

**SLB-013 (10-1-06)**  
**Spiritual Life Basics**  
**Part II: What is Life?**

Lesson I: Biological Life

1 Thessalonians 5:23

"May God himself, the God of peace,  
sanctify you through and through.  
May your whole spirit, soul and body  
be kept blameless at the coming of our  
Lord Jesus Christ."

# Preface

- We have concluded our introduction, “The Necessity of a Spiritual Life, The Times in Which We Live”. We could expand the “Necessity” Lessons into an extensive number of reasons we need to live a Spiritual Life and even more so, an advancing Spiritual Life.
- But, if the Islamofascist’s threats are near to being accomplished, we need to have these basic lessons completed and available; so we will begin the meat of our topic without further delay; and provide “Times in Which We Live Updates” as necessary.

# Life - Defining Life

By Leslie Mullen

- There have been many definitions of life created over the years, but there has yet to be a single definition accepted by all.
- Every definition has had to face down challenges to its validity.
- According to Carol Cleland of the University of Colorado, this is because definitions are concerned only with language and concepts; they can't expand our understanding of the world.
- We can only define things we already understand.

# Life - Defining Life

By Leslie Mullen

- Cleland says that scientists in the seventeenth century had the same problem trying to define water.
- There are many descriptions of water - it's wet, thirst-quenching, it freezes and turns into vapor - but other substances also have these qualities.
- Once scientists discovered molecular chemistry, they could define water to everyone's satisfaction as one oxygen atom coupled with two hydrogen atoms (H<sub>2</sub>O).
- Perhaps we need a similar revolution in scientific thought in order to define life.

# Life - Defining Life

By Leslie Mullen

- "Current attempts to answer the question, 'What is life?' by defining life in terms of features like metabolism or reproduction - features that we ordinarily use to recognize samples of terrestrial life - are unlikely to succeed," says Cleland.
- "What we need to answer the question, 'What is life?' is a general theory of living systems."



# Life

- **BIOLOGY - WHAT'S THAT MEAN?**
- It's typical for a book to lead off by setting up its basic definitions and terms, and this will be no exception.
- This is all about biology, the study of living things (which are also known as organisms, a nice catch-all term that includes anything considered alive).
- And generally, biology is thought of as more than just study, it's really the scientific study of living things.
- We'll get to what makes a study scientific before long; right now, let's deal with what makes a living thing alive.

# Life

- WHAT MAKES SOMETHING "ALIVE"?
- This is the first place that we get to deal with a recurring theme in this book: biology is a practice, a set of behaviors, done by human beings, which means that some of the "rules and regulations" can be partly understood from the standpoint of general human compulsions.
- First, humans like to name/label and categorize things, put them in neat little symbolic boxes, which helps us in our second endeavor: humans like (one could say that they need) to explain how things work.

# Life

- The science of biology provides one area of explanation, and what qualifies as a living thing falls into the area of labeling.
- It's important to remember that human explanations are always limited by our knowledge at any given time, and that labels and categories are limited by how well real objects squeeze into the constraints we put on them.
- Life goes on whether we understand it or not, and living things care not a whit whether they're in one or another of our little labeled boxes.

# Life

- Although "life" may seem at first like "art" - "I know it when I see it" - it needs to be better defined for a science to be built around it.
- We're going to develop a list of features that can be applied to living things everywhere.
- Virtually every biology textbook in existence has a list like this, but if you were to check, you would find that the lists rarely match each other point-for-point; some things are separated into distinct features, while others may be lumped together.
- But if you look closely enough, the features found here themselves are all in those other lists somewhere.

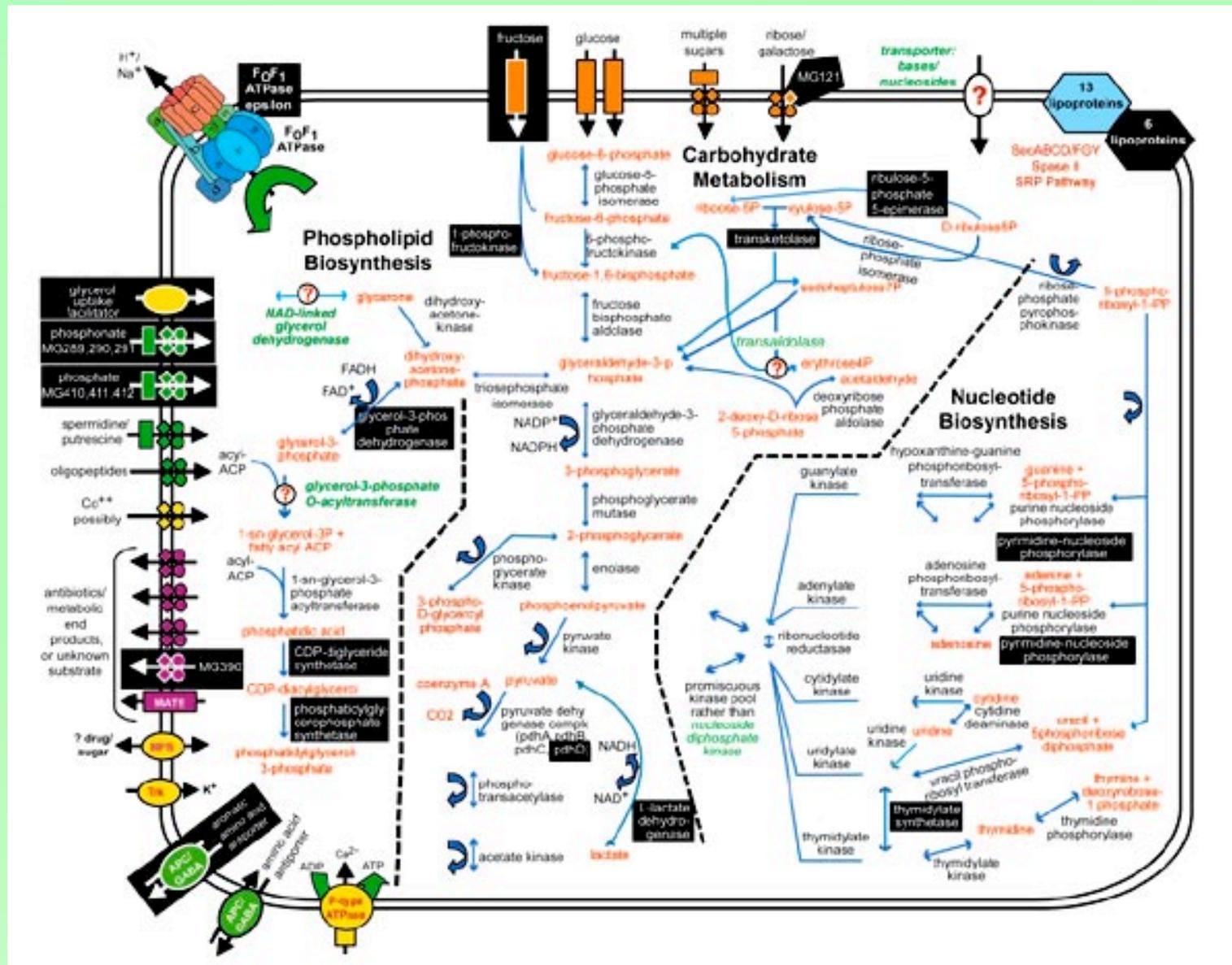
# Life

- ORGANISMS ARE GENETIC SYSTEMS
- "Oh, genetics, I've heard of that!" Of course, that doesn't mean that the term means anything to you.
- What exactly is a genetic system?
- In this instance, it means that living things are able to reproduce in a way that passes features, or at least information about making features, along from a parent to its offspring.
- For living things on the planet Earth, this feature is usually based on information stored in Deoxyribonucleic Acid, or DNA.

# Life (J. Craig Venter Institute)

- A cell requires 430 genes according to a new study by the Synthetic Biology Group at the J. Craig Venter Institute. This is more than the 265-350 estimated by Venter's team in 1999.
- Starting with a bacterium that has "the smallest genome of any organism that can be grown in pure culture," *Mycoplasma genitalium*, "global transposon mutagenesis" was used to identify dispensable genes.
- The team concludes that even this minimal bacterium requires at least 387 protein-coding and 43 RNA-coding genes.

# Life (J. Craig Venter Institute)





# Life

- Embedded in this feature of Life is reproduction - it's hard to pass traits on to offspring without reproducing, although I suppose you could imagine a living thing that is immortal and never reproduces (no one has found such a thing, though).
- In our world, reproduction falls mostly into two camps:
  - asexual reproduction, where offspring are genetic copies of the parent (they can be genetic copies yet not to be physical copies, because of how genes work), and
  - sexual reproduction, where offspring are a mix of gene sets from two sources (and which may or may not involve two separate parents).

# Life

- A side effect of reproduction is growth and development: without growth, each generation would get progressively smaller beyond their ability to survive; without development, the next reproduction phase could not be timed properly.
- Growth is a fairly simple property, while development can be a simple switch in a cell that says, "Don't divide yet," or the many complicated stages that multicellular organisms go through between one zygote (the very first cell, usually created from the fusion of a sperm and an egg cell) and the next generation's zygote-generating adult.

# Life

- An old biology proverb states that, "An adult is just a zygote's way of making another zygote."
- You might have heard a variation: "A chicken is just an egg's way of making another egg."
- [This is the Materialist's philosophy that Life (evolution) is the driving force behind all of nature -- not it's Creator]

# Life

- ORGANISMS ARE DYNAMIC UNITS
- Both parts of this term are important - dynamic refers to how living things are always changing as their internal chemistries use resources, convert energies, and produce wastes (this chemistry is known as metabolism); units refers to how living things exist as individuals, separate entities with particular needs.
- Internally, living things are a storm of interactive atoms and molecules, extremely tiny objects, not themselves considered alive, whose complex relationships, involving energy and particle transfers, make up the activity of life on its tiniest level.

# Life

- ORGANISMS INTERACT WITH THEIR ENVIRONMENT
- Living things, as stated before, are dynamic as their internal chemistries use resources, convert energies, and produce wastes.
- These changes cannot be sustained in a locked chamber with no connection to the world around them.
- Organisms must pick up materials, release materials, and try to avoid circumstances that would kill them, either from immediate threats (such as something trying to consume them, or a toxin, or potentially-harmful germ) or long-term needs (examples would be finding needed resources, or preventing its own wastes from poisoning it).

# Life

- These needs require the ability to pick up cues from the environment and respond to them, something that can be very simple, as some molecule-based "switches" are, or as complex as the information to absorb and process and the responses you produce every minute (Hello, you are responding, right...?).
- The level of interaction depends upon the "size" of the environment being discussed ("environment" is a very flexible word).

# Life

- ORGANISMS EVOLVE
- Evolution is a change in type over time.
- It connects back to that human compulsion to label and categorize things, combined with a knowledge of how the world of the past was different than today's world. All sorts of things can evolve, so this may be the feature of Life found most often in things that are not alive.
- The current best explanation for how evolution works is the Theory of Evolution by Natural Selection, developed and written down originally by Charles Darwin and Alfred Russel Wallace in 1858, with many slight adjustments and additions by many people since.

- Generally, "disagreement" in scientific circles with this theory involves a dispute about how much Natural Selection influences evolution compared to other factors, not whether the basic ideas are accurate.
- A comparable theory might be the Theory of Gravity - scientists might disagree on the details of how gravity works, but no one suggests that gravity doesn't exist.

# Life

- What is Evolution by Natural Selection? Sometimes nicknamed "Survival of the Fittest," it would be more appropriate to call it "Reproduction by the Fittest."
- Simply put, since more detail will appear later, in any given group of organisms, there will be some variety of features that directly affect how good a chance each individual has of living to reproductive age and then successfully reproducing - who manages to live long enough to make little ones?
- As a general trend, each generation of offspring will, more and more, reflect features that are advantageous to their environment, which helped their forebears survive.

# Life

- Over time, depending on an organism's suitability to the new environment, new features and combinations of features (called adaptations, a confusing term that does not always mean the same thing even to biologists) may spread through the population as a whole until the basic "type," or species (there will be a more particular definition of this term later) has changed significantly enough from the "type" of its ancestors that it needs to be relabeled.

# Life

- Evolution is not an "ever upward movement toward perfection," although that is what it often is portrayed as; species don't get better at anything other than fitting the environment of the day, which could change at any time.
- There is no target, no progress, no ultimate peak at humans (our brand of intelligence may not be a great adaptation, since it comes with a long list of self-extinction threats from our own meddling, including but not limited to weapons of mass destruction)...

# Life

- ORGANISMS ARE GENETIC SYSTEMS
  - Growth
  - Metabolism
- ORGANISMS ARE DYNAMIC UNITS
- ORGANISMS INTERACT WITH THEIR ENVIRONMENT
  - Communication
- ORGANISMS EVOLVE

# Life - Defining Life

By Leslie Mullen

- What is life, exactly?
- This is a question that keeps biologists up at night.
- The science of biology is the study of life, yet scientists can't agree on an absolute definition.
- What about a computer program that learns and evolves?
- Can a wild fire - which feeds, grows, and reproduces - be considered a living entity?

# Life - Defining Life

By Leslie Mullen

- Trying to define life is not just a philosophical exercise.
- We need to understand what separates living creatures from non-living matter before we can claim to find life elsewhere in the Universe.
- In 1944, the physicist Erwin Shrodinger defined living matter as that which "avoids the decay into equilibrium."
- This definition refers to the Second Law of Thermodynamics, which says that entropy always increases.
- Entropy is often referred to as chaos or disorder, but really it is the spreading out of energy towards a state of uniformity.

# Life - Defining Life

By Leslie Mullen

- This law can be seen in a cold glass of water that slowly grows warmer until it is the same temperature as the surrounding air.
- Because of this trend toward equilibrium, the Universe eventually will have a complete lack of structure, consisting of evenly spread atoms of equal warmth.
- But living things, said Shrodinger, are able to postpone this trend.
- Consider: while you are alive your body maintains its structure, but once you die your body begins to break down through bacterial action and chemical processes.
- Eventually the atoms of your body are evenly spread out, recycled by the Earth.
- To die is to submit your body to the entropy of the Universe.

# Life - Defining Life

By Leslie Mullen

- According to Benton Clark (an astrobiologist with the University of Colorado and Lockheed Martin), living organisms exhibit at least 102 observable qualities.
- Adding all these qualities together into a single - if exceedingly long - definition still does not capture the essence of life.
- But Clark has picked out three qualities from this list that he considers universal, creating a new definition of life.
- This definition says that "life reproduces, and life uses energy.
- These functions follow a set of instructions embedded within the organism."

# Life - Defining Life

By Leslie Mullen

- The instructions are the DNA and RNA "letters" that make up the genetic code in all organisms on Earth.
- A wild fire, one might say, reproduces and uses energy.
- So do crystals and various chemical reactions.
- But Clark says none of these phenomena are "alive" because none of them have the embedded instructions of a genetic code.
- We know there are no instructions, because there has not been any mutation over the years.
- They follow the rules of physics rather than embedded instructions, and so they behave the same every time.

# Life - Defining Life

By Leslie Mullen

- What Next?
- Could we use Clark's definition to find life on other worlds?
- The problem with searching for life forms with embedded instructions, says Clark, is that the criteria may be too specific.
- The only instructions we know of are DNA and RNA - there may be other genetic systems possible in the Universe that do not resemble the system found here on Earth.

# Life - Defining Life

By Leslie Mullen

- STRUCTURE

- When we look at living things, we find that they have a highly organized structure.
- When we consider the complexity and function of living things and their components, it is difficult to understand how they could have evolved to do the extremely complicated tasks they are capable of.
- Think about your body and just one organ - say, the lungs. They enable the interchange of inhaled and exhaled respiratory gasses.
- They have to contend with variations in air temperature, air quality, air pressure, and with the invasion of foreign matter carried by the air.

# Life - Defining Life

By Leslie Mullen

- They function all the time you are alive - up to 120 years in some people - and they work to peak efficiency if at all possible.
- The delicate tissue from which your lungs are made, would cover a [soccer field] if laid out, and this is thin enough to allow gasses to pass through, yet prevent your blood pressure from bursting the tissue.
- To fabricate something like the lung, make it fit the chest cavity, and expect it to work without maintenance for more than a century is currently an engineering impossibility. In fact, the technology to do something like this is decades or more away.
- So how could such a complex biological structure evolve?

# Life - Defining Life

By Leslie Mullen

- REPRODUCTION
- Living things can reproduce themselves.
- They have an inherent desire to multiply their species.
- Their imperative is in fact to pass on their genes to a subsequent individual.
- This reproduction process is one of almost exact replication and not only is a new and similar individual living entity created but, most important, the instructions to make even more individuals are passed on.
- This act of passing on of the "construction" information is obviously vital, if even more generations of entities are to be made.

# Life - Defining Life

By Leslie Mullen

- In life as we know it, the "construction" information is carried by genes, which are strings of DNA molecules that contain specific "building" instructions.
- In the simplest form, reproduction takes place as cell division, where a cell will divide into two, thus creating a new and independent living entity that is a copy of itself.
- Sometimes, though the copy is not exactly identical.

# Life - Defining Life

By Leslie Mullen

- The new cell is a mutation - different from the parent cell, in its genetic structure.
- This offers evolutionary advantages in some instances.
- Reproduction, where offspring are identical to the parent, is known as cloning.
- More advanced forms of reproduction exist, notably sexual reproduction, which takes genetic material from two individuals to create a new individual living entity that is similar, but not identical, to the parents.
- Usually each parent contributes half the genes to such offspring.

# Life - Defining Life

By Leslie Mullen

- METABOLISM
- By metabolism we include:
  - respiration - breathing, aerobic and anaerobic
  - energy intake - feeding or photosynthesis
  - excretion - disposal of waste products
- Metabolism is the mechanism by which living things extract energy from the environment and use it for growth, movement, neural activity and other functions.

# Life - Defining Life

By Leslie Mullen

- GROWTH
- Living things grow and change their make-up, though not their general appearance.
- They can even change much of the material they are made of, yet they remain looking the same, if a little older.

# Life - Defining Life

- EVOLUTION By Leslie Mullen
- Evolution is the process by which living things can change, from one generation to another.
- This allows them to adapt to their environment and cope with changes that might otherwise kill them.
- Most biologists agree that, at the basic level of genetic mutation, the process is random, but it will probably bestow some advantages onto some of the offspring.
- These offspring will fare better than others that are not so well adapted.
- Eventually those not well adapted to their environment, and their offspring, will die out leaving the best adapted to inherit the environment.

# Life - Defining Life

By Leslie Mullen

- IRRITABILITY
- Living things can interact with their environment.
- In order to do this they must first be aware of it.
- They can sense it. Humans and most vertebrates have five main senses - sight, hearing, smell, taste and touch.
- There are others - the ability to detect the direction of the pull of gravity, some snakes can sense infrared, some birds can sense magnetic fields.
- These sensing abilities allow living things to react to their environment and even change it.

# Life - Defining Life

By Leslie Mullen

- Additionally, living things can communicate with others of their own species and even other living things.
- This can take many forms, from speech and reading at the human level, right down to nervous electrical impulses and hormonal chemical messages at a cellular level.
- Even plants communicate by releasing chemical "markers" into the air, which other plants can detect.

# Life - Defining Life

By Leslie Mullen

- RESILIENCE
- Living things are resilient to their environment.
- That is not to say they will always survive it, but they have a certain tolerance to events and changes and they can adapt.
- For instance, some mammals grow winter fur to keep warm and shed it by molting in the spring.
- Some bacteria and fungi, when faced with arctic conditions, will go into a stasis or hibernation until conditions improve.
- Both are a form of resilience.

# Life - Standard Definitions

- This section presents what may be considered the classical properties of life, according to standard reference material. The 1984 Random House College Dictionary ([30](#)) defines life as: "The condition that distinguishes animals and plants from inorganic objects and dead organisms, being manifested by growth through metabolism, reproduction, and the power of adaptation to environment through changes originating internally." This latter property refers to the phenomenon of homeostasis, whereby an individual organism changes itself in response to a change in its surroundings. In other definitions this is called "response to stimuli" or just "responsiveness".

# Life - Standard Definitions

- Homeostasis is not to be confused with response of the species to environmental changes through the process of natural selection.
- This is evolution, and it comes about through the transmission of random mutations in the organism to its offspring.
- This ability to transmit mutations during reproduction, and thus be subject to the processes of natural selection, is a criterion of life cited by several references.

# Life - Standard Definitions

- The Encyclopaedia Britannica concentrates on metabolism in their biochemical definition of life: "An open system of linked organic reactions catalyzed at low temperatures by specific enzymes which are themselves products of the system."
- Some references include movement against a force in addition to the other criteria.
- This may include locomotion or, in the case of most plants, growth against the force of gravity.
- The transfer of matter is another standard criterion listed.
- The consumption of raw materials and the excretion of waste materials are natural consequences of metabolism.

# Life - Standard Definitions

- In general, life has traditionally been characterized in terms of growth, reproduction, metabolism, motion, and response (through homeostasis and evolution.)