to consider the political rise of Lysenko. Engels viewed interconnectedness and change as key principles of nature and society, as did Marx. Eschewing a-priori schematization, both viewed theory as derived *from* and tested *by* practice. Western classical genetics and Lysenkoism took diametrically opposite forms of reductionism. Genetics ignored cell-organism interactions with the environment, adopting predeterminism; Lysenko stressed cellular roles minimizing genes. However modern epigenetics supports Engels' rejection of an 'either-or' mentality. Parallel historical reductionism places Stalin in sole command of the USSR. Two intersecting reductionisms—in biology, and in political history—need updating to understand Lysenkoism.

KEYWORDS: Engels, reductionism, epigenetics, The Lysenko Debate, Lysenkoism, Stalin.

1. INTRODUCTION

The dominant, determinist view of genetics seemed assured when Watson and Crick discovered deoxyribonucleic acid (DNA). This was hailed as a 'code of life', or 'program':

> The completely individualistic and yet also species-specific DNA program of every zygote, which controls the development of the central and peripheral nervous systems, of the sense organs, of the hormones, of physiology and morphology, is the **program** for the behavior computer of this individual. (Mayr 1976, 365)

Such a Manichean view mirrored the Lysenkoist espousal of cytoplasm *against* the nucleus. Projecting back to the 1940s from the DNA viewpoint of the 1960s, makes Lysenko's theories appear bizarrely wrong. Yet Lysenkoist theories were *not* unusual in international genetics then, and that

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divide extended beyond the 1940s. This article asks these specific questions: How did Engels understand nature? How did the divide between proponents of gene and those of the cell develop? How does modern genetic theory sit besides Morganism and Lysenkoism? Finally, how did Lysenko come to scientific power? I argue that reductionism cannot explain genetics or Soviet history.

2. ENGELS ON NATURE AND DIALECTICS

Marx and Engels disparaged 'mechanical materialism' now more commonly termed 'reductionism'. J.D. Bernal characterized this as:

> [...] a reduction of all the universe to a number of separate abstract categories: space, time, matter, motion, Now the whole body of the scientific knowledge of the universes does not rest at on the possibility or actuality of a reduction to those categories, There are still only very small parts of the scientific fields which can be treated in this way, and the attempt to understand it upwards from pure mathematical physics to sociology is faced with a series of impassable breaks which are merely slurred over with a pious hope that we will calculate. (Bernal 1949, 369)

Engels believed two main principles imbued nature—the universality of change (coupling transformation and negations); and a 'holism' (expressed as interpenetration of opposites). He thought these were 'intuitively' understood by Greek natural philosophers, but ignored in later mechanical materialism.

The Attacks on Engels by Lukács

Especially after the 20th Party Congress CPSU(B) when Stalin was denounced, Engels became unfashionable in a left influenced by Georgy Lukács. Only recently have Marxists more willingly refuted Lukácsism, to praise Engels' *Dialectics of Nature* (Kangal 2020; Foster 2020; Sheehan 1993; Blackledge 2020). Engels had already faced attacks earlier prompting Lenin's (1962) counter in *Materialism and Empiriocriticism*. But in 1923 Lukács launched a new attack to join Marx to Hegel: "The conception of society that Lukács articulates owes as much to Hegel as to Marx" (Stahl 2018).

Lukács pleaded he had to rescue Marx from Engels' clutches: "(I am) defending orthodox Marxism against Engels himself [...] We adhere to Marx's doctrines, then, without making any attempt to diverge from them, to improve or correct them. The goal of these arguments is an *interpretation*, an exposition of Marx's theory *as Marx understood it*" (Lukács 1993, 131).

Sheehan (1993) shows that Lukács retains currency. Lukács inspired several 'Western Marxisms' (Anderson 1987), including Alfred Schmidt: "Lukács […] deserves recognition as the first to oppose Engel's fateful attempt to extend the dialectic to cover pre-human and extra-human nature, by pointing out how important it is precisely for materialism to restrict the dialectical methods to the socio-historical areas of reality" (Schmidt 2014, 168).

Lukács especially repudiated Engels' on practice as a test of theory or science:

> Engels' deepest misunderstanding consists in his belief that the behavior of industry and scientific experiment constitutes praxis in the dialectical, philosophic sense. In fact, scientific experiment is contemplation at its purest. The experimenter creates an artificial, abstract milieu in order to be able to observe undisturbed the untrammelled workings of the laws under examination, eliminating all irrational factors both of the subject and the objects, He strives as far as possible to reduce the material substratum of his observation to the purely 'rational' product, to the 'intelligible' matter: of mathematics. (Lukács 1993, 3)

Lukács thus places "pure" thought into an idealist framework.

Did Marx and Engels Diverge on Key Principles of Dialectics?

There is no need to 'defend' Marx from Engels. In their long partnership Marx and Engels conceptualized societal change in the *The German Ideology*, but then divided their labours. Marx delved into the economics underlying changes in society. Engels, after retiring from his 'day job', began to systematize their joint views on philosophy and nature. While Engels never finished he left clear directions in his completed philosophical works only as polemics against Duhring, and Feuerbach. Hence it is fatuous to extract a finally worked out theory of, say heredity. But Engels does state principles underlying a universe where three 'laws' play out. These are traceable today, but I stress two principles. First, a principle of change, or 'flux' being primary in the universe. Marx agreed, depicting 'society' as a metaphorical 'organism': "the present society is no solid crystal, but an organism capable of change, and is constantly changing" (Marx 1976b, 93).

For Engels this constant change was fundamental: "The whole of nature, from the smallest element to the greatest, from grains of sand to suns, from protista to men, has its existence in eternal coming into being and passing away, in ceaseless flux, in un-resting motion and change" (Engels 1987b, 327).

Such change came about through 'motion', although such motion was easier to grasp in inanimate nature than in organic nature:

> The investigation of the nature of motion had as a matter of course to start from the lowest, simplest forms of this motion and to learn to grasp these before it could achieve anything in the way of explanation of the higher and more complicated forms. […] Only after these different branches of the forms of motion governing non-living nature had attained a high degree of development could the explanation of the processes of motion representing the life process be successfully tackled. (Engels 1987b, 362)

Only such intense awareness of 'flux' explains how Engels could write before Darwin's 'Origins' publication (1859), in 1858:

> So much is certain; comparative physiology gives one a withering contempt for the idealistic exaltation of man over the other animals. At every step one bumps up against the most complete uniformity of structure with the rest of the mammals, and in its main features this uniformity extends to all vertebrates and even—less clearly—to insects, crustaceans, earthworms, etc. The Hegelian business of the qualitative leap in the quantitative series is also very fine here. (Engels 1936, 114)

This leap was a movement of change, not in a linear but a 'spiral' form of motion. In 1878 Engels' outlined his 'General Plan':

> Dialectics as the science of universal inter-connection. Main laws: transformation of quantity and quality—mutual penetration of polar opposites and transformation into each other when carried to extremes-development through contradiction or negation of the negation—spiral form of development. (Engels 1987b, 313)

Engels' second major principle was opposition to rigid 'hard and fast lines'. This utilises two laws—the inter-penetration of opposites, and the negation of the negation:

> Dialectics, so-called objective dialectics, prevails throughout nature […] Hard and fast lines are incompatible with the theory of evolution. Even the borderline between vertebrates and invertebrates is now no longer rigid […] just as that between fishes and amphibians, while that between birds and reptiles dwindles more and more every day […] Dialectics, which likewise knows no HARD AND FAST LINES, no unconditional, universally valid "either"-"or" and which bridges the fixes metaphysical differences […] and reconciles the opposites, is

> the sole method of thought appropriate in the highest degree. (Engels 1987b, 492–493)

Thus for him, polar opposites weave into each other. In biology the complexity of living systems frequently revived 'vitalism'—a 'living force' arising from inexplicability and/or theology. Complexity forced some to a mechanical application of dialectics, lapsing into vitalism. Against this simplification Engels demanded more data, rejecting reductionist pseudo-explanations to fill gaps:

> In organic nature the category of force is completely inadequate and yet continually applied. True, it is possible to characterise the action of the muscles, in accordance with its mechanical effect, as muscular force and also to measure it [...] One can even think of other measurable functions as forces, e.g. the digestive capacity of various stomachs, but one quickly arrives ad absurdum [...] This misuse however, has led to speaking of a vital force [...] The last refuge of all supernaturalists. (ibid., 560)

In short vitalism cannot resolve inexplicability of complexity, as the 'whole' does not equal the 'parts':

> Part and whole, for instance are already categories which become inadequate in organic nature. The ejection of seeds—the embryo—and the new-born animal are not to be conceived as a "part" that is separated from the "whole"; that would give a distorted treatment. It becomes a part only in a **dead body**. (Hegel quoted in Engels 1987b, 494)

Engels realised that dissecting portions away enabled deeper study, but such processes were 'for everyday use': "of course for everyday use, for the small change of science, the metaphysical categories retain their identity" (ibid.). This is why Engels resonated with developmentologists in the 1930s *Theoretical Biology Club* (Peterson 2017). Though some preferred Whitehead's 'Holism', Bernal especially recognized Engels' priority (Bernal 1937).

Engels did not announce a-priori theoretical rules. Engels insisted that only 'strictly scientific research' reveals the underlying dialectic. Factual bases enabled later scientists to transcend the Greek 'brilliant intuition'. Lack of facts in evolutionary history, rendered Lamarck not more than "anticipatory": "We must not overlook the fact that in Lamarck's time science was as yet far from being in possession of sufficient material to have enabled it to answer the question of the origin of species except in an anticipatory way, prophetically, as it were" (Engels 1987a, 69).

Instead of foisting theory onto nature, Engels argued to move from observation to theory: "In every field of science as in historical science, one must proceed from the given facts, in theoretical natural science too the inter-connections are not to be built into the facts but it be discovered in them, and when discovered to be verified as far as possible by experiment" (Engels 1987b, 342–343).

Marx agreed fully when discussing societal changes with the 'critic' Mikhailovsky: "By studying each of these evolutions on its own, and then comparing them, one will easily discover the key to the phenomenon, but it will never be arrived at by the all-purpose formulae of a general historico-philosophical theory, whose supreme virtue consists in being super-historical" (Marx 1989, 201).

Some Specific Views on Heredity

In the late 1800s Engels could not specify specific theories. Yet he had startling insights, through a lens of interconnectedness and unity of opposites. For example, the interplay of heredity and adaptation:

> One can conceive of heredity as the positive, conservative side, adaptation as the negative side that continually destroys what has been inherited, but one can just as well take adaptation as the creative, active, positive activity, and heredity as the resisting, passive, negative activity. But just as in history progress makes its appearance as the negation of the existing state of things, so here also—on purely practical grounds—adaptation is better conceived as negative activity. (Engels 1987b. 492–493)

> Duhring states […] nice trash about preformationism. Nothing is easier than to turn such opposites, like all other opposites of this kind, around and prove that adaptation, precisely by altering the **form** preserves the essence, the **organ itself**, while heredity, by the fact alone of the mixture of 2 individuals different each time, constantly brings about changes the accumulation of which does not exclude a change in species. As a matter of fact, the results of adaptation are also inherited! [...] Haeckel is quite right in considering heredity essentially the conservative, positive side of the process and adaptation, its revolutionising, negative side. (Engels 1987c, 600)

Opposing the later Lukács, Marx used the same processes as Engels, when settling accounts with Proudhon:

> this thesis […] opposed to itself, splits up into two contradictory thoughts—the positive and the negative, the yes and the no. The struggle between these two antagonistic elements comprised in the antithesis constitutes the dialectic movement. The yes becoming no, the no becoming yes, the yes becoming both yes and no, the no becoming both no and yes, the contraries balance, neutralise,

> paralyse each other. The fusion of these two contradictory thoughts constitutes a new thought, which is the synthesis of them. This thought splits up once again into two contradictory thoughts, which in turn fuse into a new synthesis. Of this travail is born a group of thoughts. This group of thoughts follows the same dialectic movement as the simple category, and has a contradictory group as antithesis. Of these two groups of thoughts is born a new group of thoughts, which is the synthesis of them. Just as from the dialectic movement of the simple categories is born the group, so from the dialectic movement of the groups is born the series, and from the dialectic movement of the series is born the entire system. (Marx 1976a, 162–63)

Summary: Engels argues that change and the inter-penetration of opposites are crucial. How did genetics fare by ‘tests of practice’ over the next 100 years?

3. BUILDING THE GENETIC AND EVOLUTIONARY STANDARD NUCLEAR LINE

This potted history of genetics hopefully assists interpreting later controversy. Ernst Mayr, the evolutionist echoes Engels, opposing ‘continuity’ to ‘change’ in heredity: “Intuitively all students of nature felt the existence of some conflict or contradiction between the facts of inheritance and those of variation. Inheritance implies continuity and constancy; variation implies change and divergence” (Mayr 1982, 681).

This tension played out in the 1900s. Controversy engulfed the proposed primacy of the nucleus against the cytoplasm of a cell (Sapp 1987). Those promoting the cytoplasm resented the ‘nuclear monopoly’ established in the ‘fly room’ of Thomas Hunt Morgan: “Many German investigators fought vigorously against what they called the “*Kernmonopol*” (“monopoly of the nucleus”) [...] far into the twentieth century” (Churchill 1987, 357).

In the 19th century heredity was still loosely conceived as a blending of characteristics of the two parents. But this was mired in ‘uninhibited speculation’ (Mayr 1982, 668). Biologists were roughly divided into preformationists who argued a prefigured outcome (whether ovists favouring the ovum or as spermists)—or epigenesists relying on unspecified powers of development (ibid., 645). Gradually a particulate theory of hereditary transmission became established. Particles now did not ‘blend’ but retained separate agency. After Darwin and Mendel, such particles (gemmules, factors) were located on chromosomes, becoming ‘genes’ in isolated nucleii. How did *Kernmonopol* become established?

Darwin on Heredity and His Particles of Heredity

Engels (1987b, 476) thought evolution was one of three 'great discoveries' transforming views of natural science. Darwin's theory is now fundamental. But reductionists including Richard Dawkins (1976) favour certain aspects. Especially the role of 'chance' or 'non-directed' mutations 'filtered', and retained or discarded by 'blind' natural selection. However, Charles Darwin was inconsistent, also espousing a Lamarckian inheritance of acquired characteristics. Darwin favoured environmental influences to defend the theory of natural selection:

> Darwin nearly always concluded that each of the variations he paraded before his readers was the product of a divergence from a single original source rather than of a convergence due to racial or species crossings. It suited Darwin's theory of speciation that the conditions of life, not hybridization, provided the root cause of such somatic changes. (Churchill 1987, 344)

> We see the young of living beings, become permanently changed or subject to variety, according to circumstances, —seeds of plants sown in rich soil, many kinds, are produced, though new individuals produced by buds are constant, hence we see generation here seems a means to vary, or adaptation. Again we believe (know) in course of generations even mind and instinct become influenced. (Darwin n.d.)

Darwin also highlighted the ubiquitous effects of inheritance: "No breeder doubts how strong is the tendency to inheritance; that like produces like is his fundamental belief'" (Darwin 1958, 35).

> If the varying individual did not actually transmit to its offspring its newly-acquired character, it would undoubtedly transmit to them as long as the existing conditions remained the same, a still stronger tendency to vary in the same manner [...] But if variations useful to any organic being ever do occur, assuredly individuals thus characterised will have the best chance of being preserved in the struggle for life; and from the strong principle of inheritance, these will tend to produce offspring similarly characterized. (Darwin 1958, 97, 128)

Because he lacked experimental proof, Darwin resorted to hypothesis: "My view is merely a provisional hypothesis or speculation; but until a better one be advanced, it will serve to bring together a multitude of facts which are at present left disconnected by any efficient cause" (Darwin 1875). He proposed a particulate 'gemmule':

> Each kind of cell in the body is represented by its own kind of gemmule; the mosaic of characteristics in hybrids is due to the mixing of parental gemmules;

> and the facts of reversion to ancestral characteristics […] is due to the activation of previously dormant gemmules. (Mayr 1982, 693)
>
> […] gemmules were the surplus products of cells; when set free to circulate, they multiplied and provided for new growth, regeneration, and gemmae, and they collected in the gonads to form gametes. (Darwin 1875, 32)

Mendel's Solution to The Problem of Heredity

Meanwhile Gregor Mendel reported (1865) a different heredity, neglected until 1900. Mendel derived 'discrete units' from chemistry and physics (Orel 1984, 32; Sandler and Sandler 1985). In experimental crosses using peas he mapped 15 external characteristics (phenotypes) in 34 varieties. He showed that segregation (separation) of simple characteristics was largely predictable. His 'factors' became the later dominant and recessive genes differing in generations in a 3:1 ratio (Orel 1984, 50, 56). But where—physically—were such factors?

Identifying Chromosomes—The Rise of the Nucleus

Robert Hooke found cells in 1665, as Anton Van Leeuwenhoek described bacteria. Only in 1833 did Robert Brown distinguish nucleus from cytoplasm, after which the Schwann-Schleiden cell theory of life (1842) was stated (Mayr 1982, 652–655). For Engels this was another of three 'great discoveries' (Engels 1987b, 476). Initially ill-understood, functions of nucleus and cytoplasm became clearer. In 1876 Oscar Hertwig watched fertilization microscopically as the sperm pronucleus fused with the egg pronucleus. In 1883 van Beneden confirmed that in threadworm (Ascaris) a full chromosome number was only achieved after fertilisation, half each from male and female parent. August Weismann now defined heredity as lying in chromatin of chromosomes with: "a definite chemical and above all molecular constitution" (Mayr 1982, 699).

Weismann's experiments removed tails in mice with no generational transmission. So he concluded Lamarckian inheritance was incorrect, and now (1893) invoked 'protection' for 'germ cells'. The 'germplasm' or 'nucleoplasm'—was 'reserved unchanged' (Weismann quoted in Robert 2004, 59): "In each ontogeny, a part of the specific germplasm contained in the parent egg-cell is not used up in the construction of the off-spring, but is reserved unchanged for the formation of the germ-cells of the following generation" (Keller 2000, 17).

The germplasm "determined" heredity in military manner. 'Determinants' progressively commanded somatic cells into ever 'simpler brigades':

> (Weismann) posited the existence of particulate determinants, each of which possessed the properties of life, assimilation, growth and reproduction. Arranged in hierarchical groupings along the chromosomes, the determinants were postulated to parade out in the course of ontogeny so as to determine the different types of cells as ontogeny unfolded […] The 'nucleoplasm' as 'an army composed of corps, which are made up of divisions and these of brigades and so on […] and as the groups become simpler so does their sphere of action become limited.' (Sapp 2009, 904)

Thomas Boveri in 1889 also confirmed that normal development sea urchin embryos depended on a full chromosomal number (Mayr 1982, 679, 749). However, embryo development differed whether only male sperm nuclei, or only female egg nuclei, or both—were present. Boveri followed Weismann's eternal protection of nucleus from externality (see Figure 1.a).

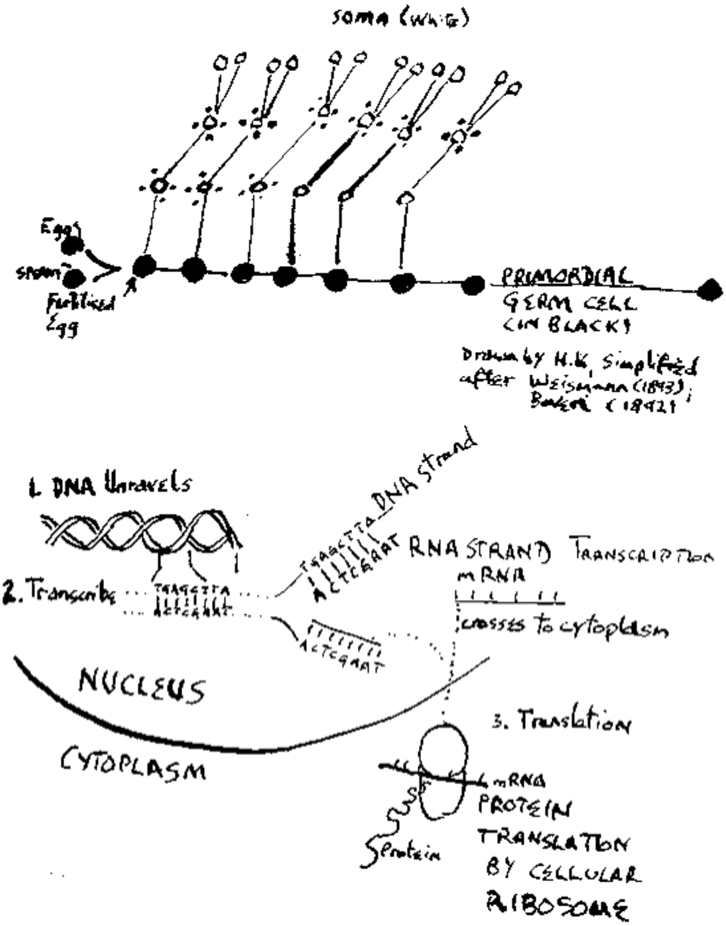
Mendel's Factors Become the Gene

In 1900 De Vries, Correns and van Tschermark each independently verified Mendel (Mayr 1982, 727–731). Since each chromosome was unique, Walter Sutton (1902) proposed that maternal and paternal chromosomes joining at fertilisation formed "the physical bases of the Mendelian law of heredity" (Sapp 1987; 2009). Wilhelm Johannsen coined the terms ''gene'', ''genotype'' and ''phenotype'' in 1909 to explain Mendel's factors (Mayr 1982, 736; Sapp 2009). In 1928 the Sutton-Boveri theory formalised chromosomes as 'bearers' of hereditary transmission (Mayr 1982, 748).

Biologists began conceptualising genes as lying on or forming chromosomes. Morgan showed mutations in the fruit fly (Drosophila) were associated to phenotypic changes. Yet even in his 1934 Nobel Lecture, Morgan revealingly acknowledged that:

> There is no consensus of opinion amongst geneticists as to what the genes are whether they are real or purely fictitious […] it does not make the slightest difference whether the gene is a hypothetical unit, or whether the gene is a material particle. In either case the unit is associated with a specific chromosome, and can be localized there by purely genetic analysis. Hence, if the gene is a material unit, it is a piece of a chromosome; if it is a fictitious unit, it must be referred to a definite location in a chromosome—the same place as on the other hypothesis. Therefore, it makes no difference in the actual work in genetics which point of view is taken. (Morgan 1934, 315).

Still, gene theory became ever more determinist and mechanistic by the 1940s. Geneticists came to speak of ''a gene for this and a gene for that" (Sapp 2009).



(a)

(b)

Figure 1. Composite Figure Weismann Concepts Old and New (drawn by author).
Legend: The figures show that the concept of an eternal unchanging genetic substance has persisted into the current 'Central Dogma'. This substance was not clearly identified by Weismann and Boveri. However, Figure 1.a shows their concept of the germ cells (in black filled—in circles) being separated off from the body cells or soma (in white open circles). The diagram based on originals from 1900s has been simplified and re-drawn. The notion of an eternal unchanging 'genetic substance' is seen. This depended upon the separation of nucleus and cytoplasm. Figure 1.b shows how this notion underlies the Central Dogma of Crick and Watson from 1950s. After their reports of the structure of DNA, the coding depicted by A, T, G and C marks nitrogenous bases (pyrimidines and purines) that link to each other in specific pairings. These allow for translating a coding at nuclear level into proteins. But their theory permitted only one-way information flow from DNA or RNA (transcription) through to the migration of messenger RNA (mRNA) to the cytoplasm where it is 'translated' into protein by a complex formed with the cytoplasmic ribosomes. DNA and RNA cross-talk was allowed after later modifications.

The Cytoplasmologists and Embryologists—Largely Anti-Reductionist

Actually Weismann's scheme had already been disproven in 1891 by Hans Driesch. Contrary to Weissman's prediction, early experimental division of the fertilised egg did not prevent two normal larvae developing. Correspondingly, embryologists tended to be anti-reductionist:

> Cellular differentiation was not the result of the disintegration of the germplasm. Experimental embryologists thus maintained that development was an epigenetic phenomenon: the fate of a cell was the result of its position in the whole. They turned away from machine theory, and from reductionist conceptions that bestowed the properties of the whole onto parts. (Sapp 2009, 904)

Since Driesch could not explain his results, he invoked 'entelechy' or vitalism. However, this began a long struggle against reductionism and determinism, where:

> […] embryologists conceived of the cell as a whole as an interactive system, and they embraced the concept of emergence […] New atoms with new properties are formed by new combinations of protons and electrons, new molecules by new combinations of atoms. In a similar manner embryologists argued, the distinctive properties of life, and the formation of new materials and qualities in the course of development, arise or "emerge" from the interactions of parts which in themselves do not show these properties. (ibid., 905)

Against Weismann, the American cytologist Ernest Just insisted that: "Ectoplasm was also responsible for the movements of chromosomes, which Just compared to 'puppets in a puppet show'" (İbid., 907).

Even as late as 1950 embryologists like Andre Lwoff echoed Just: "Lwoff's post-war rhetoric against what he called the "dictatorship of the genes" was similar to Just's: "Cytoplasm is not just a collection of enzymes or plastic and complaisant receptor passively submitting to the dictatorship of genes, but certainly contains self-reproducing bodies endowed with specificity" (İbid., 908).

Even as the nuclear-ists became dominant, J.H. Woodger urged biologists to avoid the Chyabdis of 'vitalism' and the Scylla of 'mechanism':

> Within an increasingly positivist philosophical framework, biology, with its remnants of vitalistic thinking and non-rigorous methodology was […] filled with speculation. The outstanding critic […] of biology was J. H. Woodger, who in 1929 […] (criticised) what he viewed as a science in its infancy and rife with metaphysics […] Only after biology paid "critical attention to the purification

> of its concepts," and only by "making sure of its foundations," would it become a mature science. For Woodger, biologists, who thought they had found their Newton in Darwin, were mistaken, since biology had not yet reached a stage in its development comparable to eighteenth-century physics. (Smocovitis 1992, 4)

Perhaps Woodger heard Engels ringing in his ears. Two biologists tried to balance continuity or stability (nuclear forces) with disruption and adaptation (cytoplasmic forces): C.H. Waddington (England) and I. I. Schmalhausen (USSR). Independently they offered 'canalisation' (Waddington) or 'stabilizing selection' (Schmalhausen). At core was an integration of environmental pressures to internalise effects into the genome:

> Schmalhausen argued that natural selection was not only directional, producing new adaptations to new circumstances, but stabilizing. That is, if a characteristic of a species causes it to be well adapted, then random variation in the characteristic caused by external or internal disturbances would reduce the fitness of the organism, so natural selection will operate to prevent such disturbances. The development and physiology of the species will be selected to be canalized, that is, insensitive to such random disturbances. (Lewontin and Levins 2000, 103)

But these voices, and Woodger's—were ignored for some time.

The Evolutionary Synthesis

Ironically J.B.S. Haldane although impressed by Engels, alongside reductionist mathematicians formed the 'Modern Synthesis' of genes and evolutionary theory. As Woodger said, they "found their Newton in Darwin", applying mathematical principles to gene-environment fitness: "Terms borrowed from the physical sciences, like "cause" (Haldane's preferred word), "factor" (Wright's preferred word), and finally "mechanism" (Dobzhansky's and Huxley's preferred word) slowly supplanted the term and the view of selection as agent" (Smocovitis 1992, 20).

Some derided this as a reductionist 'bean-bag genetics' (Dronamraju 2010; De Winter 1997). However, genes were proclaimed the motor of evolution, generating changes driven by random nuclear-chromosomal mutation. This view incorporated 'blind' chance filtered by environment as natural selection, preserving 'superior fit'. Till recently Marxists in modern biology adopted this view, for example Richard Lewontin: "The organism [...] bears a significant mark of random processes" (Lewontin 2000, 38).

However, the 'New Modern Synthesis' faced challenges. Some original insights came from immunology. Since organisms have to deal with external infections queries arose as to how immunity developed. As Radman says:

> A classic example of the generation of genetic diversity is the interaction between infectious agents and the immune system. Viruses and bacteria mutate extensively in an attempt to generate rare variants that can escape the host's immune system. In turn, the immune system mutates to try to create antibodies that recognize these new variants. (Radman 1999, 867)

The Central Dogma

Undoubtedly by the 1960s a *'day to day'* metaphysics had reaped fruitful insights. After Watson and Crick famously discovered DNA (1953), and decoded it (1957), the 'Master Molecule' was hailed (Keller 2000, 51). The similarity to Weismann's Kernmonopol is startling (Figure 1.b). Crick's one-way traffic from nucleus to cytoplasm became the 'Central Dogma': "Transfer [of information] from protein to protein, or from protein to nucleic acid is impossible" (Crick 1970; Sapp 2003).

Even after he modified Crick's Central Dogma (sticking in gene 'regulators' responding to environment) Jacob, still insisted (1970): "The gene gives orders. The protein executes them" (Mosini 2013, 61; Sapp 2009, 909).

But more challenges accumulated, forcing another Nobel Laureate (1994) Phillip Sharp to admit: "The chemical definition of a gene has become much more difficult" (Sharp 1994).

Sharp again modified, making only the gene the 'exon' (parts read into protein transcripts) not the whole DNA. But increasingly the Central Dogma 'master molecule' required patching.

Extended Evolutionary Synthesis Becomes Necessary

A more fluid relationship between DNA and cytoplasm was needed to account for complex switching of two-way signals between nucleus and cytoplasm. At minimum these include: reverse information flow from RNA to DNA (violating 'one-way traffic'); split genes mandating complex splicing of exon-genes for protein transcription (avoiding 'junk DNA' or introns); small non-coding RNAs acting as 'silencers' of DNA (generated by environmental stimuli) and; complex protein folding to unlocking effects of localized cellular environs (Table 1). Figure 2 encapsulates the new picture of two-way messaging that resulted in the Extended Evolutionary Synthesis (EES) (Danchin et al. 2019). Inter-generational ill-effects from stress and poor environment are mediated by methylation marks, incredibly important for humans (Weaver et al. 2004). (see Figure 3).

Table 1. Some Modern Evidence Doubting Validity of Central Dogma. *

New Data	Implication On Central Dogma	Table References
Most prion vectors have no nucleic acids; Most unicellular organisms have no soma-germplasm separation; same true of many "plants, fungi, multicellular monerans and protists, and certain sponges, coelenterates, and worms".	• The Central Dogma is not universal • 'Prions operate outside of canonical steps of molecular biology's central dogma'	Prusiner (1995) Wahl and Murray (2016) Buss (1983) Halfmann and Lindquist (2010)
RNA to DNA information flows using reverse transcriptase, enabling virus to induce host genome to produce virus	• Challenges one-way information only (nucleus to cytoplasm) • Central Dogma did specify RNA to DNA information could occur. However, virus is from outside nucleus boundary	Temin and Mizutani (1970) Crick (1970)
Exons transcribed, not introns ('junk DNA'); split genes; mRNA spliced by spliceosomes (protein–RNA complexes).	• Challenges simplistic one gene—one protein Central Dogma • Before split gene expressed, mRNA edited	Sharp (1994)
DNA copy edits prone to error; require complex repair	• DNA is not as claimed ''self-replicating,'' "DNA by itself can actually do nothing; it is one of the most inert molecules known to science." • Cellular Dogma complex, introduces potential for 'creative errors'—variations for evolution	Lewontin (1992) Radman (2001) Keller (2000, 26) Sapp (2009) Shapiro (1999)
Many proteins will not fold properly if not guided by proteins called molecular chaperones	• Translation of mRNA products require cytoplasm to exert effects	Mosini (2013)
Methylation, histone marks, non-coding RNAs, PWI RNAs (pwi protein), iRNA (interfering RNA) Si (silencing RNA) – complex feedback loops on DNA	• DNA cannot form end biological products itself • See Figure 3 illustrating some of these	Bonasio et al. (2010) Peng and Lin (2013)

Table 1. Some Modern Evidence Doubting Validity of Central Dogma. * (continued)

Concerning Evolutionary Theory		
	Implication on Evolutionary Synthesis	**Reference**
Random 'undirected' mutations are not the sole source of variation; variation can be driven by plastic response to environment.	• Allows cells, organisms to respond by specific mutagenesis to environmental stresses (SOS response) • Random mutagenesis in genome by DNA breaks repaired– limits buildup of potentially deleterious mutations • Targeted environmentally driven mutations exist; provocator genes	Galhardo et al. (2007) Keller (1983) Radman (1999) Shapiro (1999)
Most 'random' mutations are sub-optimal at best, more likely harmful in a ratio of 5 times as un-mutated	• Implies single isolated spontaneous mutations do not drive evolution;	Keller (2000, 32) Radman (1999) Radman, Taddei and Matic (2000)
Presence of horizontal gene transfer; presence of 'jumping genes' transpositions	• Challenges 'gradualism' infinitely small variations drove evolutionary change • Speciation can be faster shifts of genes chromosomes) common across species • Most important in prokaryotes (bacteria) and archaea (another kingdom of bacteria), also applies to eukaryotes (plants and animals)	Koonin (2009) Keller (1983) Quammen (2018) Woese and Goldenfeld (2009)

* The table shows some key objections to the Central Dogma. References given give full explanations of the concepts. For brevity this has been compressed here. The table is broken into two parts, the top relates more to the cellular functioning and division between nucleus and cytoplasm; while the second part shows objections with specific consequences for the evolutionary synthesis of the 1960s.

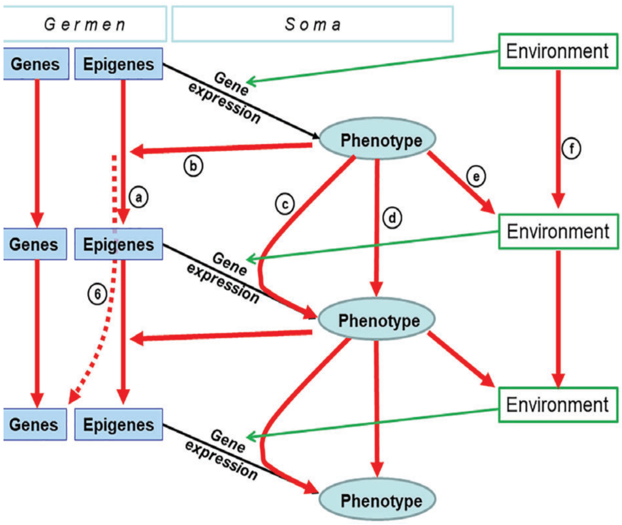


Figure 2. Multiple means of messaging from environment taken into genome (figure 6 in Danchin et al. 2019, 275).

Legend: The emerging view of inheritance that enables a variety of pathways. These allow for 'accumulation' of information from various strands: Development (black arrows); heritable epigenetic marks giving generational inheritance (dotted red arrows); epigenetic marks becoming part of the more stable genome (number 6); environmental signaling (green arrows); designations 'a' to 'f' detail several mechanisms of the way in which reverse information (i.e. cytoplasm to nuclear stable genome and epigenome) can occur. That includes (e) of cultural inheritance.

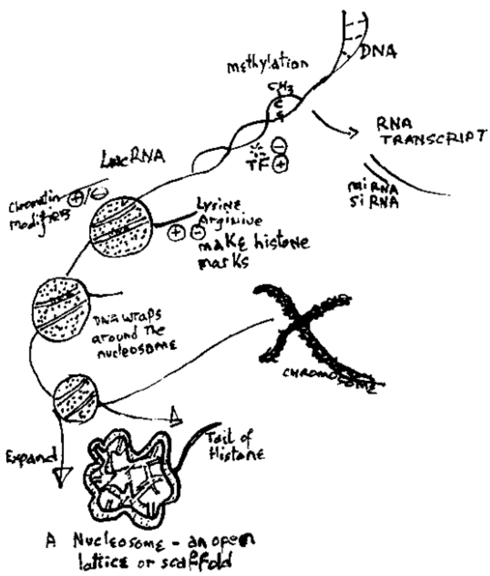


Figure 3. The complexity of the epigenome (drawn by author).

Legend: Waddington first described the epigenotype: "Between genotype and phenotype, and connecting them to each other, there lies a whole complex of developmental processes: (the) 'epigenotype'" (Waddington 2012, 10–13). Most of these are limited to one generation, but some are trans-generational: "Acquired epigenetic signatures […] induced by environment will be erased in the early embryo and germline […] Epigenetic reprogramming restores totipotency of the zygote […] if germline reprogramming fails, epigenetic marks are potentially transmitted from one generation to the next. […] A number of loci (>4500) […] escape reprogramming [...] prime candidates for transgenerational epigenetic inheritance" (Fernandez-Twinn, Constância and Ozanne 2015, 85–95).
1) Chromosomes are chromatin units of four histone proteins and DNA, called nucleosomes. This scaffold allows cells of 1/100 millimetre to pack in a tightly coiled yard-long DNA (Austin n.d.). The 3D structure is complex and non-rigid, allowing electrostatic forces to 'open' or 'close' portions for variable expression (Goldberg, Allis and Bernstein 2007, 635–638). Many external signals make '*histone marks*', altering transcription, especially on 'tails' with sites allowing 'post-translational modification' (methylation, acetylation, phosphorylation, or ubiquitination). This 'histone code' crucially affects gene expression by cinching the chromatin tighter or looser – exposing or hiding gene expression sites. (e.g. lysine 27 of histone 3 (H3K27) and lysine 4 of histone 3 (H3K4) promoters of trained immune genes are acetylated and trimethylated, priming immune genes to establish epigenetic memory to train immune response, e.g. BCG vaccination [Fok et. al. 2019].)
2) DNA itself can also be '*chromatin marked'* at Cytosine-phosphate-Guanine' (CpG) sites. Methyl groups (CH3) are copied onto daughter strands, allowing some to become heritable. Methylation '*silences'* the underlying DNA sequence. Other effects include repelling or attracting transcription factors. Methylation patterns usually arise from environmental changes, or aging or disease. [e.g. '5mC is associated with gene silencing and plays an important role in developmental processes such as genomic imprinting and X-inactivation' (Fernandez-Twinn et al. 2015); or P-DMRs [Pre-natal malnutrition—associated Differentially Methylated Regions] induced by maternal starvation, result in foetal-child suboptimal glucose handling, higher BMI, elevated total and LDL cholesterol (Fernandez-Twinn et al. 2015)]
3) A growing list of non-coding (lc) RNAs do not make functional proteins but affect transcription. RNAs (long [L] and short [s]) include: micro miRNAs; silencing siRNAs; or piwa RNA. Most LncRNAs in the nucleus modify chromatin, to up or down regulate expression [e.g. behavioral and metabolic responses in next generation in traumatic stress' (Fernandez-Twinn et al. 2015); e.g. Immune-gene Priming LncRNAs (IPLs) accumulate H3K4me3 at promoters of trained immune genes (Fok et al. 2019]
4) transcription factors bind onto DNA directly to promote or repress gene expression.
All these mechanisms interact (Meaney and Ferguson-Smith 2010, 1313–1318).

Epigeneticists who had long argued against one-way traffic, were vindicated:

> […] chemical changes of chromatin structure, which have come to be called "epigenetics" or "epigenomics," has led some researchers to confront the notion of the privileged role of genes as causal agents of heredity and development […] In 1942, Conrad Waddington defined "epigenetics" as the causal mechanisms by which genes bring about phenotypic effects. Evidence since the 1970s of "epigenetic marks" on DNA by methylation and chemical modifications of

> histone proteins and their role in the regulation of gene expression in vertebrates has led to a new usage of the term. A new definition of *epigenetics* has been put forward, namely "the study of mitotically and meiotically heritable changes in gene function that cannot be explained by changes in DNA sequences. (Deichmann 2014, 73)

> Today, developmental–evolutionary ideas of the type that Waddington put forward are at the core of the Extended Evolutionary Synthesis. (Jablonka and Lamb 2020, 10)

One striking adjustment invokes reshuffling mechanisms enabling rapid speciation. Gene 'jumping' (transposons) in maize were reported by Barbara McClintlock in 1950 but steadfastly minimised, only in 1983 was she awarded a Nobel (Keller 1983, 8–13). Horizontal Gene Transfer (HGT) was spotted first in bacteria, then in several other organisms. One author drily remarks:

> (One) explanation for the presence of a globin gene in the genome of a plant is that it was translocated there recently in evolution as a passenger on a virus [...] Such a mechanism circumvents the rules of classical Mendelian genetics with rather important implications for our understanding of the mechanism of evolution. (Hyldig-Nielson et al. 1982, 700)

Old conceptions of 'strict' speciation are now untenable (Lewin 1982) and such HGT radical shifts in genome occur across eukaryotic kingdoms including into humans (Quammen 2018, 338–342).

The new model is steadily becoming more detailed (Noble and Noble 2017). Many warned about gene paradigms ignoring the environment (Lewontin 2000, 35; Rose, Kamin and Lewontin 1984; Rose 2002), but were unable to explain the balance between 'continuity' and 'change'. This has become soluble through the 'epigenome': "The "epigenome" comprises a range of modifications that are imposed on the genome (DNA) and ensure the stable transmission of gene expression patterns without changes to the DNA sequence" (Hemberger and Pedersen 2010, 598).

This environmentally formed epigenome itself can become transmitted:

> "Epigenetic disruptors" could change gene activity and in the case of stem cells, alter cell fate or number, causing, for example, an increased risk of cancer. "Epimutations" arising in this way may even pass through the germ line to the gametes, thereby affecting subsequent generations. (ibid.)

Elegant mechanisms explain differing durations in which gene-environment 'switches' operate. This ranges from short-term (a few generations), to much more robustly stable (Danchin, Pocheville and Huneman 2019).

This re-weaves the two separated strands of continuity and adaptation into a coherent mechanism. Nonetheless Dawkins (1976) and company are unlikely to concede quickly the new models that decisively reject Weismann and Central Dogma (Danchin, Pocheville and Huneman 2019).

Lysenko's Biological Theory Comparisons to Modern Epigenetics

Dialectical biologists accepted even in 1985 that: "the major scientific differences between Lysenkoist and geneticists have been resolved by developments in genetics [...] textbooks and practice of most geneticists, genetic determination carried with it an aura of fate" (Levins and Lewontin 1985, 165, 169).

"Lysenko's Ghost" as Graham (2016) puts it—lingers. Has time verified or refuted core elements of Lysenkoist theories as stated below?

1) The mutability of the gene

For Lysenko, heredity was a life long physiological interaction process between organism and environment, one where the gene was not immutable or eternal: "The principal error the geneticists commit is their contention that genes are immutable in a long line of generations. True, they admit that genes are mutable in the course of tens and hundreds of thousands of generations. Well we thank them for such mutability!" (Lysenko 1936, 189; Soyfer 1994, 88–89).

Comment: Lysenko was correct there is no eternal 'immutable gene'. Perhaps, Lysenko showed changes in some phenotypes using vegetative hybrids and non-sexual hybrids. But it was entirely irrelevant to him to prove mechanisms. Clear unequivocal proofs of gene interactions, environmental effects, and mechanisms to explain this do now exist, but rest on understanding DNA coding.

2) Special role for the nucleus, or chromosomes, or Mendelian factors or genes

Lysenko denied any Weismann separation:

> Following Weismann, the Mendelists—Morganists contend that the chromosomes contain a special "hereditary substance" which resides in the body of the organism as though in a case and is transmitted to succeeding generations irrespective of the qualitative features of the body and its conditions of life. The conclusion drawn from this conception is that new tendencies and characteristics acquired by the organism under the influence of the conditions of its life and development are not transmissible, can have no evolutionary significance. (Lysenko 1948, 521; Zirkle 1949, 105)

Lysenko rejected the Morganist concept of chromosomes: "We (*do not*) deny the biological role and significance of chromosomes in the development of the cell and of the organism. But it is not the role which the Morganists attribute to the chromosomes" (Lysenko 1948, 524).

Comment: Modern theory confirms Lysenko on rejecting Weismann's separation of the nucleus. Despite denying accusations he ascribed no role for chromosomes, Lysenko never stated clearly what this was. Moreover, Lysenko over-extended beyond current theory:

- Most biologists now do not argue for an **exclusive** special role for the chromosomes and the nucleus.
- However, Lysenko minimizes genes even if a predominant effect is evident. For example, even a single gene mutation may have extraordinary deleterious effects in inborn errors of metabolism. True–effects can be modulated by environmental steps such as appropriately varying diets, but gene effects are undeniable.

3) Organism-environment interaction

For Lysenko heredity included the environment: "Heredity is [...] the property of a living body to require definite conditions for its life and development and to respond in a definite way to various conditions" (Lysenko 1943, 390). "Heredity is the effect of the concentration of the action of environmental conditions assimilated by the organism in a series of preceding generations" (Lysenko 1948, 538).

Comment: By today's standards this is correct. Such formulations are found in Lewontin: "The organism is not specified by its genes, but is a unique outcome of an ontogenetic process that is contingent on the sequence of environments in which it occurs" (Lewontin 2000, 20). "The organisms not only determine what aspects of the outside world are relevant to them by peculiarities of the shape and metabolism, but they actively construct, in the literal sense of the word, a world around themselves" (İbid., 54). "The concept of "alteration" of the environment does not capture entirely the way in which organisms mould their immediate local conditions" (İbid., 56).

4) Inheritance of acquired characteristics

This was the fundamental reason that Lysenko rejected Weismann:

> The materialistic theory of the evolution of living nature necessarily presupposes the recognition of heredity transmission of individual characteristics acquired by the organism under definite conditions of its life, it is unthinkable

> without recognition of the inheritance of acquired characteristics. Weismann however set out to refute this materialistic proposition. (Lysenko 1948, 518; Zirkle 1949, 102)

But if Weismann is rejected, then a 'sharp controversy' divides biologists:

> [...] a sharp controversy which has divided biologists into two irreconcilable camps, has thus flared up over the old question: can characters and properties acquired by plant and animal organisms in the course of their life be inherited? [...] We the representatives of the Soviet Michurin trend, contend that inheritance of characters [...] is possible and necessary. (Lysenko 1948, 522)

<u>Comment</u>: Lysenko's view that such inheritance does occur, is generally supported by current theory.

- Mechanisms are now proposed for conserving life accumulated changes. These may arise from environmentally directed adaptations or from genetic mutations.
- Nuclear genes or DNA are modifiable by environmental events. Nucleus and cell share in the overall total response of the cell and organism.
- However, it is the DNA molecule and its regulators that gives mechanistic insight as to how the environment directly affects heredity.

5) The possibility of changing heredity in a directed way and the phasic development of plants

Lysenko believed that heredity (especially of plants) could be moulded in a 'definite direction':

> By regulating external conditions, the conditions of life of plant organisms, we can change varieties in a definite direction and create varieties with desirable heredity. Heredity is the effect of the concentration of the action of the environmental conditions assimilated by the organisms in a series of preceding generations. (İbid., 538)

Lysenko's theory of phasic development of plants sprang from the reintroduction of 'vernalization'. This practice is the acclimatising of winter wheat to grow in the spring, by applying cold conditions. Such attempts to stimulate spring growth dates from 1662 (Graham 2016, 87); but more recently to 1850s in the USA, 1900s by Gassner in Germany, acknowledged by Lysenko (1935, 13–16).

However, vernalization was a part of the broader theory of plant phasic development: "The development of plants requires a definite set of factors, which in addition to mineral nutrition, includes temperature, light moisture, suitable length of daylight etc" (İbid., 33);

Comment:

- The general thoughts on nutrition are not unique, but are also non-specific.
- Despite Lysenko's 'voluntarist' tone, Hudson and Ritchens note:

> Perhaps no tenet of Lysenko's system has aroused such opposition as his belief in the capacity of plants to select nutrients for themselves, in particular, the selection by ova of appropriate pollen grains, which is but a particular instance of his general theory. It has been said that Lysenko attributes free will to plants and also presence in anticipating the conditions under which the plant or its offspring will find themselves in future. Neither of these criticisms is fair. (Hudson and Richens 1946, 58)

- Regarding vernalization, even vehemently anti-Lysenkoists state: "There is no historian of agronomy who would deny that this technique is really effective, at least when applied in determinate conditions […] in dry climate" (Lecourt 1977, 63).
- But it was difficult to put into practice in the USSR (Graham 2016, 87). While Lysenko's application in the USSR did not elevate grain production, nor did it reduce it (Levins and Lewontin 1985, 189–191).

6) Other forms of non-Mendelian heredity in plant biology.
Lysenko rejected segregation in Mendelian terms, favouring instead theories of blending inheritance. This informed agricultural theory of: 'double dominance' (including an environmental factor); degeneration of 'pure lines' (thus improvement by heterosis or hybrid vigour); intra-varietal crossing with rejuvenation; and grafting (Hudson and Richens 1946, 32-51). Claims for graft hybridisation were important as: "The controversy as to whether or not graft hybridization grafting (*i.e. induces heritable modifications—HK*) occurs is one of the several long standing problems of biology […]" (İbid., 45, 50).

Lysenko argued that since graft hybridization gave true new hybrids, it was impossible for chromosomes to have played any part: "Chromosomes cannot pass from stock to scion and vice versa—that is a fact that no one disputes. Yet hereditary properties such as the colouring of fruit, its shape, the shape of the leaves and others, are transmitted from scion to stock and from stock to scion" (Lysenko 1948, 547).

Comment: Lysenko's own data on statistical and experimental rigour were inadequate. However, by modern data Lysenko's theory is often correct in these vegetative propagative tools:

- Modern work verifies graft hybrids occur. However, it is by a mechanism Lysenko would not accept—Horizontal Gene Transfer. Some authors anxiously rebut Lysenkoite heritage:

> Finally, although our data demonstrate the exchange of genetic material between grafted plants, they do not lend support to the tenet of Lysenkoism that "graft hybridization" would be analogous to sexual hybridization. Instead, our finding that gene transfer is restricted to the contact zone between scion and stock indicates that the changes can become heritable only via lateral shoot formation from the graft site. (Stegemann and Bock 2009, 651)

Others in contrast, invoke Lysenko's 'graft hybrid hypothesis':

> The heritability of graft-induced phenotypic changes suggests that regulatory processes underlying the scion–rootstock communication also involve a genetic component. In fact, the presence of heritability coincides with Lysenko's graft hybrid hypothesis, which suggests that graft hybridization has similar properties to those of sexual hybridization. This concept, which seems to be inconsistent with Mendelian genetics, was initially rejected by Western scientists, but research over recent decades has provided evidence for the existence of graft hybridization. (Wang, Jiang and Wu 2017, 58)

- Some rapid increases in yields of cereals world-wide since the 1940s have involved hybrid vigour. But newer combination breeding and mutations seem more useful (Altman et al. 2021; Priyadarshan 2019; Kempe, Rubtsova and Gils 2014; Schlegel 2018; Alemayahu 2017).

7) Natural Selection and Darwinism

Hudson and Ritchie pointed out that:

> [...] a large portion of the characteristic tenets of Lysenko's school are to be found [...] amongst Darwin's theory [...] Summarizing [...] Darwin definitely believed that the environment could cause a directional change in the hereditary constitution of organisms, and that the Lamarackian principle of Use and Disuse and atavistic reversion were also operative. (Hudson and Richens 1946, 6–7)

However, Lysenko also criticised Darwin: "In his day Darwin was unable to fight free of the theoretical errors of which he was guilty. [...] based on Malthus' theory of overpopulation with the inference of a struggle presumably going on within species" (Lysenko 1948, 517; Zirkle 1949, 101).

<u>Comment</u>:

- Marx and Engels criticised Darwin for importing into nature societal views from Hobbes and Malthus. Most Marxists accept this and extend it to today's discredited 'sociobiology' (Rose, Kamin and Lewontin 1984; Lewontin 2000).

- Lysenko extrapolated criticism to attack 'intra-specific competition' (Lecourt 1977, 95). This is generally not accepted. Modern data [e.g. pines in China (Yang et al. 2019)] stress the opposite, although one survey does suggest a role for 'mutualist exchange, niche expansion or hybridization (Prinzing et al. 2017).
- Lysenko's application of this theory, failed 'the test of practice' in the so-called 'Stalin Plan to Transform Nature' (Brain 2011).

8) Consistency between Dialectics and theories for science

Finally, critics say the USSR state demanded a consistency between the laws of dialectics and the theories around science: "The most significant trend of biological research in the USSR—the subservience of science to social and political philosophy" (Sax quoted in Zirkle 1949, 55);

Comment:

- Lysenko dogmatically made a-priori statements, with weak evidence.
- However, some of Lysenko's biology turns out by modern theory to be correct, and challenged Western dogmas.
- The principle of *change* and *inter-connectedness* in the world however—remain fundamental.

Scathing dismissals like "the open absurdity of the Lysenkoist 'theory'" (Lecourt 1977, 63), are untenable.

Summary: Intense division between nuclear monopolists and cytoplasmic embryologists, was present in the West *as well* as in the USSR. As Morgan said: "The inheritance of all known characters can be sufficiently accounted for by the presence of genes in the chromosomes. In a word the cytoplasm may be ignored genetically" (Morgan 1926, 491).

Both Morgan, and Lysenko were reductionist, and both were wrong in areas. Only a two-sided consideration (per Engels) enabled the molecular toolbox of DNA, and environmental signaling to fit into a coherent theory. Doubtless that while Lysenko was partly correct, '*Arakcheyev-ism*' rendered USSR science unable to rectify gaps.

4. LYSENKO'S ADVANCE TO CONTROL OF USSR GENETICS AND AGRICULTURE

What explains Lysenkoism rise to power? By 1945 the USSR had lost 20 million people or a tenth of the population (McCagg 1978, 18), lost a massive infrastructure and was encircled (Levins and Lewontin 1985, 164). Cold War politics portrayed Lysenko and Morgan as political representatives: "Lysenko portrayed Mendelian genetics as an 'American', 'imperialist', 'racist', and 'fascist' pseudoscience, the Western media presented 'Lysenkoism' as a 'Soviet', 'Communist', 'Marxist', 'totalitarian' pseudoscience" (Dejong-Lambert and Krementsov 2012, 377).

Yet generally overlooked is an internal class war battle inside the USSR. This is seen in the 'Leningrad Affair' (Bland 1980), the attack on Vosnoskensky and the 'Economics Debate' (Bland 1994), and the Zhdanov-Malenkov struggles. Frequent explanations for Lysenkoism are inadequate.

The Personality Cult

Joravsky acknowledges the complexity behind Lysenkoism: "One must realize the inadequacy of explanations that simply point to Lysenko's malevolence, or to Stalin's, or to some abstract non-historical principle of totalitarianism" (Joravsky 1986, 114). Levins and Lewontin agree:

> Lysenkoism cannot be understood simply as the result of the machinations of an opportunist-careerist operating in an authoritarian and capricious political system [...] (or) the consequence of "bossism" in which the political bosses of Soviet agriculture, including the "supreme boss" embraced an incorrect scientific doctrine in a blind and capricious flailing about for solutions to Soviet agricultural problems. (Levins and Lewontin 1985, 163–164)

Sheehan also argues against simplification: "Lysenkoism cannot be understood simply as a story of personal opportunism and political terror, nor as a cautionary tale against the dangers of bureaucratic interference in intellectual life or of ideological distortion of science" (Sheehan 1993, 228).

As does Rolls-Hansen: "The support that Lysenko received from within the scientific community as well as from the outside depended on a number of factors that were quite independent of Stalin's will" (Roll-Hansen 1985).

The Cult of Personality was begun by Stalin's enemies—not by Stalin (Bland 1999). Recent materials also question conventional wisdom. Stalin edited out of the "Short History":

> Dozens of paragraphs and scores of parenthetical references relating to himself and his career [...] Perhaps the most famous indictment of the 'Short Course', this accusation about Stalin's ostensibly craven need for self-aggrandizement ignored enormous amounts of evidence to the contrary and mischaracterized the general secretary's editing of the text in ways that persist to the present day. (Brandenberger and Zelenov 2019, 13, 35)

The Purges

Yezhov's purges cut through Soviet life, but Joravsky concluded: "It is widely believed that the Lysenkoites had a direct line to the apparatus of terror and deliberately used it to get rid of their opponents. Insinuations to that effect have even been printed in the Soviet Union, though the evidence offered has been extremely weak" (Joravsky 1986, 118).

Eighty-three biologists and agricultural specialists were repressed, 6 of whom were "active anti-Lysenkoites", outnumbered by ten non-Lysenkoites (ibid., 123). Joravsky (1986, 115) remarks an 'irrationality' about the terror: "Irrationality, in this case meaning the lack of intelligible purpose, seems to be the hallmark of late Stalinist terror". Perhaps not so irrational. Yezhov conducted a strategy to alienate the masses from the Party, only reversed when Beria took over the NKVD. Inflated numbers of victims contain a systematic upward bias (Getty, Rittersporn and Zemskov 1993).

Who Supported Lysenko?

Likely Stalin agreed with aspects of Lysenkoism:

> [...] Stalin also believed there was some deep biological truth in the inheritance of acquired characters, a truth that was not recognized by contemporary classical genetics. Looking back from the importance of 'epigenetics' in the early twenty-first century one can perhaps add that there was a grain of truth in Stalin's judgment. (Roll-Hansen 2015, 105).

However early on Stalin's support for Lysenko was 'weak':

> [...] as he was pushing his way to the top [...] Stalin's public endorsement was comparatively weak [...] At a farmers' meeting in 1935, when Lysenko stumbled in his speech and apologized for being a vernalizer rather than an orator, Stalin interjected "Bravo, Comrade Lysenko!" (Joravsky 1986,83)

> The highest chief, Stalin, was subtly evasive, though pro-Lysenkoite. On May 17, 1938 [...] he proposed a toast [...]: "To the flourishing of science [...] whose people [...] do not want to be slaves of tradition [...]" Stalin refrained from a forthright statement that would have ended all disagreement and mobilized all officialdom in support of agrobiology. As a result, the chiefs of higher learning and ideology kept on fumbling for a compromise. (ibid., 104–105)

Agricultural leaders led by Georgii Malenkov supported Lysenko, while Agitprop headed by Andrei Zhdanov resisted:

> Chiefs of agriculture unreservedly supported agrobiology. Chiefs of science, education, and ideology were sympathetic but reserved, conceding dominance to Lysenko in the ag-ricultural field but trying to maintain an academic existence for genuine biology. (Joravsky 1986, 104)

> No matter who wore the regalia, the chiefs of agriculture supported agrobiology, while the chiefs of higher learning and ideology temporized. (Joravsky 1986, 112)

The Division Between Zhdanov and Malenkov

Two factions within the party had emerged – Andrey Zhdanov's and Malenkov's (McCagg 1978, 20). Khruschev supported Lysenkoist agriculture in Ukraine, while Malenkov's ideologues aided Lysenko: "The ultraconservatives P.F. Yudin and M.N. Mitin [...] intrigued with Lysenko to discredit A. Zhdanov in Stalin's eyes" (Hahn 1982, 25, 34).

Yuri Zhdanov, was enticed into open attack on Lysenko. The latter sought Stalin's intervention, who advised Lysenko to address a key issue:

> The Weismannists-Morganists also accept the effect of the environment. Their divergence from the Michurinists lies in their denial of the hereditary transmittance of the change." Even when the geneticists accepted the influence of the environment on heredity, they believed it was not controllable. According to Stalin, the Michurinists "consider the effects to be regular and understandable, and within man's ability to control. (Pollock 2006, 53)

This enabled Malenkov to stage the 1948 session on Biology. Lysenko's address summarised two 'trends in Soviet biology'. Stalin edited Lysenko's speech, removing statements such as "any science is class-oriented by nature" (Stalin wrote in his edit: "Ha-Ha-Ha!! And what about Mathematics? And Darwinism?"); and: "By its nature the modern capitalist system cannot tolerate a true depiction of natural development", and "there is no genuine science in that bourgeois society" (ibid., 57).

Since the conference demanded to know if Lysenko's line was endorsed by the party, Malenkov's team ensured Lysenko's reply that the Central Committee endorsed Lysenko. This effectively stopped opposition. Under Lysenko's domination, wide spread firing of university teachers, academicians and researchers known to be anti-Lysenkoist ensued. This direly affected USSR science.

After the Silencing of the Academy

By now Stalin's influence was limited by the Politburo under Malenkov and Khrushchev (Hahn 1982; McCagg 1978; Harris 2008). As early as 1978, the academic historian McCagg, identified that: "In 1950 and 1951 Stalin's power was limited […] The reports from the (US—Ed.) Moscow Embassy strongly fostered the 'prisoner' image of Stalin at this time" (McCagg 1978 307, 382).

After the biology debate, Stalin's interventions were limited to 'theoretical' interventions on linguistics and economics. Though beyond the scope of this article, two points are noted. In linguistics Stalin's thrust was against "*Arakcheyev-ism*" (Count Arakcheyev led a despotic and brutal police regime in Russsia in the 19th century) and domination by one linguist (Marr) and his ultra-left views (Stalin 1972). Not coincidentally, Lysenko was behaving similarly, and in 1951 Stalin was: "considering how to 'liquidate the monopoly of Lysenko in biological science'" (Zydanov quoted in Roll-Hansen 2015, 104).

> Lysenko's failures became obvious and were reported to Stalin. In 1951, its main ideologist Prezent was relieved of all his duties and expelled from the party with severe political accusations. Stalin soon allegedly made the pronouncement that: "Lysenko should be forced to love criticism" (*citing Soyfer*). In 1952, with Stalin's permission, Botanicheskii zhurnal (Botanic Journal) published Turbin's article that criticized Lysenko's views on species and speciation. These were ominous signs of a forthcoming fall from grace. However, Stalin died on March 5, 1953 and Khrushchev assumed power. Lysenko again promised to greatly increase agricultural yields and gained Khrushchev's support. (Borinskaya, Ermolaev and Kolchinsky 2019, 7)

In the economics debate started by Stalin, the policies that Stalin argued against, came into being with Khrushchev's restoration of capitalism (Bland 1980).

Finally, the 'Stalin Plan to Transform Nature' predated Lysenko's takeover of genetics. Lysenko subverted it into dense 'mutual aid' plantings alongside wheat. Standard views on forest policy follow Weiner (1999), to argue that Stalin destroyed forest preserves. That view is challenged by Brain:

> Stalin's environmentalism," I will argue (was) a real phenomenon […] when Stalin chose to set aside huge tracts of Russia's best forestland in order to safeguard its hydrological properties, largely in response to the entreaties of Morozov's surviving students, and required that the protected forests remain

> essentially unchanged over time. Morozov's teachings essentially became official state policy. Morozov's influence reached its zenith during the Great Stalin Plan for the Transformation of Nature, when a basically conservative project designed to restore the Russian landscape to its prehistoric ideal was twisted into a promethean endeavor dominated by Lysenko. (Brain 2011, 9)

5. CONCLUSIONS

Engels' view of nature of an interconnectedness is contrary to both Morganism and Lysenkoism. These latter are both reductionist, and obstructed a clear understanding of reality in nature. Battles in genetic theory based upon political ideology occurred in both the West and the USSR. Epigenetics is the 'proof of the pudding' of dialectics in genetics. Not only heredity but theories of evolution are being re-thought. Complicating the purely biological reductionism is often another type of reductionism, a political reductionism that insists upon painting Stalin as the all evil one. That political reductionism masks the real history of the battles of factions of revisionist politicians inside the USSR. Such reductionist simplifications obstruct any real history of Lysenkoism.

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