Please note: For the benefit of our readers who are not particularly scientifically inclined, we have included special summary sections at the end of each major section. We are calling these sections "In other words:" and they are set off by asterisks "******".

The Physics of Zombies III: Madore's Rule of Zombie Photosynthetic Vitality

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I. Abstract

Madore's Rule of Zombie Photosynthetic Vitality requires that zombies must be receiving energy from a photosynthetic system. Zombies' existence demonstrates a disregard for normal metabolic functions and a disdain for traditional eating habits. Zombies do not need normal food and can continue indefinitely without it. Humans, plants and bacteria each produce Adenosine Triphosphate as an energy source; zombie production of same is investigated. Implications for survival and combat are discussed.

Keywords: Zombies, Energy, Vitality, Madore, Adenosine Triphosphate, Necropology

Content:

Preface

We encourage readers to read our first papers in this series: "The Physics of Zombies: Madore's Rules of Zombie Cohesion" and "The Physics of Zombies II" before reading this paper. While it is not essential to understanding and enjoying this paper, we will use terms and concepts that are drawn from our previous research. The papers are available here:

Physics I: www.scribd.com/doc/57439058/
Physics II: www.scribd.com/doc/60157179/

1. Introduction

Where do zombies get the energy for their actions? Just how is it that most zombies have seemingly endless reserves of energy while humans must rest and constantly scour the environment for food? How and what do zombies eat?

These are major questions within the field of Necropology, questions that that we believe we have answered in this paper.

We are all familiar with the following phenomena:

A) A zombie is hit by a hail of machine gun fire. The machine gun fire hits the zombie in the guts. The bullets disembowel the zombie and the zombie loses the entirety of its human digestive system. The zombie stays animated despite having no human digestive system or an obvious way of nutritionally sustaining itself.

B) Several hundred zombies gather in a group, forming a black hole around a prey target. The zombies stand day and night; no need for snack breaks. They maintain vitality and vigilance despite receiving no recognizable sustenance.

C) Just before a human locks a stout, safe, secure door behind him he winds up and swings a baseball bat at a zombie that is chasing him. The swing is so powerful that it knocks the jaw right off of the zombie. The zombie, without a jaw and unable to chew food of any sort, continues to stand at that locked door, scratching and trying to gain entrance for months and years longer than a human could.

How is all that possible? That is what we want to know!

This paper is NOT about "why don't zombies die?" [1]

Rather, it is about how zombies "continue to do things without food/eating" after death.

There is a subtle, but important, difference between the two notions. The latter supports the former, but is not the entirety of the answer.

This paper focuses on one aspect of undead: the source of their energy, their vitality, for continuing to attack and transform humans despite no evidence of a nutritive diet.

[1] We will most certainly be writing a paper at a future date on the full reasons/causes of zombies' seeming immortality and their post-death preservation. Count on it!

We believe that we have the answer to how a zombie functions despite a *seeming* lack of nutritive energy intake. However, before we can dive into "what zombies use for energy" we must tackle a thorny issue, namely, what they *do not* use for fuel: brains.

2. Brains versus Bites

First off, let us dispense with a silly notion that has no place in this discussion. Zombies do *not* eat brains. The human skull is incredibly hard and made of the same material as human teeth (excepting the enamel); anyone grinding away on a skull with their teeth is going to wear out their teeth *before* they can bite through a skull.

The typical zombie attack consists of a human being attacked by zombie bite and being "turned" (transformed) due to infection vectoring in from the bite site. Zombies simply do not sit around and "crack skulls" to get at the brain matter inside.

Zombies bite but they do not seek out or obtain brains. If that were otherwise, "new" (additional) zombies would not be produced, as the initial zombies would have inflicted a "head shot" of their own on prey by relieving them of their brains. Zombie plagues would stop at the start, or, zombies would be walking around without brains.

End of story. The zombie battle cry of "braiiinnnsss" is best left for humorous depictions of zombies and will not be considered in this paper. Sorry.[2]

So, what, if anything, *do* zombies eat? Where do they get their energy? Before we can answer we must look at where humans and plants obtain their metabolic vitality and then see if there is any basis for comparison with zombies.

Here we go…

3. Human Vitality and ATP

Let us be clear as to what the focus of the mystery should be: *Metabolic/Food Energy*.

Where do humans get it? Where do zombies get it?

Every action that a human being takes requires energy. Humans receive most of their energy from food. We eat. We take in food and break it down until the energy it contains is released into our system for use by our cells.

Everyone knows this. A baked potato illustrates this point easily…

A baked potato contains vast amounts of carbohydrates. When you eat a baked potato the "breakdown" starts immediately in the mouth. Mastication is the jump off point in digestion: we chew the potato pieces until they form a mushy ball, a "bolus", of food.

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[2] Cheer up, it is *good* news: your brains are safe! Further good news: We are researching the reasons *why* zombies bite (if not for sustenance) and we have made incredible progress and will publish the results.

The bolus is pushed / squeezed down the esophagus until it reaches the stomach where digestive acids continue the attack. The carbohydrates are reduced to simple sugars in the stomach and further along in the digestive system.

Most people understand that a baked potato is broken down in to a simple sugar, "glucose", by human digestion. What most people do not know is that human cells cannot themselves use glucose. Glucose must be further broken down into another substance before it can be absorbed and used by the cells for energy. Glucose, simply stated, is too "big, complicated and low-energy" for a cell to use for energy, it must be broken down.

Humans break down glucose at a molecular level and use its break down as fuel to create the fuel that cells use: **Adenosine Triphosphate** (ATP).

Adenosine Triphosphate, "ATP" for short, is not only the basic source of energy for human cells, it is the source of energy for *all* plant *and* animal cells.

ATP is the molecule that provides the energy for all cell activities *and* all the activities that cells conduct in concert. When a cell does anything it utilizes ATP as a power source. When a group of cells does anything, they utilize ATP as the molecular level power source. For example, if your muscles contract it is because the cells that form the muscle tissue are powered by ATP. If there is no ATP then are no functioning cells of any sort. Plant cells will not function without ATP. Animal cells will not function without the energy from ATP.

Sure, okay, ATP is utilized by every living cell on earth, but *how* does it provide energy to those cells?

ATP provides energy when a phosphate is unhooked from the ATP molecule.

Wait! What does that mean?

In complex terms, ATP starts out as Adenosine which is just the base *Adenine* and the sugar *Ribose* linked together. Adenosine goes through a process whereby three phosphates are added to form Adenosine *tri*-phosphate. When ATP is received by the cells, one of the phosphates is stripped away with said release generating exothermic energy (heat energy) that is utilizable by the cell. Afterwards, ATP becomes Adenosine *di*-phosphate (ADP) and is returned to the cycle for another phosphate hookup and, thus, a return to being ATP.

In simplified terms, it takes *energy* to *add* phosphates to adenosine to make it into ATP and *energy is released* when the phosphates are removed from it.

When a cell receives ATP it has three phosphate "tails" on it. When one of those tails comes off, energy is released. ATP now has two tails and is called "ADP" (the *T* in ATP

means *tri* or "three" and when a tail is removed it becomes ADP where the *D* stands for *Di* or, "two").

It must be noted that ATP itself is not "energy" and it is not a "fuel" – it is not consumed during this process. ATP is *not* transformed into energy; rather, it contains potential energy that is released as kinetic energy simply by breaking it apart. Stripping away the phosphate is an "energy act." The adenosine is still there afterwards as are the three phosphates (two attached, one freed). The phosphates are attached to the ATP molecule in "high energy bonds" which, when those bonds are broken, release relatively high energy. [3]

That's it. Energy is released when a phosphate tail is removed from a molecule of ATP inside of a cell.

THAT is what powers all life on earth.

ATP gaining and losing phosphate tails.

Wow!

So, how exactly does the energy get *into* ATP to be released later? For that we must turn to a brief discussion of *Phosphorylation*. (Worry not reader: zombies are going to make a comeback in this paper before long.)

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In other Words: The basic unit of life energy/vitality is ATP. ATP stands for Adenosine Triphosphate. All plants and animals make it and use it to power their cells and cell functions. Without ATP life ceases to function as cells have no energy.
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4. Phosphorylation

So, now we know that the vitality cycle is as so:

ADP→ATP→ADP→ATP→ADP→, etc.

Where ATP is continually losing a phosphate, thus becoming ADP, and then a phosphate is added back to ADP becoming ATP yet again.

As previously stated, it requires energy to hook up the three molecular phosphate tails to the adenosine molecule, this occurs in a process called "phosphorylation" (meaning

[3] According to physics, energy may neither be created nor destroyed; it may only be transformed or transmitted. That is, energy does not "disappear" or "get used up" it must either "go someplace" or "become something." In the instance of the phosphate tails being hooked up, the energy is conserved (stored) in the form of a bond between the phosphate tail and the adenosine. *Yo! That's the **First Law of Thermodynamics** in effect, boy-eeee! Word to your mother!*

"adding phosphate"). We can further expand the process illustrated above to a fuller view of the process:

ADP + P + Energy → ATP

It is the "energy" portion of that cycle we are particularly interested in and there are multiple paths for that energy to be harnessed so that the phosphate may be added to the ADP molecule to form ATP. In animal cells, one of the places this may occur is in the *mitochondria*. The mitochondria are the power centers for eukaryotic cells (humans have eukaryotic cells).

In simplified terms, the mitochondria have two membranes: an inner and an outer membrane. The membranes are selective in what may pass through them, both inward and outward. Inside the membranes activity occurs which causes positively charged hydrogen ions (H+) to pass out of the mitochondria's inner membrane. The positively charged ions fill the space between the inner and outer membrane. The mitochondria do this constantly, pushing out H+ ions from the inner membrane to the outer, thus a constant charging cycle occurs. As we all know from basic science classes, this will eventually lead to a buildup of a "charge" between the inner membrane and the outer membrane. At a certain charge point, hydrogen + ions will rush back into the inner mitochondria from the space between the membranes.

The difference between the charges inside and outside of the mitochondria is called the *osmotic gradient* where "osmosis" is movement between areas of high concentration/pressure to areas of low concentration/pressure and "gradient" is simply a measure of the difference between the two areas. Inside the mitochondria the H+ ions are positively charged and are repulsed and move outside the membrane, then, as the charge recedes they are drawn back into the membrane – an ebb and flow like the ocean's tide. Thus, as H+ rushes out and rushes back in, the difference between the outside and inside charges is called the "osmotic gradient."

ADP molecules cling to the inner membrane of the mitochondria, right at the point where the H+ ions rush back into the inner membrane. They are sitting right at the proper spot that energy is being released in the act of the H+ ions' return to the inner membrane.

The ADP molecules receive an "assist" at this point. The ADP molecules are awash in an enzyme (*ATP synthase*) which prepares them to receive another phosphate tail. When the ions are pushed back into the inner membrane the enzyme is forced to add a phosphate tail to ADP to balance the charge. The ADP molecule now becomes ATP (or becomes it "again" if it is a returning ATP that has previously lost its tail).

We can now expand the earlier formula as so:

ADP + P + Energy from H+ Ion difference between inner and outer membranes plus enzyme reaction = ATP

The ATP molecules are now free to go about their business of powering cells and then returning to the mitochondria for another phosphate hookup.

We have already briefly mentioned that "inside the membranes activity occurs which causes positively charged hydrogen ions (H+) to pass out of the mitochondria's inner membrane." Inside the mitochondria the "activity" that creates and pushes the H+ ions out of the mitochondria is called *cellular oxidation.* Cellular oxidation involves the breakdown of foodstuffs "aerobically" (with oxygen) and the release of H+ electrons emanating, and carried away from, the broken down material. As we have just learned, it is this release of H+ back into the mitochondria that powers the ADP→ATP cycle.

In this instance of ADP→ATP cycling, the "power" comes from food. If food were not being broken down, then:

There would be no release of H+ ions from the inside membrane of the mitochondria to the area between the membranes.

Which means:

There would be no H+ ions re-entering the inside membrane once the "pressure" was built up outside.

Which means:

There is no power to attach a phosphate to the ADP molecule.

Which means:

There is no ATP "tail" to be detached when ATP reaches cells that require energy.

Which then means:

Cells do not receive energy and if they do not receive energy, they cannot do the things that cells do. They have no vitality.

The ultimate power in this scenario comes from the breakdown of food which in turn releases H+ ions inside the mitochondria. There is "stored energy" in food that is converted in the mitochondria into "stored energy" in ATP.

Is there perhaps another power source other than solid food that can provide H+ ions to power ATP production? Absolutely! Happens all the time….

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In other Words: The basic unit of life energy/vitality is ATP. ATP stands for Adenosine Triphosphate. ATP is made when the human body breaks down glucose and uses the energy from the breakdown to power a system inside the mitochondria that adds phosphate "tails" to a

molecule of Adenosine. When the tails are added, power is stored. When the tails are removed inside a cell, energy is released and used by the cell.
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5. Photophosphorylation

Simply looking at the word "photophosphorylation" should give one a strong indication of its meaning. We now know that phosphorylation means "adding phosphates" thus, *photo*-phosphorylation means, essentially, "photon (light) energy-powered addition of phosphates." Simply stated, here, light is the power source to add phosphate to ADP.

Photophosphorylation is the power cycle used by plants to perform the ADP→ATP conversion cycle.

How does a photon power an ADP→ATP cycle?

First, let us establish where the photon is coming from in this discussion. Here the photons are particle-waves that emanate from the sun, in other words, solar power.

Okay, then, how does a solar photon get into a plant in order to power an ADP→ATP cycle?

It doesn't. A photon does not "get into" a plant and then power its ADP→ATP cycle.

Okay, what happens then?

A photon is released from the sun, travels all the way to earth and then strikes a pigment, a photon receptor, within the plant. A pigment is a molecule that can either reflect or absorb light energy. In plants, the main pigment that absorbs light energy is called *Chlorophyll A*. Chlorophyll A absorbs most light in the Ultra-violet (UV) spectrum of 400-500 nanometers (nm).

When a single photon strikes a molecule of Chlorophyll A it strikes a single electron within a single atom within the molecule. The electron becomes "excited" by the hit, meaning, it becomes energetic from the collision. This "excitation" causes the electron to move further out from the nucleus of the atom and, if excited sufficiently, pass out of the atom all together. The loss of an electron causes the atom (and possibly) the molecule it is attached to, to be positively charged. In plants, this produces H+ ions.

This sounds like a set-up for the animal style "H+ ion osmotic gradient" that powers ATP production, is it?

Yes, very perceptive! Here's how:

The photons hit the pigments. The atoms that make up the pigment molecules become excited, lose electrons and become positively charged (H+ ions). These H+ ions in plants

are then harnessed in essentially the same way as they are in animals. The work, however, does not take place in the mitochondria (which plants do not have) rather, they "work" inside a structure called a *chloroplast*.

A chloroplast is essentially a membrane bag inside a plant cell. Inside the membrane bags are even smaller membrane bags called *thylakoids*. Inside the thylakoids are the chlorophyll pigments and ADP/ATP molecules. Just as in animal cells, the ADP→ATP cycle occurs due to H+ ions passing in and out of the thylakoid membranes with the released energy being recaptured in the form of a phosphate tail being added to ADP to form ATP.

A brief review at this point will be especially helpful:

Inside animal cells, food is oxidized which releases H+ ions which, due to an osmotic gradient, pass in and out of membranes inside the mitochondria. The energy of their passing is utilized to attach a phosphate tail to an ADP molecule turning it into ATP. When ATP reaches an animal cell, the phosphate tail is detached and the energy from that detachment is used by the animal cell.

Inside plant cells, outside photons excite inside atoms, excited atoms release negatively charged electrons which make the atoms/molecules positively charged. Due to an osmotic gradient, positively charged ions (H+) pass in and out of the membranes of the thylakoid in the chloroplast. The energy of their passing is utilized to attach a phosphate tail to an ADP molecule which turns it into ATP. When ATP reaches a plant cell, the phosphate tail is detached and the energy from the detachment is used by the plant cell.

Plant cells do the same job as animal cells in relation to ADP→ATP cycling, however, the power source for the cycle is different. Animals use "food" to power the cycle while plants utilize photons to power the cycle. In both cases, ATP is produced and ATP is the energy source for all life.[4]

What the heck does this have to do with zombies? Well, let us get on to that now…

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In other Words: The basic unit of life energy/vitality is ATP. ATP stands for Adenosine Triphosphate. ATP is made inside plants when they use the energy from the sun (or light) to power a system inside the chloroplast that adds phosphate "tails" to a molecule of Adenosine. When the tails are added, power is stored. When the tails are removed by the plant cell, energy is released and used by the cell.
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6. Photosynthetic Zombie Vitality

Where do zombies get their energy?

[4] Let us keep in mind that the energy that's in human food started out as energy from the sun, as follows: The Sun → photon→plant ATP→plant glucose→Humans consume. It ALL comes from the sun.

A zombie that has been shot in the guts has: no stomach, no intestines and no place to digest food properly. A gut-shot zombie has no way to deliver food to the mitochondria to oxidize.

No food being oxidized means that there is no ATP production in the mitochondria.

No ATP production in the mitochondria means that no energy is being delivered to the body's cells.

No energy being delivered means that there is no cell activity.

No cell activity means just that, no cell activity. No muscles contracting, no eyes scanning, no jaws clacking, no chasing and no catching.

Yet... we have all seen zombies running, grabbing, smashing, tearing, rending.

Thus, it is an irreducible fact that they simply *must* be receiving their energy from somewhere! They have vitality and they must be getting it *someplace*!

We believe we have the answer and it is a simple one: zombies have photophosphorylation pigments that deliver energy to cell structures.

Wait, *what?* Are you saying that zombies are plants?

NO, absolutely not!

Allow us to make it abundantly clear that we are *not* saying that zombies are plants. Rather, we are saying that zombies have a system for creating ATP that requires photons to power the system instead of normal food. We hold that zombies have pigments that act in concert with a light-energy transmission system to maintain zombie vitality long after a normal, human digestion/vitality system ceases to function.

Wow! Cool, at least we're finally talking about zombies again!

7. Zombie Pigments and Zombie Bacteria

Our research reveals that zombies must be receiving their vitality from an energy input and that input *must* be the sun and/or other light sources.

Well, okay then, some questions:

Q. So, what is the essential element of such a system?

A. Zombie pigments capable of absorbing light energy and transmitting that energy to a zombie's ATP production system

Q. Are there human-compatible pigments that are reactive to photons and capable of atomic excitation that could be harnessed to create an osmotic gradient to pump H+ ions into and out of the mitochondria?

A. Yes.

Q. Really? Okay, name one!

A. *Rhodopsin*.

In a previous paper, we have already demonstrated that rhodopsin pigments are being produced within zombies.[5] For those who have not read that paper, allow us to recap the action:

Rhodopsin is a naturally occurring pigment that can be found (among other places) in the human eye. It absorbs light in the infra-red range. Our research has led us to the discovery that the zombie virus has a "free loader" bacterium that produces bacteriorhodopsin that binds with the proteins in the human eye to effectively give zombies infra-red "heat vision."

We now believe that rhodopsin is more prevalent in zombie-infected humans than we had previously thought. In fact, we believe it is omnipresent throughout the zombie system – in every single cell. Before we can relate that information to you, we need do a breakdown review of normal, non-zombie bacteria and its relation to rhodopsin and ATP production. (Damn, it was all about zombies and now we're back to tutoring!)

Normal Bacteria, Rhodopsin and ATP production is as follows:

In the types of bacteria that use rhodopsin as a pigment, it is used in essentially the same way as *chlorophyll A* is used in plant chloroplasts. The pigment acts as the first stage in an energy transport chain. Rhodopsin is the photon receptor pigment and the electrons excited from photon interaction are passed along to the interior of the bacteria. Bacteria have two membranes and the H+ ion pumping occurs between the two membranes. ATP is produced as a result of this ion pumping, just as it is in human mitochondria and plant chloroplasts.

To review:

Human mitochondria have ion pumping action between membranes. The pumping action powers ATP production (adding phosphate tails and storing energy in phosphate bonds). The power source for the pumping action comes from oxidizing food.

[5] Again, the paper that deals with rhodopsin production that allows for zombie heat vision is located here: http://www.scribd.com/doc/60157179/

Plant chloroplasts have ion pumping action between membranes. The pumping action powers ATP production (adding phosphate tails and storing energy in phosphate bonds). The power source for the pumping action comes from photon excitation of the *chlorophyll A* pigment in the chloroplast.

Bacteria have ion pumping action between membranes. The pumping action powers ATP production (adding phosphate tails and storing energy in phosphate bonds). The power source for the pumping action comes from photon excitation of the *rhodopsin* pigment in the bacteria.

In our previous paper, we believed rhodopsin was limited to the proteins in the eyes (since that is where we currently find it in humans). As it turns out, the zombie virus allows bacteria to invade and bind to many other proteins and protein sites in humans, including the mitochondria. Essentially, we believe that the bacteria that are responsible for zombies' heat vision is also responsible for overall zombie vitality. We shall now refer to this bacteria "zombie bacteria" or "*Zb"* for short.

Zb does something amazing; it binds to human proteins and envelopes mitochondria in a symbiotic fashion, pumping protons into the mitochondria to produce an osmotic gradient inside the normal human system that produces ATP. Our research leads us to the inevitable conclusion that the following occurs when the zombie virus invades the human body:

The zombie virus brings with it a bacterium that merges with mitochondria and then provides the energy for ATP production for itself and the host cells. This symbiotic merging provides energy from the Zb's light receptors to the host mitochondria which, in turn provides ATP energy for the bacterium and the host cell.

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In other Words: The basic unit of life energy/vitality is ATP. ATP stands for Adenosine Triphosphate. ATP is made inside bacteria when they use the energy from the sun (or light) to power a system inside the bacteria that adds phosphate "tails" to a molecule of Adenosine. When the tails are added, power is stored. When the tails are removed by the bacteria, energy is released and used by the bacteria. The zombie virus brings with it a bacterium that binds to human mitochondria and produces ATP for itself and the human host cell.

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8. Zombie Bacteria and Poly-Transport Energy Chains

Our research demands that zombie bacteria, Zb, are responsible for the vitality that zombies manifestly display. Further, we believe that the energy for said vitality is brought into the zombie's cellular system in two vectors that supplant the normal conditions of digestion-based energy.

Zb Energy Transport Chain "A" – Direct Photonic Electron Excitation

It is evident that the virus attacks the nucleotides and basic DNA structure of the host mitochondria.[6] Clearly, the virus heads for the mitochondria and begin to alter the structure of the RNA/DNA complexes. What was unknown was that the "free loader" bacteria also takes advantage of the alterations of the nucleotides and the mitochondrial membranes and spreads into the system behind the advancing virus.

We believe that the virus and the bacteria travel together and conduct the following invasion:

1) The virus penetrates the mitochondrial membrane walls through dissolution of some of the protein bonds on the molecular level
2) The virus continues its mitochondria transformation by altering the RNA (and DNA) of the host such that the bacteria is considered "friendly" (and not susceptible to normal bodily responses to bacterial infection)
3) The Zb bacteria attack the now-weakened membrane walls, enveloping the mitochondria with a third, symbiotic, bacterial membrane
4) The Zb bacteria extend and shares its own pigment based electron transport chain into the mitochondria itself, powering mitochondrial ATP production

Again, bacteria that produce rhodopsin utilize the rhodopsin in the same manner as chloroplasts utilize *chlorophyll A*. That is, the pigment is utilized as a photon receptor that, when excited by photonic collisions, passes along the electron through a "transport chain" from the outside of the bacteria (where it is hit by the photon) to the inside of the bacteria. As the bacteria now share a membrane wall with the mitochondria, the proton pumping is shared with the mitochondria and the proton pumping action can be used by the mitochondria (through the osmotic gradient) to power the attachment of the phosphate tails to ATP.

Wait. What?

Okay, here it is again: The zombie virus makes human systems susceptible to a special bacterial infection. The bacteria enter the body at the same time as the zombie virus. The bacteria latch onto the mitochondria in the human body. Mitochondria produce ATP through the osmosis of H+ ions, typically powered by the oxidation of foodstuffs. When the bacteria latch on to and envelope the mitochondria, the bacteria produces an H+ ion flow the mitochondria utilize to produce ATP. The bacteria become the "energy source" as it transfers light energy to the mitochondria in a similar manner to chloroplast ATP/energy cycling.

[6] Well, it's evident to us at least. The zombie virus conditions the host mitochondria to not reject the bacteria as an invader – no "kill this bacteria" is sent. Further, the mitochondria no longer respond to normal "PCD" (programmed cell death) commands. No surprise there as the mitochondria themselves are the ultimate source of that command. There MUST be a wholesale DNA/RNA transformation going on, nucleotides are acting funny. At least they're funny, to us. ☺

After normal human mitochondria are enveloped by Zb, we refer to the new "Zombie bacteria enveloped mitochondria" form as *ZbeM*.

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In other Words: The basic unit of life energy/vitality is ATP. ATP is made inside zombie mitochondria that have been surrounded by bacteria. The paired bacteria/mitochondria use the energy directly from the sun (or light) to power a system inside the pair that adds phosphate "tails" to a molecule of Adenosine. When the tails are added, power is stored. When the tails are removed by the zombie cell, energy is released and used by the zombie cell.

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Zb Energy Transport Chain "B" – Indirect Photonic Electron Excitation

Not all ZbeM are in a location within the zombie body such that they receive direct photon excitation. Basically, bodily-interior ZbeM are simply too far away from the skin surface to receive direct sunlight and thus cannot pump protons from that action/excitation.

For example, a deep muscle tissue cell with a ZbeM is shielded from the sun due to the layers of muscle, fat and skin that stand between it and the light. However, we believe that there is a mechanism for sharing of excess electrons resultant from surface (and slightly sub-surface) photonic excitation.

Interior cells that do not receive direct sunlight may still utilize the photosynthetic system through simple *electron transport*, as follows:

1. Exterior ZbeM receive photonic excitation particle-wave packets from a light source, then
2. Exterior ZbeM pass along electrons to their constituent mitochondrial membranes and pumps, then
3. As the ZbeM reaches sufficient charge for ATP production, no further electrons may pass along the transport chain to the mitochondria, then
4. Electrons that do not pass down the chain are considered "spare" electrons and are released from the photon-receptor pigments on the exterior of the ZbeM, then
5. Spare electrons are gathered by neighboring ZbeM that are not receiving direct excitation and have remaining capacity to absorb the charge, then
6. If no neighboring ZbeM have sufficient capacity to absorb the charge, the charge is passed along to even more distantly located ZbeM that are capable of storing the charge *or* passed off into the medium that holds the zombie body (i.e., ionization of surrounding air, water, etc.)

Essentially, if a ZbeM is on the exterior and is receiving more photonic excitation than it can utilize, the channel it uses to flow the electrons to the mitochondria becomes, well, "clogged." Once the electron channel is full, it backflows and the electrons are available for pick up by neighboring ZbeM. Thus, an "outside" ZbeM (outside relative to interior

ZbeM) can pass along its excitation incredibly deep inside the zombie to where no sunlight reaches. If no ZbeM are capable of storing/using the charge, the charge is bled off into the atmosphere.

Together, Energy Transport Chains A & B represent a powerful and complete source of energy for ATP production, as so:

ZbeM that receive direct sunlight can power its local ATP production.

ZbeM that do not receive direct sunlight can power their local ATP production via "spare" electrons coming from other ZbeM.

ZbeM take photonic excitation and use the pumping power created by H+ ions into ATP energy storage the same damn way plants, animals and normal bacteria do!

Where do zombies get their vitality?

The answer is that they receive their vitality from symbiotic ATP production powered by light, that is, photosynthetic vitality. [7]

Madore's Rule of Photosynthetic Vitality states that photophosphorylation inside Bacterially Enveloped Mitochondria produce Adenosine Triphosphate that powers both the host zombie and the invading bacteria.

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In other Words: ATP is made inside zombie mitochondria that have been surrounded by bacteria. The paired bacteria/mitochondria use the energy borrowed from other bacteria/mitochondria pairs to power a process inside the non-lighted pair that adds phosphate "tails" to a molecule of Adenosine. When the tails are added, power is stored. When the tails are removed by the zombie cell, energy is released and used by the zombie cell.

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9. Conclusions: *ZbeM* Implications for Zombie Combat / Survival

Zombies are not human. Zombies are not plants. Zombies are not bacteria. They are a human system that has been invaded by a virus that brings along an opportunistic bacterium. The bacteria bind with human mitochondria in a symbiogenesis fashion to create a new non-human ATP production system. [8]

[7] One might also consider the possibility of a "Channel C" contributing the energy load – or at least keeping the energy load from being called upon for a certain amount of energy dependent signaling. That is, a negligible amount of energy may be provided directly by the bacteriorhodopsin pigments via what we refer to as "blue light lensing" – wherein the pigments, in light-line with neurons may provide direct stimulation of neuronal centers (muscle excitation may result). This would allow for direct cellular signaling, which saves energy on signaling costs for the system. However, it is not exactly energy being provided for the system to use, rather, the energy that would be used to signal is conserved.

[8] Just something to consider: Bacterial and viral invasions of cells (with consequent wholesale transformations of the host cell) have happened before. In fact, it is the likely source of plant/animal use of ATP in the first place. The human mitochondria might only exist and use ATP due to a previous invasion by a bacterium that conditioned all ATP producing cells to provide ATP for the invader. This paper could

Final, dramatic "other words": The zombie virus clears the way through the human body for a bacterial infection. The Zb bacteria move in after the virus and envelope the mitochondria. After setting up house around the mitochondria Zb provides the fire and the mitochondria does all of the ATP cooking!

The main source of "food" for zombies is light.

THIS explains how a zombie does not need to eat, nor have a recognizable digestive system, and yet still walks around just like humans that do eat.

So, zombies are ultimately powered by the sun. That's great! Just throw a blanket over them and they will eventually run down, right?

Not so fast!

The average human has approximately 3 (three) seconds of ATP available for cellular activity. This number decreases by the amount of exertion a human is putting out. The higher the exertion, the lower the amount of time before the ATP runs out. The human body continually produces ATP to offset the loss of vitality.

We believe that ATP production and storage is greatly enhanced in zombies versus humans.

For instance, if a zombie no longer needs to store glucose in the mitochondria and can instead store ATP in those locations, the increase in ATP storage is at least 36 fold for each *molecule* of glucose replaced!

Further, if one hypothesizes a notion of ZbeM reproduction inside the cells then one need consider that Zombies might have more total ATP available than any known plant or animal. As is, the number of mitochondria in a human cell varies greatly, from one to 10,000 per cell. At this point, we are uncertain of how many ZbeM's the typical zombie cell holds or if they are capable of reproduction. Thus, a zombie might have 10,000 times (or more) the number of ATP production sites that a human has… Cue the scary music!

Massive amounts of ATP production sites mean that zombies should have several hundred hours of ATP available for them to use to bite, chomp, smash, chase and transform humans.[9]

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have easily been titled "Photosynthetic Zombie Vitality via *Re*-Symbiogenesis of ATP production for the benefit of an invading bacteria and virus." Oh well, too clunky for anything but a footnote.

[9] Zombies might also be storing ATP via CO_4 fixation. This might mean that zombies have mind-blowing amounts of energy stored in places previously reserved for glucose and other now non-essential metabolic materials. If true, this means they are thousands and thousands of hours away from loss of vitality when not exposed to the sun or light sources.

Even further, when one factors in the notion of "zombie torpor" the relative vitality of zombies stretches into nearly infinite. Zombie torpor is the notion that zombies can essentially "power down" and use relatively little ATP for basic functioning – akin to "sleep mode" in computers. When a zombie is standing still, scanning, waiting, hiding in a closet, they enter "zombie torpor" (they can re-enter active mode with explosive rapidity).

Thus, zombies might have hundreds of hours of vitality simply based on post-glucose storage sites and thousands of hours *more* if they have more ZbeM sites. This is vitality that is available *without* the sun or other sources of light.

However…

The best time to attack zombies, please pardon the humor, is *just before* the "dawn of the undead." This makes sense, as zombies should have the most energy available to them at the end of a long, sunny day. If they remain active through the night, their energy levels should be decreasing relative to their daytime charging. If there is a dark night and no ambient light sources and no direct light sources; the ATP levels should be decreasing.

Thus, just before dawn, the zombies should be at their most "vulnerable." A strenuous chase and energetic activity should be a drain on a zombie. Not much of a drain, but some.

However…

Any amount of light shone on a zombie will have the effect of charging the zombie's batteries.

So, that flashlight taped to the end of the barrel of your shotgun to light up zombie targets? Yeah, that's powering the zombie in your sights. Shoot him quickly!

Still thinking about throwing down road flares to confuse a zombie? Think again, you're just throwing him some lunch.

However…

Any situation where one might keep a zombie from receiving any light for an extended period of time should result in the zombie – EVENTUALLY – losing vitality enough to cause "full death." How long that period may be is simply unknown.

Until then, dump some long-lasting, light-blocking, paint on a zombie's head and hope for the thing to grind to an eventual halt… Oh, and, if you have a shovel and the time – try burying them "alive." That should help!

Best of luck, folks! Stay out of the sun!

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Song listened to on looping repeat while writing:

Brad Sucks': "*Making Me Nervous*", 2005 – great metronomic beat for typing. Also it has a bad-ass line appropriate for the paper: "sunshine in my brain, making everyone complain." Now there's some photosynthetic vitality for you!