Dear future Biology students,

The following assignments have been compiled to help prepare you for Advanced Biology in the upcoming school year. The time that you put into these assignments will benefit you and help ease your transition into an Advanced Science class. All of these assignments will be due by the first day of class, though I encourage you to email them to me before this. I am very excited to get to explore the many exciting topics of AS Biology with you next year. Meanwhile, I encourage you to reach out with any questions, concerns, or general comments.

Thank you,

**Ms. Campbell**

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**Part 1: “What is Life?”**

You may already be aware that Biology is the “study of life,” and in coordinated science, we’ve discussed many processes essential to life. But, what exactly is life?

* 1st: **Read** both of the attached articles that seek to answer this question and consider your own answer to this question.
* 2nd: **Write** a 4-8 sentence paragraph defining life in your own words.

**Part 2: “Inside the Cell”**

* 1st: **Read** the entire booklet, “Inside the Cell,” taking notes on the main ideas and the definitions of the cell terms and other vocabulary below.
* 2nd: **Answer** the “Got It?” questions from pages: 19, 31, 45, 59, 73
* 3rd: **Build** a cell. Chapter 1 introduces many important cell structures. From this chapter, you will be responsible for knowing the Cell Terms listed below. Choose at least 10 of these to include in your cell model (I encourage you to use google to brainstorm ideas). I’d love to see what you create, but if it is not feasible to bring it into school, please take a few pictures of it instead.

**Cell Terms:** Organelle, chromosomes, DNA, nucleus, nuclear envelope, nuclear pores, cytoplasm, cytosol, ribosomes, rough endoplasmic reticulum, smooth endoplasmic reticulum, Golgi apparatus, lysosomes, mitochondria, cytoskeleton, microtubules, flagella, cilia,

**Other Vocabulary Related to AS Biology** (Listed in order of appearance in the reading): Micrometer, Proteins, Lipids, Antibodies, Hormones, ATP, Genome, Light Microscope, Transmission Electron Microscope, Scanning Electron Microscope, Viruses, Transcription, RNA Polymerases, mRNA, Translation, Amino Acids, RNAi, tRNA, Vesicles, Endocytosis, Exocytosis, Channel Proteins, Lipid Raft, Cell Cycle, Extracellular Matrix, White Blood Cells, Platelets, Genomics, Mitosis, Meiosis, Cell Cycle (G1, S, G2, and M phases), Interphase, Checkpoints, Phases of Mitosis (Prophase, Metaphase, Anaphase, Telophase), Cytokinesis, Mutations, Spindle, Diploid, Haploid,

* 4th: **Write** a reflection: Consider your personality and your relationships with others in your life. Choose one organelle from Chapter 1 of the booklet that best represents you and explain your reasoning in a letter/email to me, Ms. Campbell. If possible, please type this and email it to me *before* the end of summer

**Part 3: Prepare for the new school year**

* Obtain the school supplies for Biology: One binder (any size) devoted to Biology; One graph-paper composition notebook devoted to Biology (this may be the same one from Coordinated Science); Pencils; Eraser
* Add my email ([ellen.campbell@asu.edu](mailto:ellen.campbell@asu.edu)) to your email contacts list
* If you have a computer, add to your Favorites list/add a bookmark to my Weebly site. Throughout the school year, I will post all assignments here. Additionally, all of the resources listed in this document can be found there.

**Part 4: Optional activities**

* Read Cambridge’s Learner’s Guide for AS Biology <http://www.cie.org.uk/images/150289-cambridge-learner-guide-for-as-and-a-level-biology.pdf>
* Watch these videos:
  + <http://thesciencenetwork.org/programs/the-great-debate-what-is-life>
  + <http://ed.ted.com/lessons?category=life-sciences>
* Browse other great reads:
  + <http://ngm.nationalgeographic.com/2013/04/125-species-revival/zimmer-text>
  + <http://www.smithsonianmag.com/science-nature/top-ten-places-where-life-shouldnt-exist-but-does-144112310/>
  + <http://www.theguardian.com/commentisfree/2013/jan/13/secret-life-unveiled-chemistry-lab?INTCMP=ILCNETTXT3487>

**To Recap: These are the assignments that should get turned in**

* Part 1: Paragraph on “What is Life” (5 points)
* Part 2: Answer to the “Got It?” questions (5 points)
* Part 2: Build a Cell (10 points)
* Part 2: Write a Reflection (5 points)
* *“I think the next [21st] century will be the century of complexity. We have already discovered the basic laws that govern matter and understand all the normal situations. We don’t know how the laws fit together, and what happens under extreme conditions. But I expect we will find a complete unified theory sometime this century. The is no limit to the complexity that we can build using those basic laws.”*
* ***— Stephen W. Hawking,*** *interview in San Jose Mercury News (23 Jan 2000)*

**Article 1: What is life?** Author: Tim Radford *The Observer*, Saturday 26 April 2008

Source: <http://www.theguardian.com/science/2008/apr/27/genetics.evolution>

One hundred and fifty years of serious, secular study have brought us to a better understanding of what constitutes all living organisms, but the why and how of life itself remain elusive. Life looks increasingly like a chemical experiment that took over the laboratory. All living things turn to dust and ashes when they die, or, to put it another way, to constituent atoms and molecules of hydrogen, oxygen, carbon, phosphorus and so on.

But, in another sense, living things do not die: they begin again, from a tiny cell, and scavenge the dust, the air and water, to find the elements necessary to fashion an aspidistra, an elephant, or an attorney-general, using only the raw materials to hand and energy from a thermonuclear reactor 93 million miles away. The freshly minted, self-replicating organism then grows up, grows old and melts away, but not before imparting a fragment of itself to generate yet another copy, but not an identical copy. The process is visible and transparent, everywhere on the planet, but it is ultimately mysterious. It has been going on for at least 3.5bn years, but researchers may never satisfactorily explain how it ever got started.

The mystery may endure because, once up and running, the life machine kicked up enough dust to cover its original tracks. It altered the air, muddied the water and recycled the rocks around it. For at least 30 centuries, thinkers ascribed the beginning of life to an extraterrestrial agency: they talked of the hand of God, the divine afflatus, the vital spark, or of "seeds" of life travelling through the cosmos. By 1850, however, chemists, physicists, geologists and biologists - many of them deeply religious, and all of them familiar with the religious tradition - had begun to take the problem seriously, and concluded that complex life had in some sense evolved from simpler beginnings, exploiting the materials around it for its own survival.

Charles Darwin in 1859 proposed that life may have brewed in a soup of organic chemicals in some "warm little pond" on the surface of the primordial Earth. He left the question open: it remains open. His inheritors have proposed that life could have been generated in the first sunlit oceans that swept across the young planet, or in the crater left by an asteroid impact, or made a template of itself in a bed of wet clay, or in the dark silence of submarine volcanoes, or that it had been delivered in a meteoritic fragment from a faraway planet.

But as far as we know, life exists on Earth and nowhere else. This is a puzzle because, at one level, the universe looks as though it was set up to generate life. In the first place, the constants of physics are so finely tuned that, were they even infinitesimally different, there would be no stars or planets, no carbon atoms, no oxygen, no aspidistras, elephants or attorney-generals. In the second place, the space between the stars - where no life could ever exist - is rich in life's prime ingredients: the organic chemicals. Astronomers have identified more than 100 of these, including cyanide, formaldehyde, alcohol, ammonia, and acetylene. Comets are rich in hydrocarbons. A meteorite that fell to Earth in Australia in 1969 has so far yielded more than 70 amino acids. These are the building blocks of protein. In 1953, two Chicago chemists filled a flask with ammonia, methane, water and hydrogen - the Earth's primitive atmosphere must have contained all these - and ran an electric current through it. After just a week, they had 13 of the 22 amino acids that are the constituents of protein, the stuff of all living material. If that happened in one week in one laboratory, they reasoned, it could certainly have happened through a billion years of lightning strikes.

But it is a big jump from life's building blocks to self-replicating, planet-altering life, so big that the astronomer Sir Fred Hoyle famously argued that life had as much chance of emerging from a chemistry set by accident, as a jumbo jet had of appearing from a windstorm in a junkyard. Yet life exists, it shares a common biochemistry, and species are grouped in such a way as to suggest common ancestry. But how it began, and precisely when and where, remains a mystery.

Life looks after itself, but humans look after the classification of life, and humans argue. The first biologists divided life into animal and plant kingdoms, and then subdivided these into phyla, or divisions, classes, orders, families, genera, species and subspecies. But this was long before the discovery of DNA, which showed that creatures that seemed similar could nevertheless have evolved from very different lineages, and so categories are always under revision. The process of classification began long before anyone realised that microbes and their parasitic viruses dominate all life on the planet. Complex life was a late arrival. This microbial influence is so profound that another biologist, Carl Woese, proposed just three kingdoms: archaea, bacteria and eucaryota. All of these are family trees with many branches, but the last group, the microbes with nuclei, end with three little twigs from which evolved all the planet's plants, animals and fungi. Biologists now argue the case for either five (monera, protista, plantae, fungi, animalia) or six kingdoms (plants, animals, protists, fungi, archaebacteria and eubacteria).

**Article 2: What is life? The physicist who sparked a revolution in biology** Author: Matthew Cobb, 7 February 2013Source: <http://www.theguardian.com/science/blog/2013/feb/07/wonders-life-physicist-revolution-biology>

Seventy years ago, on 5 February 1943, the Nobel prizewinning quantum physicist Erwin Schrödinger gave the first of three public lectures at Trinity College, Dublin. His topic was an unusual one for a physicist: "What is Life?" The following year the lectures were turned into a book of the same name.

One of Schrödinger's key aims was to explain how living things apparently defy the second law of thermodynamics – according to which all order in the universe tends to break down. It was this that led my colleague Professor Brian Cox to use Schrödinger as the starting point of his BBC series Wonders of Life, leading to What is Life? shooting up the Amazon sales chart. But Schrödinger's book contains something far more important than his attempt to fuse physics and biology. In that lecture 70 years ago, he introduced some of the most important concepts in the history of biology, which continue to frame how we see life.

At a time when it was thought that proteins, not DNA, were the hereditary material, Schrödinger argued the genetic material had to have a non-repetitive molecular structure. He claimed that this structure flowed from the fact that the hereditary molecule must contain a "code-script" that determined "the entire pattern of the individual's future development and of its functioning in the mature state". This was the first clear suggestion that genes contained some kind of "code", although Schrödinger's meaning was apparently not exactly the same as ours – he did not suggest there was a correspondence between each part of the "code-script" and precise biochemical reactions.

Historians and scientists have argued over the influence of Schrödinger's lectures and the book that followed, but there can be no doubt that some of the key figures of 20th century science – James Watson, Francis Crick, Maurice Wilkins and others – were inspired to turn to biology by the general thrust of Schrödinger's work.

The role of the brilliant "code-script" insight is less clear. Reviewers of What is Life? in both Nature and the New York Times noted the novel phrase, but despite the fact that in 1944 Oswald Avery published clear evidence that DNA was the genetic material, virtually no one immediately began looking for – or even talking about – a molecular "code-script" in DNA, although Kurt Stern suggested that the code might involve grooves in a protein molecule, like the grooves in a vinyl disc. Part of the reason for this lack of immediate excitement and for Avery's discovery not being widely accepted was that DNA was thought to be a "boring" molecule with a repetitive structure – exactly what Schrödinger had said a gene could not be. It took the work of Erwin Chargaff, inspired by Avery, to show that the proportion of the "bases" in the DNA molecule – generally presented by the letters A, T, C and G – differed widely from species to species, suggesting the molecule might not be so boring after all.

As early as 1947, Chargaff suggested that the change of a single base "could produce far-reaching changes … it is not impossible that rearrangements of this type are among the causes of the occurrence of mutations." The culmination of this line of work was Watson and Crick's double helix model, which was based on the experimental data of Rosalind Franklin and Maurice Wilkins.

But in 1947 there was a missing component in biological thinking about the nature of the code, one which was at the heart of Watson and Crick's decisive interpretation of their discovery a mere six years later – "information". That idea entered biology through some applied research carried out to aid the war effort. In 1943, the US National Research and Development Committee set up a group of scientists to study "fire control" – how to ensure accurate anti-aircraft fire, by the control of information from radar, visual tracking and range-finding. Two of the men involved in this project were Claude Shannon, a mathematician who developed what became known as "information theory" to understand how signals were processed, and Norbert Wiener, who thought there were parallels between control systems in machines and in organisms, and who coined the term "cybernetics".

The first person to argue that a gene contains information was the co-founder of cybernetics, John von Neumann. In 1948, von Neumann described a gene as a "tape" that could program the organism – like the "universal Turing machine" described in 1936 by Alan Turing (intriguingly, Turing had discussed it with Shannon while working in New York in 1944). A few years later in 1950, geneticist Hans Kalmus deliberately applied cybernetic thinking to the problem of heredity and suggested that a gene was a "message". Cybernetics briefly became wildly popular, filling the pages of broadsheet newspapers all over the world and encouraging biologists to look for feedback loops in living things. Following the 1948 publication of Shannon's dense book Information Theory (co-authored by Warren Weaver, who had chaired the fire control group and also coined the term "molecular biology"), the abstract concept of information percolated into the scientific mainstream. Although the term had a precise meaning for Shannon, in the hands of the biologists it turned into a vague metaphor, a way of thinking about something they as yet had no real understanding of: the nature of the gene.

Ten years after Schrödinger's brilliant insight, Watson and Crick's second 1953 article on the structure of DNA provided the world with the key to the secret of life, casually employing the new concepts that had been created by cybernetics and propelling biology into the modern age with the words: "it therefore seems likely that the precise sequence of the bases is the code which carries the genetical information." These prophetic words – shorn of the conditional opening phrase – are uttered in biology classes all over the world, every single day.

In a decade of tumultuous discovery, insights from biology and computing built upon Schrödinger's genius, changing our view of life forever. Life had become information, genes were the bearers of that information, carrying it in a tiny, complex code inside every cell of our bodies. And the breakthrough began in a Dublin lecture theatre 70 years ago this week.