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Inequality: The Dangers of Meat Haves and Have-Nots in a Nicotinamide-adenine-dinucleotide World.

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Abstract

Our evolution and recent history can be seen as a "World Hunt" for meat as part of an omnivorous diet. Meat contains key micronutrients namely Nicotinamide (vitamin B3) and methyl-donors with deficits causing pellagra, an archetypal disease of poverty. Inequality is a leading ultimate risk factor invoked in the aetiology of common diseases let alone threats from climate change and pandemic triggered catastrophes. We hypothesize that the origin of inequality was our evolutionary and nutritional move from equal to unequal sharing of the meat supply some 10-20 thousand years ago. High meat intake may have bioengineered powerful ruling classes and lower intake the proletariat with higher fertility, but inferior (brain) health. A fairer quantity of a safer meat intake in future should moderate global variances of fertility, height, health, and prosperity. Death rates of acute infections including emergent zoonoses (such as COVID-19) and chronic infections (such as TB) should fall as might the incidence of some diseases of affluence. Meat justice by improving human capital could make redundant superficial markers, such as skin colour, used to discriminate against peoples and heal a divided world.

Key words: Disease Transitions; Demographic transitions; Anthropocene; Nicotinamide; COVID-19; ACE2 receptor; Tryptophan; Multiple sclerosis; Tuberculosis.

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Introduction

Prelapsarian human nature was egalitarian sharing animal products that are the main sources of nicotinamide, tryptophan and methyl-donors. The origin of inequality was in the Mesolithic with unequal sharing of meat creating phenotypic variety in a genetically homogeneous population (genomes were later modified by nutrition and infection[1]). A high meat intake allowed for a ruling intellectual class and a lower intake a worker class with higher fertility but poorer health. Meat intake currently manages hundredfold variances within a global annual 300 million metric tonnes (was 7 million in 1960 and could rise another 75% by 2050).

Meat inequality is high and for billions their slice of the "meat-loaf" is wafer-thin undoubtedly affecting their well-being. Wells (2016) threw down the gauntlet: **"If we cannot define the link between nutrition and power we will never gain the power to resolve global malnutrition and its numerous costs".**

Extreme Meat Inequality: The Forgotten case of Pellagra

Indeed inequality is generally held to be the pernicious culprit responsible for many medical and social ills faced by food-insecure billions that can lead to trade-offs between survival with high fertility but poorer health and shorter lives [2, 3] [4, 5]. [6, 7]. As defined by Bellamy(1897) the basis of equality is when ***"...there are no more a-hungered".***

An iconic examples of a nutritional trap is when a low meat intake risks the degenerative condition pellagra whose sufferers, with inferior cognitive and social intelligence, were ostracised as the "Butterfly caste", and contracted infections such as tuberculosis (TB) also closely linked with poverty[8, 9]**.** Terms used to stigmatize, shame, blame and pillory pellagrins are still in common usage today to keep the poor in their place. Worse was the call for forced sterilization based on eugenic and racist policies building on the "myth of the lazy native". Yet there turned out to be a biological and trans-generational explanation for this man-made layer of destitution preventable by public health means.

A Desire for Meat

Nutritional traps drive a "flight to quality", as noted by Ernst Engel in the 19th Century[10]. As the price of bread falls or when incomes rise people spend less on starches but more on meat up to a point. This gastronomic desire extends to cannibalism documented in the Magdalen (30,000 years ago) as funerary defleshing and later ritualised by states short of meat in Central America or, as infanticide or witch-hunting [11, 12]. Cannibalism has proponents for a "materialist" theory and the need for protein but it is also a symbol of "savagery" giving many an excuse for racism, slavery and "civilising" colonialism[13]. In retaliation the cattle-based original capitalism and its descendant expropriations of land and nature has been convincingly called "cannibal capitalism".

Rich Americans eat more than their body weight in meat every year whilst many in the "Global South" are on negligible amounts. Developed countries are not immune as their poor, often children and minorities, fall below "Eat Well Plates" as witnessed by the rise of food banks and the recognition of place based food deserts where good food is unavailable creating (obesogenic)socio-ecological environments that argue against neoliberal paternalistic views on the incompetent poor having "mismanaged lives" that need to be disciplined or shamed, stereotyped as "chavs" and stigmatized as "body fascism" or politicized by neoliberals as "deplorables", as were pellagrins in their pathological NAD-deficient food-scape in "Foucaultian" fields of lost-power and little choice. More geographical meat transitions are still occurring though again not everywhere: in 1962 the average Chinese was eating 4kg pa but now that figure is 60kg pa and

rising fast towards the American average of 120kg pa. 10 calories of animal feed produce 1 calorie of meat and need enormous quantities water, oil, fertilizers, pesticides, and antibiotics let alone consumption risking dangers from food poisoning and zoonoses with human and economic costs. [14, 15] Given all that, and given animal rights abuses and that meat producers are high contributors to global greenhouse emissions, one would hope that there is a sound biological demand rather than a higher supply on the market or "showing off" .

Demography and Subsistence are Key considerations

Modes of subsistence and demography are the place to start a quest for the source of inequality[16, 17]. Malthus noted that poor parishioners reliant on cereals had high rates of baptisms relative to burials sparking concern that their high fertility led to cycles of deprivation[18, 19]. He commented on the sparse numbers of the more carnivorous hunter-gatherers and that population densities increased exponentially with cereal based agriculture. Conversely Boserup suggested population pressure increased agricultural innovation to cope and De Castro's "Geography of Hunger" (1952) pointed out reverse causation was at play in that global epidemiological and experimental data suggested that a degree of malnutrition increases fertility and quotes Doubleday's "True Law of Population" (1853) on high meat intake decreasing fertility.

Fertility may have a "U" shaped relationship with meat intake. Low nicotinamide in diet leads to its synthesis "in house" from the degradation of tryptophan. This pathway is an "immune tolerance" mechanism that can welcome foreign antigens such as the foetus or symbionts , but risks dysbiotic and acute infections - and may switch to immune intolerance as the nicotinamide dose increases [13, 14]. Teleologically this allows "baby booms" as diet improves when emerging from famines and for slight changes in fertility compounded over generations to alter trajectories from extinction to strong growth and shifts toward quality over quantity of offspring[20, 21]. Disease inequality could derive from subpar meat intake and nicotinamide related biochemical and epigenetic mechanisms to affect "human capital" with other life-history trade-offs and dietary mismatches over lifetimes then forming the developmental origins of adult disease (DOHaD) and late-life and transgenerational inequality[22, 23]. Current demographic and disease correlations with various factors, such as education, may be hiding a "lurking" variable of food, particularly meat, resource; this systemic dietary inequality was not present in our "deep" history. [24, 25]

Meat and Brains: "Planet of the Apes"

Primordial pecking orders with dominant alpha males or females were more over access to mates. At the time of the "Great Divorce" *Homo* increased meat intake, sourced on the savannah, became reproductively isolated ("kissing cousins" on forest edges excepted) and at a fork in the road speciated [26, 27]. **Figure 1.**

Food and Fortune

Trans-continental food quests with the prosocial and technological skills for hunting catalysed the NAD(H) based energy rise required for high general intelligence in positive feed-back loops [28, 29]. **Figure 2.** Hunting parties crossed the globe extirpating animal, bird, fish, or sea-mammal species in their wake.

Homo sapiens and Neanderthals independently evolved large brains on high meat diets but both species were "thin on the ground" with populations that "tottered" with local extinctions and population bottle-necks that led to the exponential expansion and cultural flowering of one but the simultaneous extinction of the other[30, 31]. *Homo sapiens* honed in on the difficult to digest and toxic plant foods detoxified by cooking and xenobiotic enzymes in a cultural and genetic co-evolutionary approach[32, 33]. This move down the food chain along with pro-fertility cultural innovations, exemplified by cosmetic ornamentation and seductive figurines, perhaps rescued us from extinction [34, 35].

At Human Evolution's Heart was Meat-centred Equality.

Hunter-gatherer social norms were egalitarian sharing meat with kin and non-kin, at least within the reproductive in-group. Land was then a shared "commons". Social animals fight for the spoils even when by-standers - so this was our "social leap". Leaders only existed for time limited tasks. "Stag Hunt" and "Ultimatum" games demonstrate a residual sense of fair play in contrast to the misanthropic "Homo economicus" depicted in the "Tragedy of the Commons" [36, 37]. This redistributive system created the most long lived economy in our history and was the dietary evolutionary environment to which we adapted [38]. Adaptations have occurred since (such as lactase persistence) but a mismatch with this "Palaeolithic" diet may still be relevant to modern day illnesses - particularly for the poor or the post-reproductive who are of an age when selective pressures to adapt are attenuated implying that their metabolism, in particular, would perform better on the long-abandoned ancestral diet[39, 40].

A more Variable Subsistence Package developed.

Horticulture emerged in the Mesolithic in marshlands and uplands. Communal village "nests" allowed storage, helped by pottery, and pans for vegetable and meat stews [41, 42] and veneration of fertility and diet - later examples were Ceres, Maize, and Bull cults[43]. A sexual selection process included language, dance, laughter and cooking domesticated and "civilized" us encouraging our reproduction and controlling the reproduction of domesticates[44].

The "Great Disequalization": Outer Walls Inner Castes.

There was a lag of some 5000 years between gardening and Neolithic agriculture and aquaculture that started in arid zones between rivers suitable for irrigation or flood-retreat alluvial zones. Another long gap exists before city and national walls. Walls kept out pastoralist egalitarian barbarians and their meat surpluses traded or raided for grain - and kept in a populace with their cereal surpluses that could be taxed by rulers [45]. Cities record social stratification with kings, priests and military elites feasting on quality foods and waging wars over meat

resources. Nobles were taller and healthier and better educated as a "cognitive class" not unlike our well-fed "meritocracies"[46, 47]. This disequalization event perhaps started earlier in a mosaic such as in the sedentary Nafutian culture but wherever it occurred a relative shortage of meat fits the facts well: inequality even developed in non-agricultural communities who needed technological advances such as ocean-going canoes or horses to hunt new sources of meat as it ran out[48].

Much has been made of class differentiation in Eurasia being more over the quality of food but over the quantity of food in Africa however if meat is the crucial factor, and manners, spices and sensuality more superficial, this paradox disappears as meat was more of a luxury in equatorial Africa[49, 44]. The importance of meat is shown by cattle as capital with transfers in "bride-wealth" dowries and as a universal central-dish in feasts[50]. Crucial determinants of inequality were ownership of land and livestock that could be inherited with Gini coefficients as low as .25 for foraging hunter-gatherers compared to .5 amongst agriculturalists.

Stocks and Trade: An overdue Tribute to "Barbarians".

Savvy pastoralists at independent sites developed dairy that as a source of nicotinamide riboside could explain the convergent genetic evolution of lactose tolerance and the cultural evolution of fermented yogurts and cheeses [51, 52]. Steppe peoples and their ideas spread across Europe around 2500 BCE, replacing or amalgamating with agriculturalists as did later mounted pastoralists[53, 54]. The fall of the Roman Empire on a diet of "bread and circuses" and many pandemics allowed Germanic pastoralists with their pedigreed animal husbandry to overwhelm a cereal dependant system (with its "agri deserti") and Roman deserters[55].

See-Saw Cerealization: Meet thy Maker and Breaker

A Green revolution around 1000 AD with unification of African and Asian crops now with rotations and multiple planting seasons during a warm medieval period allowed further "Cerealization and Calorie-ization". The social gulf between meat-eaters and grain-eaters was a cultural fact of life with social penalties for transgressors[56, 57]. Populations boomed then busted with the Black Death[58] then recovered slowly on the higher meat diet available to the survivors whose better human capital may explain the rise of Europe.

Old and New Worlds: All Things (NAD) were Not Equal.

American megafauna, as in Australia, had, unlike the "Old World" no prior experience of resisting human predators leading to their easy extinction as the hunters arrived 10-15 thousand years ago. The New World thus had less animals and were unlucky with their limited choice of domesticates, given no sheep, goats or cattle. Comparison between Old World social structures and the New World shows that the latter were the less stratified with less inherited wealth[59]. Old Babylonia yields a Gini of .40 whereas near contemporaneous Teotihuacan scores a low Gini of .12. Similar observations were made in China with its low level

stratification and pigs but no draft animal's supports availability of "food on the hoof" as the driver rather than animal labour. This all suggests a "U" shaped curve with high and low meat intakes favouring egalitarianism and collectivism but somewhat constrained meat supplies leading to stratification. (Later in North America an abundant meat supply was an explanation given for the lack of socialism and high stratification "on the shoals of roast beef and apple pie" [60]).

The Columbian exchange exported maize and tubers, east in a non-uniform fashion, driving local population explosions. In exchange ungulates were introduced to the New World. Breeding rates were extraordinarily high so much so that ecological damage was caused by often feral "plagues of sheep" (that compares with "plagues of corn" in Europe). 17th C Spanish and Portuguese ranchers maintained herds of 7-10 million animals producing a surfeit of veal in industrial scale pastoralism[61, 62]. However introduced zoonotic diseases, such as smallpox, decimated local populations probably immunologically weakened by their low meat/high cereal diet as much as lack of "herd resistance".

Observers noted that as meat intake increased Native Americans health improved and they became, they thought by Galenic "humoralism" more Spanish, partially reversing concerns about racial decline with inter-marriages but still creating new castes with the poorest Amerindians displaced to reservations unable to hunt[63]. One astute writer (1596) presciently noted that "meat generates superfluous humours so they now sneeze as we do" suggesting an early switch from infectious to allergic disease repeated in the late 19th century as meat intake recovered from an earlier fall in Europe as we discuss later [64, 65].

Maize went east as an important part of the Columbian exchange but of all the cereal staples it has the lowest concentration of tryptophan and nicotinamide so much so that there was an evolutionary drive to cook in a (female)labour intensive process with alkali producing "nixtazmel" in Mesoamerica; but this culture or even mixed planting and eating with beans was not exported east putting those in the east at a higher risk of pellagra – despite this maize was popular as it adapts to variable altitudes and water supplies with high yields unlike wheat or rice[66, 67].

By contrast with successful pastoralists then nowadays many herders are poor. This reflects changes in the meat market with more advanced societies distancing themselves from zoonotic risks and industrializing meat production. Pastoralism per se is no advantage unless it allows the owners a higher income or access to their own animal source foods free of contamination [68].

Meat Elites: NAD "Us and Them" Co-Operations and Conflicts.

We argue that a sliding rule of meat intake benefits states as well as classes by engineering upper "expert" classes with high longevity (adding to their crystallised intelligence) to the lower classes with their "essential" but often poorly paid and dangerous front-line jobs, but higher fertility. As Henry George said in 1879 ***"This association of poverty with progress is the great enigma of our times; not to answer is to be destroyed."***

At a more macro- level a latitudinal gradient in food-getting technology to catch prey in the more animal dependant climes exists and once weaponised fuelled northerner's fire-power as perhaps did their more individualistic culture[69]. Luminaries such as McNeill and Maddison mention transatlantic meat flows alongside technological nous in their expositions on the rise of Europe [70, 71]. Colonialism and World Wars aimed to ensure enough pastureland for the winners and at the same time cutting off the colonies or enemies food supply inflicting developmental and epigenetic scars on the losers, as documented in the Danish "Hongerwinter" of 1944[72, 73].

Colour and Nicotinamide.

Variation in human skin pigmentation, whether from genetic polymorphisms or tanning, is the most important physical trait used to instantly categorize human groups and individuals [74, 75]. Pale skin has the adaptive advantage in low UV environments for vitamin D production. Darker skin protects against the rash of pellagra and the closer to the equator the more populations were at risk as the meat/vegetable ratio falls compared with temperate and polar climes. Resistance to the rash is good short-term but as it serves as an early warning to (self-)treat before more serious and harder to spot effects on cognition that may be disadvantageous at a population level and opens a door for discrimination .

The idea of intellectually and morally inferior races based on complexion (that otherwise seems absurd), accelerated with the scramble for Africa and Atlantic with slave-owners conveniently believing whites and blacks were different species - views that others did their best to dispel ***"God hath made of one blood all nations of men"***. Links with low meat intake go back to Saharan trades with captives turned to slaves from civil wars usually over the meat supply as equatorial pastoralism is harder. Local ungulates resisted domestication and are threatened by large carnivores and year round transmission of vector-borne diseases in the vast tsetse fly belt - and by rapid proliferation of pathogens in food in the heat .

Many believed they were sold for cannibalism but in fact died in droves in the sugar plantations of the Caribbean ; in the Americas they were fed somewhat better such that fertility rates allowed for generations to be born in slavery - but were not so well fed as to avoid pellagra particularly after emancipation and neoslavery [76, 77].[78] [79, 80]**.** Policies directed at indigenous and imported peoples were early assimilation or attempted annihilation if expropriating hunting lands or "Buffalo Bills" executing bison but "last drop of blood" and segregationist policies that allowed reproduction if more after labour - either policy conspired to deliver an inferior diet for many[81]. In contrast to the Comanche and their colleagues, cattle now fenced in by barbed wire on ranches and ranges and protected in a "6-shooter colt and cowboy empire" created a beef and red meat republic and industrialized meat processing, as in Chicago, for an international capital market aided by steam railroads and ships with refrigeration.

Confederate cotton states that housed pellagra were in the forefront of supremacist "White privilege" "Klansman" and "America First" thinking. The

common interests of this multi-colored underclass were muted by racial tensions encouraged by white elites to divide and rule the workers and even written in to national and state constitutions and laws. W.E.B. Du Bois writing after the American Civil War referred to a divisive dignity with being white seen as a substitute for inclusive economic policies that could have improved diet for all assembly-line and other workers: degradation of black labour being seen as more important than uplift of white labour. Even the 1890s Farmer Alliance bottom-up populist movements were weakened by segregation and racism undermined later "Wars on Poverty".

Others were not immune as poor Italians, Irish and Gypsies or even alcoholics in degenerate "drinking classes", also prone to pellagra, are often considered inferior races [82]. Genocidal thinking against others, such as Jews or the Tutsi tribe, may be because they were thought superior but these are historical exceptions as are those examples of collectivist and communist anti-middle class agendas, such as in China, Russia or the Cambodian Khmer Rouge. Most of the rest are subject to well fed "White Anglo Saxon Protestant (WASPs)" and Western, Educated, Industrialized, Rich and Democratic (WEIRD) people being in charge though this in reality may allow for the mediocre to flourish. Diet and type of agriculture when contemporaneously studied across America or across countries affects cultural norms from "tightness" to a "looseness" that supports a more individualistic and entrepreneurial society with extreme wealth inequality – "tightness" maps closely to former pellagra states or cereal based cultures and collectivism with a high incidence of chronic infections and other signs of poor development [83, 84].

Beyond the Pale: Pellagra and the Undeserving Poor

The "undeserving poor" whether amongst white skinned "Hillbilly" rural classes in America or in England (originally noted by Cobbett in 1872) were prominent sufferers from pellagra and like poor blacks attracted the attention of eugenicists and social Darwinism although, to be fair, more positive "social hygiene" ideas targeted diet and education.[85] [85]. Developmental impairments may have spawned the "sciences" of phrenology, physiognomy and craniometrics that helped create myths about black racial groups having deficits in brain capacity.

Push-back has occurred with peasants, slave ("Black Spartacus"), and many indigenous people's revolts although poor diet may weaken resistance. Pellagrins had specialist trade unions and newspapers "Il Pellagrasso" and, driven by "Pellagraphobia", "Pellagrasorium" hospitals. School meals welfare programs have a surprising history for example in being promoted by the activist Black Panthers despite attracting heavy opposition from the FBI who perhaps realized those at the knife-edge had got to the heart of the matter of connecting diet to power and the political economy[86]. The rise of the middle classes and enlightenment thinking on food and the first restaurants insisted on regimens elaborating on meat and 2 vegetable based diet [87, 88]. Frustration such as by the 20th C solidarity movement in Poland was driven by annoyance at queueing, often unsuccessfully, for meat that eventually freed them and others of the communist yoke[89].

Poor Immigrants Emigrating for Meat

"Out of Africa" hunting parties from around 70,000 years ago (and earlier for our hominid ancestors), was driven by the need for meat. Later meat food-ways in the age of migration and the "hungering for America" came from groups known to be pellagra prone such as the Irish, Italians and Mexicans. Once arrived, they ate like the aristocrats they had left behind. Similarly the African-American northern "great migration" around 1879 of some 6 million freed "Exodusters" were fleeing from the pellagra-prone southern states. The initial poor state of all such immigrants, that included smallpox outbreaks in slums, contributed to xenophobic discrimination as did their high fertility setting off worries about degeneration and displacement of the local whites[90] [91].

Gender, Religion and Nicotinamide

This overlaps with gender inequality that explores a similarly dark history. Female sex, like colour, is compounding risk factors for pellagra with men, the "bread-winner bringing home the bacon" and also the "carver" controlling and rationing the meat amongst family members were given priority over women. This long standing dietary disadvantage and lost privilege over meat rations may have increased fertility but could have spawned much male entitlement including to sex (sometimes traded for meat)[92]. High fertility, as mentioned attracts criticism as "Welfare Queens" and the attention of eugenicists, family planners, and as a part of "Great replacement theory" these worries intersect with antipathy to rival religions that promote reproduction and rely little on converts.

Occam's Razor: Real Bias is against the Less Educated.

Intersectional and multiplicative effects of these injustices and many exceptions from superficial markers, that may reflect the cultural schisms and "identity politics" of the day, is compatible with a common more material and tangible cause in diet. Indeed the politics of recognition may at times be at odds with the political and human need for redistribution. Diet induced poor cognition that, if unrecognized, neither allows for equality of opportunity or for society to show solidarity with those who do not rise (even though essential workers), leading to their segregation or even incarceration [93, 94].[95]. Data suggests that the college educated "meritocracy" (usually well-fed), have more bias against less-educated than they do against any other dis-favored group as a "tyranny of merit" . This is even true of America's black upper class that originated in freed slaves, or because they worked inside the master's house, had a better diet than field slaves and more access to educational material. Dietary differences could explain disparities between communities given that success differs between black Caribbean's and black Africans with both performing better than poor whites and neither better than rich Asians or rich Whites. Lower IQ, often in the "Imbecile" ran were core features of "pellagra sine pellagra" who frequently failed the very basic tests required to join the military. A good diet was important to the evolution of "WEIRD" people[96]. The net track record of such intellectuals realizing they are part of a "meat elite", rather than having a superior genetic or racial endowment,

or sticking up for the poor or racial groups or believing in an overriding role for artificial selection is a classic "trahison des clercs"[97].

Dietary head starts also define Diamond's milestone hypothesis on global faunal inequality with "lucky latitudes" for farming at the onset of the Anthropocene.

Meat Inequality: The Climate Link.

The origin of the climatically benign Holocene heralded the "Anthropocene" that consists of a series of horticultural and agricultural developments - some even call it the "Plantation-ocene"[98, 99]. The Anthropocene influenced climate by deforestation and terraforming affecting CO2 and methane emissions from rice production and animal domesticates keeping the benign Holocene climate rolling[100] [101, 102]. These arguably reversed temporarily after the pandemics of the Columbian collision - as the 1610 "Orbis spike" – and a "Little Ice Age". An unhomogenised intercontinental meat supply and green agricultural advances has ever since driven population explosions of both domesticates and ourselves. Alongside the advent of fossil fuels and artificial fertilisers these have conspired to become major contributors to climate change with further inequality in ruptured "Sacrifice Zones" characterized by low to negligible meat intake variances that make for both a "Meat-obscene" and a "Planet under Pressure."

Farewell to Alms – One for All and All for One.

Dietary variances may allow some wanted diversity and plurality but meat became the origin of inequality however this was against strong resistance as reflected in a fitful history over the right for a balanced diet that we will now summarise[103]. As has been said ***"The arc of the moral universe is long but it bends towards justice."***

Aristotle first proposed that government provide good nutrition by means tested communal meals and that private land could be used by people in need so that all could flourish. Utopian thinking pleading for public help for paupers such as by 4thC Saint Ambrose –***"the earth has been created in common for all, rich and poor"*** – and the 13thC Thomas Aquinas and 16thC Juan Vives and Thomas More argued that stealing if hungry was not a criminal act with the latter in his Utopia (1516) first suggesting a Universal Basic Income. Later John Locke (1689) a strong supporter of the state protecting the sanctity of private property rights excluded cases of "pressing Wants" where stealing if hungry could be justified - ***"God hath not left one Man so to the Mercy of another, that he may starve him if he please".*** Thomas Paine (in 1796 irritated by a bishop preaching ***"God made rich and poor"***) argued for redistribution ***"not bounty but justice"***- not with scraps, crumbs or handouts but compensation for lost farmland to ***"buy a cow and to cultivate a few acres"***. Howlett (1781) however insightfully felt that opposition came from a gravitational pull to increase fertility and create a labourer class[104].

There was further intellectual support in early "socialist" and (French and American) revolutionary thinking of provision as a right not as charity. Thomas

Spence's pamphlet ("The Rights of Infants" 1797) and Charles Fourier are good examples ***–"If the civilised order deprives man of hunting, the class that took the land owes to the frustrated class abundant subsistence".*** Von Humboldt with like-minded agrarians including Goethe and Jefferson and Madison in the infant USA understood the effects of colonialism and deforestation and the need for less parasitic approaches to nature bucking the biblical "***dominion over all the earth and every creeping thing***". Many empires encountered local resistance and insurgencies such as the Indian Mutiny of 1857 with early dissent from universalist thinkers who eschewed biological racism and believed all men to be equal such as Burke, Bentham, Smith and Diderot (1780) were concerned about European explorers, pioneers, and colonialist unjust attitudes ***"instead of recognising this man as a brother, you see him as a slave".*** This enlightened attitude later lost out to civilising missions of "backward societies" and the frontier spirit , supported by Mill and de Tocqueville, and racial ideas of white superiority mitigated but not solved by Wilberforce and the anti-slavery movement or the American civil war.

Enclosures , Empires and the "Third World".

Oppositions to underhand removals and expropriations of common pastureland from serfs are recorded. Resistance included the Magna Carta (particularly the the Charter of the Forest (1217) that talks about "common herbage") and the 17th Century leveller movement and opposition to the notorious Black Act (1723) [105, 106]. Poachers and commoners even blackened their faces to disguise their identity and to show solidarity with slaves. Nevertheless Arcadian grasslands got eroded by the "enclosure" movement and punitive laws for poaching and the birth of "***Enemy of Nature***" capitalism with its lack of recycling manure as natural nutrients back to the soil and "metabolic rifts" as first proposed by Marx. Enclosure of pastureland is also associated with the concept of "social closure" when scarce resources only get shared with those of the same class such as certain clothing and education – and the rich monopolising a gourmet taste for meat[63].

Dietary ideals sank into oblivion with imperial grabs of land creating "new Europe's" with "cash crops and stocks", mining of bones from Napoleonic battlefields and importing guano for fertiliser, and the "triangular" slave trade. Governments and companies employed armed forces to crush uprisings with "scorched earth" campaigns leading to famines and genocides creating the third world by kyboshing local development and introducing pellagra-genic maize [107, 108]. **Figure 3.** Imperial interlopers farmed then imported cattle improving their diet at others expense resulting in "slow violence", "long dyings", "zones of abandonments", "necropolitics" and "tristes tropiques" and "Victorian holocausts" with both ruins and ruination[109]. Other plunders and blunders include the ugly histories of the Irish famine, the Scottish Clearances, the Soviet war on the Kulaks, the US "dustbowl" and the Chinese Cultural Revolution. Colonial near starvation led to debilitating phenotypic adaptations (in survivors) often acquired in childhood in "metabolic" ghettos, such as by Native Americans and Aboriginal peoples thrown off their hunting lands; or later as in the legacy in the Caribbean of a low meat/high sugar diet followed by a western diet triggering the "double

burden" pandemic of metabolic ("amputation capitals") and cancerous syndromes[110]. Slave trade reparations were not given to the to the slaves or to their epigenetically affected descendants however there is some history of trying to help the poor locally[111].

From Poor Laws to Meat Rations

Elizabethan poor laws were a reaction to the dissolution of the monasteries and a resurgence of "Royal Forests" that reduced common pastureland. The 1834 poor law with workhouses and means testing legitimized the concept of the undeserving poor and resulted in Edwardian slum-dwellers being no better off than the later starving victims of Somalia or Rwanda. Poor diet came to the fore when the state of recruits to the Crimean and Boer wars affected the country's defenses with hunger marches adding to the pressure.

Initiatives such as a broader diet in WW2 rations and school milk and meals improved health and infant mortality as did "cradle to grave" welfare states. Lessons on the primacy of diet still got forgotten and never rolled out internationally despite experimental evidence that poor diet influenced individual, class, tribal and national success s[112].

More evidence on diet comes from the Indian caste system as the lowest untouchable class (Dalits) in a "metabolic ghetto" were short and unhealthy on rice and vegetables compared with Brahmins (who ate nicotinamide rich buffalo milk, yogurt and butter) and other castes on wheat and meat. In Kenya the meat and blood eating Masai were taller and healthier than the vegetarian Kikuyu tribes, who suffered greatly from TB. Specific mention was made of the near impossibility of modernising in the Caribbean on a plantain diet yet botanical benevolence, such as introducing sago plants and breadfruit, was commoner than promoting meat perhaps as the immediate pressure usually seemed to be about bread.

"Flour wars" have triggered the downfall of empires and aristocracies such as in 18th C France and early 20th C Russia and along with the British experiences in Ireland and Bengal and the recent bread riots in the Arab Spring uprising suggest that the food supply chain is an iceberg underlying stable societies and financial markets. Governments and commerce should aim higher than avoiding caloric starvation[113]. Indeed WW2 rationing was thought to have made class war obsolete with a nutritional egalitarianism, that covered meat and milk, and led to a 30 year upswing in equality lasting long after the normal levelling effect of the exigencies of war[114, 115]. This temporary upswing included "sharing the prize" with black southerners in America helped by the civil rights revolution that had not happened with the 1930's New Deal that was, despite some good aspects, racialized on housing and jobs and therefore the income to buy meat[116, 117].

Tiger Economies – A Unified Field and Food Theory.

The age of Industrialization increased the gap between the North Atlantic states and the rest of the world: the former had high meat intakes with the "laggards" being cereal dependent. Japan overcame Buddhist piety that proscribed

consumption of four legged animals, imported beef and altered their class system. Later "Tiger" economies built arcs of food security less hooked on subsidised cereals and more generous on the more elastic need for meat. They realized, or were advised, to "use it (their land) or lose it" risking become "banana" republics. The lesson of the 19th C Ireland "meat republic" is apposite as the Irish landowners exported cattle to the UK whilst their own cottager population boomed on a poor potato diet until blight led to widespread starvation and emigration[118, 119].

China followed suit, after disastrous collectivist experiments when some 45 million people starved, and massively increased meat consumption surging to the forefront. India have followed but with lower increases in meat consumption (and lower growth), as has Latin America but not sub-Saharan Africa. Cuba managed with modest increases in meat consumption to demonstrate beneficial effects on measures of health and happiness[15, 120]. Such countries achieved modernity with no significant aid that usually came as subsidised cereals or the "Green Revolution" unlike much of Africa.[121]. Cereals and sugars along with apartheid thinking of Africans being inherently poor unscientific farmers in "cattle complexes" considered as wealth not food in a "malnutrition syndrome" (whilst valuable food is exported) has created a vicious cycle leading to "starving on a full stomach" and micronutrient deficiency, including B3/Nicotinamide and pellagra outbreaks particularly amongst refugees from war. The paradox here being that Africa has plenty of sun and enormous land-banks but their agricultural methods and utensils would be familiar at the time of Christ creating crop yield chasms with knock-on effects for animal fodder and meat intake.

Tables have been turned in that food exporters are now in the rich world that subsidises its farmers with the poorest countries off-shoring even grain staples risking international food spikes. "World-making" needs more international effort than expecting self-determination to help with diet and could be seen as a practical reparation[122]. After all, the development of a European core was given priority over colonial settlers raising cattle for sale at the centre at prices that excluded the peripheral colony and allowed the industrial "take-off" [123, 124]. The rise of Anglo-American hegemony and the current convergence in a predominantly Asian drama correlates with meat intake but could be enacted everywhere to help demographic and disease transitions.

Levelling Playing Fields.

If looking backward to imperial violations provides no traction risk of pandemics and wars may be the better bargaining tool as poor countries are not, after all, stationed on Mars[125]. The history of disease and demographic transitions when the West was just as poor is instructive as progress correlated then to an increased meat and milk supply and the colonial "klepto-parasitic" meat-trade [126, 127] [128, 124]. As Walter Rodney said in his 1972 book on how Europe underdeveloped Africa ***"Pellagra was unknown in South Africa till about 1914".***

Many have commented on the importance of meat and skimmed milk on health in particular the incidence of TB – and as a cure for Kwashiorkor and is the basis of many school milk and meals programmes. These early 20th C programmes often driven by fear of TB were sometimes reversed such as in 1950's south Africa for African but not European children as they were "white man's food! " [129] [110].

Beefed up: Au Revoir "Old Friends" and Plagues.

It is difficult to overestimate the pervasive importance of TB the "White Death" in the 19thC that mysteriously vanished (as did other infections) first in the wealthy as Disraeli pointed out ***"Two nations: as if inhabitants of different planets formed by a different breeding and fed by a different food – the rich and the poor".*** At this time food imports (the UK at this point accounted for 80% of the trans-equatorial meat trade) were aided by lower shipping costs, trains and salting then refrigeration[130, 131] [117]. **Figure 4.** Better breeding helped as did the rise in the use of poultry. The case for nicotinamide intake being causal has been that TB excretes and is inhibited by nicotinic acid with many antibiotics being analogues and that TB incidence always rises on a poor meat diet[132, 133]. TB's toxin, an NAD glycohydrolase, depletes the macrophage of NAD on a cell-death pathway that enables replication and dissemination. Over 300 like toxins are responsible for other pandemics [134, 135] so NAD levels offers "broad spectrum" protection against many organisms that is lost if diet then deteriorates

Inflection: Inflammatory Disease in Affluent Geographies.

As TB, died down a promiscuous range of auto-immune, inflammatory, and mind altering "Diseases of Modern Civilisations" took-off alongside infertility, first in the upper classes who eat more meat [136, 137]. A less plant based diet affects fermentation-derived short-chain fatty acids such as butyrate that interact with the nicotinic acid receptor [138, 139]. This flip also relates to the altered education of immune systems as "Absent Old Friends" affect the differentiation and migration of antigen-specific protective regulatory T cells and the balance with pro-inflammatory T helper 17 (with BCG having mitigating effects). The result is "immune intolerance" to otherwise harmless antigens and allergic and auto-immune disease [140, 141]. As already mentioned a prequel took place in the Spanish New World when those on a higher meat diet developed "sneezes".

So Long So Much Auto-Immunity – Example of MS

Less Tryptophan in diet abrogates pathology in models of multiple sclerosis. MS is not the only auto-immune disease where one can link diet, microbiomes, autoreactive T cells, and IDO- 1 mediated tryptophan breakdown [142, 143]. Risk factors include meat, low Vitamin D, genetic pro-inflammatory predispositions, and inter-current infections that all affect T cell regulation. Adjusting tryptophan and nicotinamide in diet could lead to more resilient Treg/T (17) helper cell ratio – the same mechanism that stem-cells or the adoptive transfer of regulatory T cells, helminths or microbiomes are thought to work[144, 145].

Modern Diseases and the Ageing Stakes – Highs and Lows.

NNMT is a detoxification enzyme reducing nicotinamide levels that controls behaviour, neurodegeneration and lifespan by regulating energy, methylome and autophagy. NNMT is raised in many diseases of affluence whilst NAD levels fall: enzyme induction could be from high nicotinamide intake [146, 147]. **Figure 5. As Brenner has said "NAD coenzymes catalyse the conversion of everything we eat in to everything we are and everything we do".** High nicotinamide dosage from plentiful meat and milk often with supplements may play a part in diseases of affluence as is fairly well established for red or processed meat and cancer, particularly colorectal, and deaths and yet in Japan a "Goldilocks" diet with more meat and dairy is thought to be responsible for a decline in cerebrovascular mortality and their unusual longevity[148].

Pellagra: Longevity at a Price

Theories on ageing involve nicotinamide: pellagra was a real world case of premature ageing consistent with rises in life expectancy and lower incidence of dementia when diet improves [149, 150]. Longevity pathways, are activated by NAD booster molecules. NAD- rhythms are lynch-pins that explain circadian clocks and physiological states from hunger to fatigue to stress, and even the effects of alcohol. Antagonistic pleiotropy, a popular theory for ageing with genes important in development having adverse effects from relaxed selection in later life or developmental run-on includes NAD-consumer and NNMT genes [151, 152].

Pellagra comprised of dozens of mimics of neurodegenerative diseases and psychopathology that selectively affect high energy neurones in complex synaptic circuits. Topical explanations invoke proteinopathies, mitochondrial failure, inflammation, oxidant stress, calcium dysregulation, gut dysbioses, and neurotransmitter loss that were downstream events in pellagra [153, 154].

NAD may be the common denominator and "silver bullet" for cells with competing "mouths to feed" that with genetic or co-existent environmental factors gets channelled to various phenotypes spreading in "vulnerability networks" and prion-like waves. Nicotinamide may need to be adjusted by genome and age to avoid DOHaD, "disposable soma" or antagonistic pleiotropic effects that may only kick-in later in life requiring the higher nicotinamide and more ancestral diet [155].

Nurture over Nature: NAD World 3.0 – Barometers and Monitors

Measuring ourselves embedded in an "NAD World" may be a parsimonious way of emancipating metabolic controls and energy flows to "refresh parts others cannot reach" by optimising nicotinamide dosage [156, 157]. **Figure 6**. Nicotinamide replacement or "Nutraceuticals" in general (often selling "candy" and empty calorie-ization) should not be the sole focus given negative effects on the methylome. Randomised trials varying meat intake are not realistic (first suggested by Daniel at the court of Nebuchadnezzar) but the predicted value, with a low ceiling effect, would lie in better cognition, resistance to microbes and "K" style fertility prioritising quality.

Human Right to Respire Right.

Subpar NAD levels are metabolic headwinds and pseudo-hypoxic states literally taking peoples "breath away" but, unlike meat, oxygen is free. Water is critical as splitting it is at the photosynthetic heart of an NAD World with riparian "hydraulic societies" raising civilizations [158, 159] . Although water can be a flashpoint on the whole cooperation has prevailed (with some high profile exceptions about dams or privatization), as it did over cleaning up water supplies to avoid infections such as cholera - perhaps because it was more obvious that the poor could infect the rich as is also true of air pollution (that now includes rising CO2)[160]. This danger is just as true for diet where obstacles should be overcome to deliver a "nicotinamide rush" as the platform for human capital, capacities and capabilities and to reduce the danger of zoonotic pandemics [161, 162].

Meat Dangers: "X" Diseases, "Y" Plagues and Zoonoses

Desperation for meat and cannibalism is implicated in prion diseases as is feeding meat to herbivores that triggered bovine spongiform encephalopathy and new version Jacob-Creutzfeld disease where NAD depletion has been implicated, consistent with the prion mimics seen in pellagra epidemics [163, 164].

Red Flags and Blind Eyes: Something New under the Sun.

Opportunistic zoonoses are prominent (70%) causes of human scourges, a price of the (peri-) domestication of animals [165, 166]. Some think influenza strains and plagues arose and spread in tribes wandering with cattle over lands conquered by Genghis Khan [167, 168]. Recent emergent diseases include Marburg (1967), Ebola (1976), HIV (1981), Nipah (1998), SARS (2003) and other Coronaviruses like COVID-19[169-171]. Cauldrons and hot-spots of emergent infections are built in high density populations with land cleared for agriculture encroaching on animal territories or are due to the desire for exotic foods[172, 173]. Those that heap opprobrium on current animal markets need to look back to London's 19th century costermongers who sold live meat in carnivalesque markets[174, 175] [176, 177].

Poor and dangerous meat supplies have been described as "Structural violence" or [178, 179] as for several billion wildlife consumption, or the income from household farming outside industrial "dragonhead" enterprises, is the only way of avoiding the "hidden hunger" of micronutrient deficiencies whether iron or vitamins A, D, B12 and B3 [180, 181]. Campaigns to ban wildlife hunting needs thought if aimed to improve pandemic preparedness without leading to an even poorer diet for the "have-nots". As Lederberg said of viruses this is really a matter of ***"Our Wits and their Genes".*** Zoonoses can be predicted and could be prevented by stringent surveillance of wildlife consumption with safe-guards including better hygiene with butchers and less exposure of Guano farmers to bat droppings [182, 183].

COVID-19 Exposes an Achilles Heel

Pathogenic coronaviruses use the inducible angiotensin converting enzyme (ACE2) receptor to invade species that has roles in renin-aldosterone, tryptophan, immune-competence, and the microbiome [184, 185]. ACE2 is a chaperone for the amino acid transporter particularly regulating tryptophan uptake and interacting

with Hartnup mutations that cause a multifactorial pellagra-like disorder. Covid-19 may have similar effects to *ace*2 knockouts affecting tryptophan convoys with loss of T cell homeostasis and Interferon responses affecting reactive and over-reactive immune responses [186, 187]. **Figure 7.** Some effective Covid treatments such as Dexamethasone and Tocilizumab affect this kynurenine pathway [188, 189]. Prominent enteritis and neuropsychiatric complications with (myoclonic) encephalopathy and "Long Covid" and other delayed complications are reminiscent of pellagra. As with other microbes being NAD-replete in the first place should improve host resistance and low initial NAD levels may explain several risk factors such as age, poverty and disability particularly if then exacerbated by post-Covid austerity diets as economies fail [190, 140] [191] [192].

Population Matters Redux – Crunch-time for Non-Coercive Measures.

Earlier we referred to Malthus' observations on a cereal dependant population and introduced meat in to the demographic debate as a quality versus quantity piece of a complex jig-saw[193] [194, 195]. Formulae such as Environmental impact = Population x Energy consumed per capita - show that population counts particularly when energy consumed per person is high [196, 197]. Coercive population measures have had mixed results as have state "cash for babies" procreation policies and has stigmatised debate. Cereal supplements increase infant birth weight but reduce time to next pregnancy whereas a diet with adequate meat directly and indirectly (through better education) speeds demographic transitions.

The extremes are striking with population predicted to fall by 50% in rich countries but to increase by 300% in poor African nations, such as "zestful" Nigeria, with consequences for age structure, economic potential, migration and geopolitical power. There is currently little recognition of dietary drivers even though de Castro proposed that malnutrition was the cause not the effect of low quality population explosions 70 years ago[198].

Cutting to the Chase: Mean about Meat Means to a Bad End.

A remedy is to retro-shift to the 18th C idea of liberty that imposes state obligations to ensure "*bon marche"* not basic "bread and circuses". Adam Smith wrote, after observing European induced injustices, "greater wealth may inspire respect for the rights of one another" with a fairer "slice of the pie". Peak meat has surely passed for the rich and needs to be levelled at say 30kg pa reducing food related emissions by a third (or more if switching from beef) and benefitting health. Given the world is home to 5 billion ungulates and 22 billion chickens this should provide an optimal "flexitarian" diet for all - with a role for plant-based meat substitutes and affordable lab-grown meat or tucking into "cricket snacks". Many political systems have accepted the need to supply grain yet none treat meat as a need rather than only for those who have the means. (16th C Henri 1V of France's "chicken in the pot" for peasants was the exception). Rulers, from fascists to socialists, have recognised the power of food as a tool for their territorial ambitions whilst not balking at using it to starve their own people or only supporting equal sustenance for the working classes if linked to productivity[199]. One predicament

of modern democracies is that they legitimize and spend large sums on defined disease, much in the last years of life, yet delegitimize those in dietary poverty normalizing their premature deaths. As Kropotkin (1892) said **"Well-being for all is not a dream".**

If they addressed these dietary issues rulers may find that their citizens are healthier and less likely to reject basic democratic principles or descend in to mono-culturalism, restrictive immigration or insurrections.

The ill effects of inequality, austerity and pauperism from "*Ancien Regimes"* to modern times on health, well-being and social mobility are well documented. Most narratives swing between clashes between oppressors and the proud oppressed and how oligarchies have self-perpetuated. The exact mechanism for harm, other than invoking stress or "social determinants" or "weathering", is however unclear. Stress reduction is, after all, convincingly invoked as a reason for pyramids of power and hierarchy[200]. Here we spell out how this originally happened in line with ecological and metabolic rift observations on the effects of industrialization allowing food meccas and food ghettos and deserts [201, 202]. We propose that once the meat supply became constrained, we evolved on a dietary spectrum with a high meat to cereal ratio supporting a ruling intellectual elite and a low ratio a fertile proletarian essential (yet disposable) working class - and when there is a surplus of population, an unsupported underclass prone to rebellion [47]. Turchin however also points out that elite overproduction and intra-elite competition in gilded ages (such as the 1920's and now) marked by extremes of income, height and health inequality has often preceded ages of discord and societal collapses before a more progressive new-deal social and ecological revival. Increased equality on a "de-growth" and socio-ecological agenda recognizing that there is an abundance of good food to be shared if better managed rather than acting as if the calorie-ization and empty calorie-ization of the poor has solved the problem rather than becoming a tangible commercial determinant of health also affecting NAD homeostasis. This drive for meat security is more sustainable than continuing with a scenario with an artificial scarcity of meat and other "luxuries" encouraged by capitalist concentrations of power in the mega-merged agri-food "Big Food" profit driven sector that leads to reduced public wealth but private riches, biodiversity loss and excess emissions [203, 204].

Meat elites are now redundant developmental over-runs (not unlike some theories of cancer). Affirmative action needs to correct this dietary discord or actions aimed at the facades fronting inequality will fail. The opposite of inequality in this context is not a Utopian state or a meritocracy of equality but equity of provisions with better metabolic homeostasis and no NAD headwinds for the poor. Hinman and Harris (1939) recognised that the meat eating races and classes have been instrumental to progress and that meatification is a marker and the ladder of class ascension and social mobility. Reframing Aristotle, this corresponds to a hierarchy of needs with a physiologically good diet being met free as a public good (as it basically is already free for the rich) but the equally important self-actualization wants for a good life being left more to an individual's freedom and

drive. Redistributing quality food has been modelled from social and economic perspectives in a new "Moral Economy" as "Sitopias" and " Diets for a Small Planet" that could now be grounded in the constitution and currency of an "NAD World" and seen more as an investment as it closes innovation gaps, as seen in China, as well as reducing risks from pandemics or "superbug" antibiotic resistance [205-207] [208, 209]. Families may be the place to start as they already have "Burkian" style covenants between the dead, the living and those yet to be born. Enough family income to provide meat reflected in more shapely Engel Curves locked in to a top-down international governance structure could work as a "Gramscian" common-sense counter-hegenomic bloc and cry from those stuck in the basement[210]. Gramsci's words ring true "The old is dying and the new cannot be born; in this interregnum a great variety of morbid symptoms appear".

Conclusion.

As Thoreau said with capitalism and its attendant inequalities in mind **"Icarian thoughts returned to ground; and we went to heaven, the long way round"** Our solution speaks for an algorithm that opens secure and safe meat larders derived from agro-ecological farming regimes that respect the best of the organic and food sovereign movements without forsaking scientific or commercial approaches shorn of soil degeneration from high tillage, excess fertilisers and pesticides and monocrops [211]. [212]. New meat technology should help but at the least cleaned up meat production from grass-and even fed-lot grain based farms to tables will help and are unlikely to become "stranded" assets any time soon[213].

Quixotic quests for preventive causes for every known complication of poverty could be avoided by moving the dial to find a "sweet-spot" to avoid nicotinamide under-and over-load. Fair reform could happen without imposing widespread vegetarianism – a vaunted solution that would not benefit the needs of the nicotinamide have-not-half. Discrimination, we say, piggy-backs on meat extremes and could dissolve as it did for the pellagra-ridden "Butterfly caste", with meat justice leading at the least to a new chapter in the history of inequality by abolishing "Precariats and Proletariats". Black Egyptian educators were after all the sparks of modern Europe not the blonde races or the later Anglosphere. Condorcet (1795) divided history into ten periods, the last of which permitted ***"the abolition of inequality between nations, the progress of equality within each nation, and the true perfection of mankind".*** A global overhaul that enables NAD equity would return us to our "other regarding" roots that, after some detours to boost population, began with meat and land equality as well as showing that we can rise above Kant's "self-incurred immaturity" in a new enlightenment movement that this time round is fair to all and might solve a more general syndemic crisis.

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Figure Legends

Figure 1. Meat and Nicotinamide dosage steadily increased during out evolution up until the time that we became behaviourally modern. Human brain size increased and got more globular with Broca's and pre-frontal and parietal areas becoming prominent and better connected using newfound neurotransmitter and neuroendocrine facilities. However fertility and population sizes were low, with several extinctions. The advent of a more plant based, and lower nicotinamide dosage, diet led to populations expanding but brain and body size got smaller and infectious diseases emerged.

Figure 2. NAD is the crucial carrier for our high energy Hydrogen based needs for optimal brain function in a "NAD World".

Figure 3. GDP falls as a % of British GDP became extreme in colonial times. Low meat diets in China, India and Africa compared to Europe and North America created the "third world". This dietary inequity is unravelling in places with the "tiger economies" undergoing "meat transitions" developing the fastest.

Figure 4. TB, the "White Death," mortality shown using London data for 1850, TB vanished as meat intake increased - chiefly from imports (in exchange for cotton goods) that in effect exported infectious diseases to the poorly fed and low meat tropics.

Figure 5. NAD declines with age whereas NNMT levels rise in affluent geographies. Amongst the poor NAD levels would be low at all ages. Major preventive windows of opportunity present themselves for both rich and poor.

Figure 6. This version of an **"**NAD World" has the dietary and social milieu, symbionts and pathogens all interacting with biochemical internal affairs. NAD has a "finger in every pie" affecting circadian rhythms, appetite, exercise alongside detoxification pathways for plant (and now drug) toxins and oxidant and other shocks from microbial pathogens and viruses that require resistance and (DNA) repair.

Abbreviations

NMN=Nicotinamide mononucleotide; NAMPT= Nicotinamide phosphoribosyl-transferase; IDO= Indoleamine 2,3-dioxygenase; NNMT= Nicotinamide N-methyl-transferase; NRK= Nicotinamide riboside-kinase; PARP=Poly ADP-ribose polymerases; SIRTs=Sirtuins; CD38= Cyclic ADP ribose-hydrolase; AhR= Aryl hydrocarbon receptor.

Figure 7. Pleiotropic ACE-2 receptor and some overlooked interactions. ACE-2 affects Tryptophan uptake and the BoAT1 neutral amino-acid system and therefore the kynurenine and the T cell and interferon dependant "immune tolerance" pathway and exacerbates lost NAD homeostasis from pre-existing conditions (such as age or poverty and poor diet) or infection induced oxidative stress and its repair. Coronaviruses could, like ACE-2 knock-downs or the BoAT1 mutations that lead to the Hartnup pellagrous phenotype, reduce tryptophan and therefore serotonin levels and cause pellagra-like symptomatology both in the acute phase and as "long Covid" if not corrected. The renin- angiotensin system also involved in the pathophysiology could be affected by other vitamins such as Vitamin D.