Multimodality in the Science Classroom: A Focus on Multimedia Representations and How Students Learn

Natalie Suflita
The College at Brockport, suflita_natalie@hotmail.com

Follow this and additional works at: http://digitalcommons.brockport.edu/ehd_theses
Part of the Education Commons

To learn more about our programs visit: http://www.brockport.edu/ehd/

Repository Citation
http://digitalcommons.brockport.edu/ehd_theses/140
Multimodality in the Science Classroom:
A Focus on Multimedia Representations and How Students Learn

by

Natalie Suflita

A thesis submitted to the Department of Education and Human Development of the State University of New York College at Brockport in partial fulfillment of the requirements for the degree of Masters of Science in Education
Multimodality in the Science Classroom:

A Focus on Multimedia Representations and How Students Learn

by

Natalie Suflita

APPROVED BY:

___________________________________                      ____________
Advisor       Date

___________________________________                      ____________
Director, Graduate Programs     Date
Abstract

Multimodality in the Science Classroom:

A Focus on Multimedia Representations and How Students Learn

by

Natalie Suflita

The element of active student engagement is one crucial facet to effective pedagogy. The use of technology and other media in the classroom has been researched but the impact of its efficacy is still in question. The fusion of technology into students’ social lives is undeniably on the rise and this mode along with other complementary media has the potential to positively impact both student engagement and learning, as exposed here through the vehicle of science instruction.
Table of Contents

Chapter One: Introduction ................................................................. 3
Chapter Two: Review of Literature .................................................... 6
  Defining Relevant Terms ............................................................. 6
  Multimodality: A Dynamic Approach for Engagement ...................... 9
  Cognitive Load Theory and Multimedia ......................................... 12
  The Classroom Connection: Cognitive Theory of Learning with Media .... 16
  Multimodal and Multimedia Design ............................................ 18
  Creating a Teacher Resource ....................................................... 23
  Harnessing Motivation and Engaging the Learner ............................ 24
Chapter Three: Application to the Curriculum ................................... 25
  Unit One: Cell Structure of Life, Cells, and Cell Processes ............... 27
  Unit Two: Reproduction & Development ....................................... 29
  Unit Three: Human Anatomy & Physiology .................................... 31
  Unit Four: Genetics and Biotechnology ....................................... 33
  Unit Five: History and Evolution ............................................... 35
  Unit Six: Ecology .................................................................. 36
  Process, Use, and Justification .................................................. 38
  Application to Curriculum ......................................................... 39
Chapter Four: Conclusion and Recommendations ............................... 40
References ................................................................................. 43
Appendix
  Unit One: Cell Structure of Life, Cells, and Cell Processes ............... A-1
  Unit Two: Reproduction & Development ....................................... A-13
  Unit Three: Human Anatomy & Physiology .................................... A-19
  Unit Four: Genetics and Biotechnology ....................................... A-30
  Unit Five: History and Evolution ............................................... A-39
  Unit Six: Ecology .................................................................. A-42
Illustrations

Figure 2.1 Visual Representation of the Cognitive Theory of Multimedia Learning..14
Figure 2.2 Seven Research-based Principles.............................................15
Figure 2.3 A Cognitive Theory of Learning with Media..............................17
Chapter One: Introduction

Introduction

With the overwhelming amount of media a student encounters on a daily basis, as well as the rapid growth of technology usage, including a 528.1% growth in global internet usage since 2000 (World Internet Usage Statistics News and World Population Stats, 2012), there is the possibility for the classroom environment to appear disjointed or outdated when compared to the diversity of learning arenas and technology a student may experience outside the classroom. In a review of research in education on multimodality that includes components of literacy and multimedia, Jewitt (2008) states that “the contemporary conditions of communication and digital technologies create the movement of images and ideas across geographical and social spaces in ways that affect how young people learn and interact” (p.242). This statement has implications for the nature of learning by students as they move through these landscapes and for an educator as they may be challenged to gain student attention, engagement, and ultimately motivation in the classroom setting due to these alternative learning environments.

Evidence for this increased and earlier use of technology is summarized by a recent survey that examined cell phone habits of third through twelfth graders and found that 20 percent of third grade students have cell phones, of which 90 percent of them are online, while 83 percent of students in middle school own and use a cell phone (Englander, 2011). Through the variety of social and cultural landscapes in which the student interacts, they experience a vast array of information presented in many different forms which impacts communication, having implications on the
traditional view of learning and literacy. From the dominance of cell phones to the
accessibility of the internet, students interact with a wide range of technology and
social media they encounter on a daily basis. This connectivity has impacted how
students communicate, gather information, and learn. As Kress (2003) expresses, the
transition is going from the centuries old dominance of writing to the new dominance
of the image as well as the movement from book to that of the screen for a learning
medium which acts together to produce a revolution in representing and
communicating at every level.

Looking at the history of education, it has regularly adopted the idea of
incorporating technology in the classroom, although the degree of effectiveness has
continued to be debated and researched. Within schools, information is presented in
different capacities for different subjects and typically can vary widely based on the
individual teacher. What is the most effective way to engage, explain, and illustrate
concepts? What do we know and are finding out about how students learn and will
this impact our teaching? How do educators prepare a motivating environment that
would enhance learning for the student? Each of these facets has a wealth of research
for an educator to explore which would help produce and procure a high quality
learning environment. What theme can further connect these possibly disjointed
areas into one cohesive approach, adding to effective pedagogy and practice? This
idea is the concept and implementation of multimodality. Multimodality, the use of
more than one mode, is a natural element to almost any setting, but is especially
evident in a science classroom where activities such as laboratory experiments,
demonstrations, and collaborations are typical interactions used to convey content. As Jewitt (2008) goes on to explain, “how knowledge is represented, as well as the mode and media chosen, is a critical aspect of knowledge construction, making the form of representation integral to meaning and learning” (p.241). In other words, the way in which ideas are represented and communicated shapes both what is to be learned and how it is to be learned.

This idea of how meanings are made is an important aspect of education. Quality teaching and learning can occur when the mechanisms behind how we learn are exposed and more fully understood. It seems logical that a better understanding of how we learn should affect how we teach. Multimodality and the closely related concept of multimedia is a relatively recent and emerging area of research to the field of education. As these concepts are more fully understood in other contexts such as psychology and physiology, the evidence can and should be used to improve education. By understanding and implementing the principles of modality, benefits in student engagement, perceptions, and learning can occur.
Chapter Two: Review of Literature

Looking to the research in education on multimodality in search of a definitive meaning yields the opposite. After reviewing this topic, it has unfolded into many related subtopics which include literacy, and leads to a large amount of research outside of the field of education. Most notably, research in psychology, art, design, and semantics have all influenced the early development of multimodality. Another closely related topic is the concept of multimedia which has a modality principle within its definition and is overall, very similar in the role it plays in education and technology related learning environments. Multimedia studies, which include the modality principle, have been exclusively tested on the scientific processes, making its use tested and tailored to the science classroom (Tabbers, Martens, & Merrienboer, 2001) and since have extended to other domains.

Defining Relevant Terms

Based on a model of working memory, the modality principle states that visual and verbal/acoustic are the two distinct channels in which information is processed. The implications of this principle are that the learning capacity and cognitive processing ability can be maximized as cognitive load is monitored for optimal retention and recall in learning. As Moreno (2006), a leading educational researcher in this area describes, media typically refers to the vehicle used to deliver the instruction, method is the technique that different media provide, and modality can refer to what channel the learner processes the information. Another definition of
these sometimes interchangeably used terms is elucidated by Lauer (2009) who explains:

“Multimodal” is a term valued by instructors because of its emphasis on design and process, whereas “multimedia” is valued in the public sphere because of its emphasis on the production of a deliverable text. Ultimately, instructors need to continue using both terms in their teaching and scholarship because although “multimodal” is a term that is more theoretically accurate to describe the cognitive and socially situated choices students are making in their compositions, “multimedia” works as a gateway term for instructors and scholars to interface with those outside of academia in familiar and important ways. (p. 225)

There may be some resistance to utilizing the research findings of multimodality and multimedia and the lack of transferring that knowledge into the field of education, possibly due to the small amount of research that has been completed to date. Alternatively, resistance to incorporating aspects of multimodal instruction may be delayed due to the wide scope of this research area. The research stems from multiple fields and it may take more time, resources, and evidence to solidify a multimodal approach that is widely accepted in the classroom. However, it can be argued that research on multimodality in other fields is plentiful and can easily translate to education and the classroom with multiple benefits for the learner. Combining effective practices from multiple disciplines applies established research to improve how knowledge is constructed and retained. Jewitt (2008) describes the multimodal perspective as image, action, and other components that are each referred to as modes and can be a set of semiotic resources for meaning making. The broad scope and impact of multimodality in the classroom can be better conceived as Jewitt discusses that multimodality has not only psychological and linguistic foundations but
Chapter Two: Review of Literature

also draws from anthropological, sociological, and discourse theories, while it has a particular influence on both cognitive and socio-cultural components of communication and perceptions. Kress (2001) furthers describes the multimodality-language connection by expressing that a different view of language leads to a different view of learning and proposes that learning can no longer be treated as a process which depends on language centrally, or even dominantly. Without eliminating or diminishing the importance of literacy skills and their valued role in the science classroom researchers in the area of multimodality communicate a broader view of learning as “Learning is thus more than a matter of speaking or writing the language of science; it is a dynamic process of transformative sign-making” (Kress, Charalimos, Tsatsarelis, & Jon, 2001, p.3). In other words this concept of “transformative sign making” links multimedia representations and literacy by requiring users to be able to transfer written knowledge to a constructed visual to illustrating unified moving parts and vice versa. Not only is the traditional view of literacy challenged in this capacity but ‘transformative sign making’ also challenges learners to tap both their creativity and critical thinking skills by requiring learners to digest information and re-represent it in another way. This multiple angled approach can reinforce learning, create meaning, and break through misconceptions while functioning as a learning scaffold that is easily differentiated for various learners.
Chapter Two: Review of Literature

Multimodality: A Dynamic Approach for Engagement

The process of meaning making includes both student and teacher, rendering each a sign maker. It is through these signs that knowledge is constructed and communicated, influencing how one applies and interprets meaning (Bezemer & Kress, 2008). These signs are the elements that are brought together by motivation of the sign maker. One can conclude that it is important that students are given the appropriate opportunity to be the designers and sign makers of concepts. This would facilitate students to connect prior knowledge and assist in motivating them to make meaningful personal connections with the content and how they learn. Furthermore, by students taking an active role in developing meanings and communicating their knowledge, assessment of their level of understanding can be appraised. By approaching knowledge, understanding, and meaning making from a multimodal perspective, students are most likely to be engaged and motivated - a key connection to any learning process. Therefore, one can borrow from the research area of literacy, and look to an engagement model for the classroom which functions to enhance motivation. This aligns with research on multimodality and literacy, aspects of which help set the stage for promoting multimodality in the science classroom. Bezemer & Kress (2008) describe six characteristics in their engagement model. These factors, through their research and reference to other advancements in this area, prove to be a necessary factor to establishing this type of culture in the classroom. It is explained that each feature can be applied to the classroom in a different way, which can vary depending on the teacher and content. This echoes the ideas conveyed in
multimodality, that meanings can be made and remade depending how they are presented and in what mode.

The main elements of the engagement model that were communicated by Jewitt (2008) for effective teaching that should be incorporated for an approach involving multimodality include; establishing knowledge goals, developing real-world interactions, providing interesting texts, upholding autonomy support, including instruction on specific strategies, and allowing for opportunities for collaboration and support.

Supporting this framework via instruction using multimodal texts is research that also supports student choice (Alvermann & Wilson, 2011). This research is impacting literacy by redefining narrow definitions of reading in combination with being aware of the impact of multiple sign systems, semiotic, or modal resources and how they are used in making meaning in scientific texts. This research, although within the study of literacy has implications for multimodality in the science classroom. This multimodal nature of scientific texts, components of which are used throughout the classroom setting, underscore the fact that “science teachers and students may draw from multiple semiotic resources to understand and communicate scientific content” (Alvermann & Wilson, 2011, p. 118).

Another element to explore within this research is transmediation, which has a literacy link and a multimodal foundation. Transmediation is the translation of content from one sign system to another which allows the learner to make connections between them, leading to a more rich and complex understanding (Siegel, 2006).
This idea can be applied to both multimedia and multimodal instruction based on learners ability, preferences, and motivation. Use of research and data outside of the intended field does not demish the topic or results but alternatively, can work to enhance the scope and applicability of the results. This continues to be the case as Alvermann & Wilson (2011) further describe the nature of scientific texts in the field of literacy, which can be broadly reapplied to the science classroom. This generalization about science literacy texts is broad enough to align with the nature of science and therefore can function as a working example of what multimodality looks like in the science classroom, Alvermann and Wilson (2011) explain:

> Because science addresses different aspects of the physical universe, the observable properties and spatial arrangement of different entities are often essential for understandings of scientific content. Therefore, scientific disciplines may be particularly dependent of a variety of visual displays or objects, such as models, diagrams, photographs, videos, and other iconic representations that bear a physical resemblance to the items they represent. (p.118)

This resonates with other resources that state that multiple modes such as image, gestures, written language, spoken language, and three-dimensional models each have their own affordances or potential uses to which they lend themselves. Connecting this foundation to motivation, some modes may be more appealing or draw on students strengths more than other approaches. As educators facilitate and function in their own capacity as a meaning makers, they can activate student motivation by drawing on student skills and interests during this process. Language and images afford different ways to express scientific ideas or concepts and therefore by its nature the multimodal process works to more fully support and strategically approach
understanding of scientific content (Kress 1997). The inherent diversity in this method and approach can function to differentiate learning, making learning more accessible with a greater probability to tap into students interests’ and motivations.

Cognitive Load Theory and Multimedia

The concept of cognitive load, developed in the 1980’s from the field of cognitive psychology, states that during complex learning activities the amount of information or interactions that must be processed at any given time can affect the working memory space in which one must processes all information before meaningful learning can occur (Paas, Renkel, & Swelller, 2004). These same researchers explain further the cognitive mechanism behind this theory:

Cognitive load theory mainly concerned with the learning of complex cognitive tasks, where learners are often overwhelmed by the number of information elements and their interactions that need to be processed simultaneously before meaningful learning can commence. Instructional control of this (too) high load, in order to attain meaningful learning in complex cognitive domains, has become the focus of CLT. The theory suggests that learning happens best under conditions that are aligned with human cognitive architecture. (p.1-2)

To respond to and work to diminish large cognitive loads when new material is being learned various principles have been created and tested to reach the optimum level for cognitive load on memory as people learn new concepts. For example, Mayer and Moreno (2003) “identified [that] pre-training effects within learning processes with multimedia, reported a better transfer effect and a reduction of individual cognitive
load effects when basic knowledge was well established” (Girwidz & F. X. Bogner, 2006, p.105).

Not all technology is beneficial technology when incorporated into education. This is supported by the history of technology in education and the many examples of technologies that initially had strong claims for impact and then fizzled out such as when the first motion pictures were thought to revolutionize the educational system in the early 20’s (Cuban, 1986) or how in the 1970s, computer-assisted instruction programs were thought to be the new wave of the future of education (Vanderbuilt, 1996). To mediate this, researchers Mayer and Moreno propose that educators must effectively use technology by utilizing it in ways that are grounded in a research based theory of how students learn. Therefore, building upon the cognitive load theory they have developed a research supported sub-theory, the cognitive theory of multimedia learning. This theory draws upon foundational theories such as the dual coding theory, the accepted model of working memory, and the cognitive load theory to determine that the learner uses a visual information processing system that digests text/animation and a verbal information processing system that digests auditory information.

During multimedia learning the learner goes through a set of cognitive processes that include selecting, organizing, and integrating. More specifically multimedia learning has the learner select relevant words and images, organize them and then integrate both of these representations with prior knowledge, as illustrated below in Figure 2.1.
Figure 2.1 Visual Representation of the Cognitive Theory of Multimedia Learning

This model is based on three primary assumptions collected from the foundational theories that uphold multimodal learning by Mayer and include:

- Visual and auditory experiences or information are processed through separate and distinct information processing 'channels'
- Each information processing channel is limited in its ability to process experiences or information
- Processing experiences or information in the channels form an active process designed to construct coherent mental representations
Chapter Two: Review of Literature

As summarized through Mayer’s research and theory of multimedia learning seven principles have been developed and are summarized in Figure 2.2 (Rias & Zaman, 2011).

1. **Multimedia Principle**: Students learn better from words and pictures than from words alone.
2. **Spatial Contiguity Principle**: Students learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.
3. **Temporal Contiguity Principle**: Students learn better when corresponding words and pictures are presented simultaneously rather than successively.
4. **Coherence Principle**: Students learn better when extraneous words, pictures, and sounds are excluded rather than included.
5. **Modality Principle**: Students learn better from animation and narration than from animation and on-screen text.
6. **Redundancy Principle**: Students learn better from animation and narration than from animation, narration and on-screen text.
7. **Individual Differences Principle**: Design effects are stronger for low-knowledge learners than for high-knowledge learners and for high-spatial learners rather than for low-spatial learners.

Figure 2.2: Seven Research-based Principles

Utilizing the research on multimodality, the principles that have been developed and tested reveal much understanding and gains into how people learn which is solidified by research from the cognitive sciences that can confirm theorized brain and memory functions through functional magnetic resonance imaging (fMRI) (Metiri Group, 2008).
The Classroom Connection: Cognitive Theory of Learning with Media

In conjunction with Mayer’s cognitive theory of multimedia, the similar cognitive theory of learning with media (CTLM) (Moreno, 2006) has established a base of learning assumptions that further connects Mayer’s research to what has been done in the field of cognitive science. These accepted learning assumptions can be utilized as multimedia and multiple modes are incorporated appropriately in the classroom and can serve as guidelines for effective instruction. Moreno (2006) articulates that: (a) Learning starts when information is processed in separate channels for different sensory modalities; (b) only a few pieces of information can be consciously processed at any one time in working memory; (c) long-term memory consists of a vast number of organized schemas; (d) knowledge may be represented in long-term memory in verbal and nonverbal codes; (e) after being sufficiently practiced, schemas can operate under automatic processing; and (f) conscious effort needs to be spent selecting, organizing, and integrating the new information with existing knowledge.

Furthermore, Moreno illustrates and describes her theory with a visual similar to Mayer that informs the processes behind how people learn but includes elements more aligned with technology. This technology connection develops a relationship in which education can easily adopt an approach to incorporate multimodality for student learning.
In summary, the National Academy of Sciences (2008) proposes important principles based how people learn and relate it to the future implications for the redesigning of learning which aligns with the multimedia approach. These principles include; (a) Student preconceptions of curriculum must be engaged in the learning process. Preconceptions and prior experiences are stored in long-term memory and function by connecting with incoming information to enhance current and prior learning. (b) Expertise is developed through deep understanding. Mental organization as well as being personally connected to the material is when students learn most effectively. This requires that students learn topics in ways that are relevant and meaningful to them. (c) Learning is optimized when students develop metacognitive strategies.
Chapter Two: Review of Literature

Summary

Multimodal and Multimedia Design

Multimodality and its related multimedia format are beneficial for the science classroom because as McGinnis (2007) expresses, students enter the classroom each having different levels of expertise, both with the content and with media usage. This diversity naturally allows for students to interact and learn from each other while providing the teacher multiple opportunities to differentiate not only content but instructional approach. It is equally important to consider the social worlds of students as these multimodal practices are connected to broader social, cultural, and global contexts. One overarching goal of science education is to prepare students with skills and science knowledge for interaction in the global landscape of the future. As Gainer (2010) articulates, “we live in a multimedia age where the majority of information people receive comes less often from print sources and more typically form highly constructed visual images, complex sound arrangements, and multiple media formats” (p.364). By providing learning environments that are multimodal in nature within the classroom, students are best adapted for the diverse and ever changing learning environments that they are most likely to encounter in education, the workforce, and society.

Once students are exposed, familiar, and versed in multimodal and multimedia construction, this approach is likely to add to the skill set of critical thinking and inquiry.
Chapter Two: Review of Literature

Arguably, equally important to critical thinking and inquiry skills is creativity. Creativity has strong connections with motivation which results in students that are engaged with the curriculum and learning in general. When considering creativity, Walsh (2007) proposes that youth have the skills and experience to combine their imagination with the many modes of the classroom, in essence it appears that youth are natural multimodal learners. The use of print, visual, and digital modes help students to apply their knowledge in new educational contexts. When teachers are able to capitalize and bring in students non-content skills to facilitate learning of the content, students may have a greater ownership in their learning. Furthermore, this idea of elevating many modes in the classroom helps students to connect their previous knowledge and skills to new contexts. Walsh (2007) states that students are multimodal designers and with opportunities for creativity, it allows students to develop critical responses to the curriculum. To engage and challenge students to be involved and interact with the curriculum in a complex way is a trademark of effective teaching.

Though approaches such as inquiry and technology are crucial to student interaction with the curriculum and naturally involve multimodal aspects, explicitly incorporating modes within each of these settings will afford a more complete representation of the content and can naturally differentiate the learning. Understandings explained through Jewitt’s (2008) research, that all modes are communication but all modes are partial, underscores that fact that modes not only construct meanings in different ways, but also relay and transfer various meanings.
through their distinctive affordances. Furthermore, Jewitt proposes that nonlinguistic representations have significant impacts for the traditional understanding and view of literacy and communication with implications for effective pedagogy. Movement between modes such as print to visual, visual to written, or print to kinesthetic, can challenge students in new ways, that a singular approach or mode alone cannot achieve. Technology itself has many modes that are constantly changing and it is precisely this technology that can provide an engaging, differentiated, multimodal learning environment to facilitate students as they maneuver their understanding through various modes.

**Implications for the Science Classroom**

Other affordances that an explicit multimodal approach in the science classroom can provide, includes helping to reach each students’ interests and learning styles. By committing to developing engaging lessons and designing laboratory experiences in which students make the connections and assess discrepancies across varied forms of representation, high levels of learning can occur. Not only does a multimodal approach more closely align with a students’ social learning world outside the classroom, but educators can use this link to transfer students knowledge into the lesser used modes such as reading and writing (Bezemer & Kress, 2008).

A multimodal approach can significantly affect student engagement, perceptions, and learning because there are many opportunities to resonate the content with students. As Jewitt (2008) explains; meanings are made, distributed, interpreted,
Chapter Two: Review of Literature

and remade. Therefore, much more than just presenting information in multiple ways, but requiring students to seek out learning through these many modes will provide opportunities for students to use their skills and tap their interests while interacting with the content. If we can achieve this broad approach on information gathering and activation, student perceptions about learning are likely to expand.

If educators can alter how students become engaged with content knowledge or challenge their perception of what is acceptable knowledge beyond simply a correct answer, then students may be exposed to the complete process of learning, enhancing a variety of skills that are valued beyond the pages of a test or the walls of the classroom. Thus, this process or cycle; engagement-perceptions-learning can be expanded in which students can critically examine resources, formats, and representations to not only communicate more effectively but to challenge how knowledge has been represented and in a way personalize their learning.

A drawback to incorporating media and technology via various modes into the classroom is that this approach, to be carried out well, may be time consuming. In an age where the requirements of teachers and students are increasing and changing, adding another element to designing curriculum may not be valued when the time required to carry out this aspect is considered. Also, with the recent focus on the importance and need for students to develop better reading and writing skills, in a climate of high stakes testing environment, a multimodal approach may not be viewed as giving just time to these tested and necessary skills. However, one could propose that the elegant incorporation of a variety of modes via a multimodal
Chapter Two: Review of Literature

An instructional approach can not only activate but re-energize students' desire to communicate through reading and writing. The idea that literacy is expanding to include other modes besides text and written communication does not ignore the importance of continuing to activate these skills via an engaging multimodal approach.

By expanding student perceptions about learning, more learning can take place because more skills are valued. For example, if a multimodal approach is readily accepted in a classroom an increase in the use of technology would be welcomed and utilized, promoting the learning of technical skills which can lead to more learning. This idea aligns with research by Bezemer and Kress (2008) who looked at what is gained and lost with transitions through various modes. By understanding the different affordances, each mode can offer student engagement, perceptions, and learning can be monitored while gaps in knowledge are mediated.

Although there are many benefits for multimodality in the science classroom, including a natural connection with how the subject is both taught and learned, there is a significant amount of research that suggests that this idea has implications on a more broad scale. Through understanding in many areas such as psychology, art/design, and literacy studies, multimodality is expressing its broad impact. Jewitt, in his overview of multimodality as he develops an appropriate definition as well as placing it in context for implications on pedagogy, states his observations. He explains that on a more global scale people are accepting and adapting to the shift of print toward digital media. This has implications for both dissemination and
Chapter Two: Review of Literature

presentation of information which now occurs with a more diverse and global audience. His second observation is that this perpetuates the research and idea that there are new literacies emerging. This idea stems from the changing requirements of communication, literacy, and knowledge. In a broad and global perspective, education should be assessing how these new demands and requirements in communication impact our current pedagogy. To best assess the impact of multimodality on student learning it is important to consider these topics. As we prepare students for the demands of the future, they will need and utilize the skill set that learning in many modes can offer.

Ultimately, student perceptions on learning may be radically different if we can infuse the needed skills for the future while the teaching content knowledge. Through this approach of utilizing many modes, student engagement and interest may increase which would promote learning and motivation for learning beyond the boundaries of content knowledge.

Creating a Teacher Resource

Taking into account both the research and countless sources of multimedia for science education, it is clear that there are benefits awaiting the infusion of pedagogy with researched based cognitive and media practices. Therefore, it is proposed that a compilation of effective media, modes, and methods be composed for the biology curriculum. Many benefits of a multimodal/multimedia approach have been discussed and with the ever changing technology landscape there is a need to develop
a resource base. Furthermore, by integrating the new Framework for K-12 Science Education, an effective means by which to carry out the cross-cutting concepts and core ideas can be developed. By developing a teacher resource that connects the multimodal approach, with technology to the broad standards, a more universal resource is created. This creates the opportunity for more interaction, refinement, and communication for this classroom resource and compilation.

**Harnessing Motivation and Engaging the Learner**

Equally, if not more important is the impact and effect of a multimodal and media approach on the learner. To ensure that the student is benefiting from these resources and approach to teaching various concepts, a set of model lessons will be developed that will connect and illustrate how to utilize the compilation and be a working example of what multimedia instruction “looks” like in the classroom with summaries of how it can impact students’ learning of those concepts. Equally important to consider is any specific misconceptions or limitations a particular mode may convey. Furthermore, incorporation of critical thinking and analysis skills can be utilized as sources of information, perspective, motivation, and audience of the developed signs and modes are considered.
As the multimodal resource was created many features were trialed. One aspect that was implemented included infusing and aligning content with the new K-12 Framework’s cross-cutting concepts. As this approach was pursued it was found less effective and that it detracted from the overall goals of the research. The cross-cutting concepts are broad themes meant to highlight both similarities and differences throughout the living environment curriculum. As various modes were sought for the different content the cross-cutting concepts detracted from the presentation of the material in this compilation arrangement. One opinion of the cross-cutting themes’ most appropriate use would be to begin a lesson with a concept in mind and then reinforce the cross-cutting concept throughout the lesson. This would give sufficient focus to that concept while not forcing various modes to fit every concept. Some modes will not fulfill every one of the concepts themes but still make an important contribution to the learning of the living environment content.

The next phase of the process called for a readjustment of the curriculum. Instead of individual topics and subtopics the scale was increased and units were broken down into teachable chapters which composed the most essential knowledge for that units’ topic. This served to both organize and prioritize the topics chosen to ensure their need and functionality in the Regents course.

Each unit is organized into a table of essential learning with a sampling of examples for each mode. Through this living and working document, it is designed to be edited, updated, referenced and contributed to by both students and teachers alike. The ‘justification’ section was added primarily for the presentation of this idea and an
Chapter Three: Application to Curriculum

explanation of how each piece can be utilized. However, the justification aspect can continue to be a part of this compilation, as it serves to describe and inform the users and direct the creator on potential lesson ideas and activities. Furthermore, requiring a few sentences of justification when students contribute to this source prompts them to consider why that source is beneficial. It challenges them to critically examine a resource to determine its potential value or worth. Implementing this skill beyond the science classroom, is arguably an growing necessity of a skill, as technology and its resources become ever more prevalent and diverse.
## Chapter Three: Application to Curriculum

### Unit 1: Structure of Life, Cells and Cell Processes

<table>
<thead>
<tr>
<th>Topic</th>
<th>Illustration/Photograph</th>
<th>Video/Simulation</th>
<th>Website/Online Excerpt</th>
<th>Interactive White Board</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cell Theory &amp; Classification:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cell Classification</td>
<td>➢ Cell Classification</td>
<td>➢ The Wacky History of Cell Theory</td>
<td>➢ The Cell Theory Song</td>
<td>➢ Interactive Cell Size and Scale</td>
</tr>
<tr>
<td>Prokaryotes vs. Eukaryotes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cell Theory &amp; Classification:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two main types of cells, their</td>
<td>This illustration gives</td>
<td>This video animates the history of</td>
<td>This song helps support previous</td>
<td>This interactive application can also</td>
</tr>
<tr>
<td>similarities and differences via</td>
<td>a depiction of the types</td>
<td>the cell theory and the scientists</td>
<td>research on cognitive load and how</td>
<td>be streamed on a smart board and</td>
</tr>
<tr>
<td>venn diagram</td>
<td>of cells and their origin</td>
<td>involved. It is simple,</td>
<td>students input information. It displays</td>
<td>allows students to manipulate the space</td>
</tr>
<tr>
<td>diagram</td>
<td>history. This illustration</td>
<td>straightforward and supports the</td>
<td>only on screen text with sound that</td>
<td>and compare the true size of a cell with</td>
</tr>
<tr>
<td></td>
<td>serves a visual</td>
<td>multimodal theories that state</td>
<td>repeats the text, therefore students’</td>
<td>know objects. It puts the size into a</td>
</tr>
<tr>
<td></td>
<td>organization of their</td>
<td>student learn best with visual and</td>
<td>attention is not distracted from</td>
<td>comprehensible perspective.</td>
</tr>
<tr>
<td></td>
<td>competents in relation to</td>
<td>audio than with visual, audio, and</td>
<td>supplemental images that would compete</td>
<td></td>
</tr>
<tr>
<td></td>
<td>each other.</td>
<td>on screen text.</td>
<td>with the visual input of the text.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Two main types of cells,</td>
<td>✓ Challenge students to create their</td>
<td>✓ Have students illustrate a section of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>their similarities and</td>
<td>own historical timeline while</td>
<td>the song. For example create an image</td>
<td></td>
</tr>
<tr>
<td></td>
<td>differences via venn</td>
<td>listening a second time.</td>
<td>for the various discoveries of the cell</td>
<td></td>
</tr>
<tr>
<td></td>
<td>diagram</td>
<td>✓ Have students complete the venn</td>
<td>theory.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>diagram</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cell Organelles:</strong></td>
<td>➢ Animal Cell</td>
<td>➢ Cell Organelles: Structure and</td>
<td>➢ Animal Model 1</td>
<td>➢ Inside a Cell</td>
</tr>
<tr>
<td></td>
<td>➢ Example: Human Lymphocyte</td>
<td>Function</td>
<td>➢ Animal Cell- homemade</td>
<td>➢ Cell Models: An</td>
</tr>
<tr>
<td></td>
<td>➢ Plant Cell</td>
<td></td>
<td>➢ Plant Cell Model 1</td>
<td>Interactive Animation</td>
</tr>
<tr>
<td></td>
<td>➢ Example: Elodea Leaf</td>
<td></td>
<td>➢ Plant Cell Model 2</td>
<td></td>
</tr>
<tr>
<td><strong>Cell Organelles:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Justification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illustrative and photographic</td>
<td>Illustrative and</td>
<td>This source gives a verbal and</td>
<td>These sources serve as working</td>
<td>A 3-dimensional tour of the plant and</td>
</tr>
<tr>
<td>examples of each type of cell.</td>
<td>pictorial examples of</td>
<td>pictorial description in both</td>
<td>examples for building and creating</td>
<td>animal cell. Interactive nature allows</td>
</tr>
<tr>
<td>Challenges students to see</td>
<td>each type. Challenges</td>
<td>animated 3D images and microscope</td>
<td>cell models. They allow students to</td>
<td>student to recognize structures but</td>
</tr>
<tr>
<td>discrepancies between the two</td>
<td>students to see</td>
<td>photographs.</td>
<td>observe an end product and weigh the</td>
<td>challenges them to know functions.</td>
</tr>
<tr>
<td>besides the variation in each type.</td>
<td>discrepancies between the</td>
<td>relative effectiveness or ineffectiveness of various 3D representations.</td>
<td>relative effectiveness or ineffectiveness of various 3D representations.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>two besides the variation</td>
<td>✓ Good review option.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>in each type.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Topic</td>
<td>Illustration/Photograph</td>
<td>Video/Simulation</td>
<td>Website/Online Excerpt</td>
<td>Interactive White Board</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------</td>
<td>------------------</td>
<td>------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Active vs. Passive Transport</td>
<td>➢ Active vs Types of Passive Transport</td>
<td>➢ Active and Passive Transport</td>
<td>➢ Graphics Gallery: Transport</td>
<td>➢ Membrane Transport</td>
</tr>
<tr>
<td>Active vs. Passive Transport: Justification</td>
<td>This illustration simplifies that passive is without energy while active requires it. Categorizes the main types and supplemental subtypes.</td>
<td>Expands on the process of each type of transport and how they function.</td>
<td>Pictoral and word summary of types of transport, another way to represent they prosess that occur at the cellular level.</td>
<td>An interactive slide show that illustrates and describes the processes of transport.</td>
</tr>
<tr>
<td>Cell Cycle</td>
<td>➢ Mitosis</td>
<td>➢ A Sweet Representation of Mitosis and Meiosis</td>
<td>➢ Mitosis animation</td>
<td>➢ The Control of the Cell Cycle</td>
</tr>
<tr>
<td></td>
<td>➢ Cell Cycle 1</td>
<td></td>
<td>➢ NOVA</td>
<td>How Cells Divide</td>
</tr>
<tr>
<td></td>
<td>➢ Cell Cycle 2</td>
<td></td>
<td></td>
<td>Cell Cycle: An Interactive Animation</td>
</tr>
<tr>
<td></td>
<td>➢ Colored Image</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cell Cycle</td>
<td>A step by step illustration of the stages of the cell cycle. ✓ Design activities to allow students to illustrate</td>
<td>This video can function as an example for students as they create their own representations, creating meaning through visual representations.</td>
<td>This resource has a detailed description of the process but also give a running animation showing the steps of the cell cycle in action.</td>
<td>This interactive simulation is a great introduction and review of the cell cycle. It has students be the cell cycle controllers.</td>
</tr>
<tr>
<td>Photosynthesis</td>
<td>➢ Photosynthesis Simplified</td>
<td>➢ Illustration of Input/Output</td>
<td>➢ Photosynthesis rap</td>
<td>➢ The Research</td>
</tr>
<tr>
<td>Photosynthesis: Justification</td>
<td>An introducorty image that simplifies the process to its component parts. ✓ An excellent writing prompt visual about the steps of photosynthesis.</td>
<td>An illustration showing the key components of photosynthesis in action.</td>
<td>This clip summerizes the process but allows students to be critical as this represents an over generalization of the process. Clip via audio only is best as images supplemental and may distract from meaning due to cognitive load inputs.</td>
<td>Interactive experiments that illustrate what the foundational experiments were that helped scientists understand photosynthesis. ✓ Platform for experimental design.</td>
</tr>
</tbody>
</table>
## Unit 2: Reproduction and Development

<table>
<thead>
<tr>
<th>Topic</th>
<th>Illustration/Photograph</th>
<th>Video/Simulation</th>
<th>Website/Online Excerpt</th>
<th>Interactive White Board</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reproduction: Sexual vs. Asexual</strong></td>
<td>➢ <strong>Comparison Asexual vs. sexual</strong></td>
<td>➢ <strong>Demonstration</strong></td>
<td>➢ <strong>Advantages vs. Disadvantages</strong></td>
<td>➢ <strong>Unique Features of Meiosis</strong></td>
</tr>
<tr>
<td>This graphic shows a drawing of each type of reproduction and the differences between each type can easily be noted.</td>
<td>This video serves mostly as a teacher source and it one to reference before creating a similar demonstration. Shows variability. ✓ Alter design to incorporate more students ✓ Could create a short lab out of this concept.</td>
<td>This table gives a layout of the types of reproduction and advantages and disadvantages of each type. ✓ Challenge students to justify the +/- ✓ Have students give a real life example for each type.</td>
<td>This illustration explains the three unique features of meiosis. These details are crucial to creating a different organism which asexual reproduction lacks.</td>
<td></td>
</tr>
<tr>
<td><strong>Menstruation Cycle</strong></td>
<td>➢ <strong>Cycle with main hormones</strong></td>
<td>➢ <strong>Ovulation &amp; the menstrual cycle</strong></td>
<td>➢ <strong>Growth of Follicle vs. Lining</strong></td>
<td>➢ <strong>Sex Hormones - The menstrual cycle</strong></td>
</tr>
<tr>
<td>A focus on the main hormones, their role, function and what aspect of menstruation they effect.</td>
<td>This 3D animation highlights the main hormones, where they are secreted and what they do. The 3D setting allows the viewer to get an understanding how how these multiple actions take place. ✓ Have students make flow chart of hormones and action in body.</td>
<td>This source is an excellent reference for the lab on menstruation. The double illustration captures multiple pieces of information. ✓ Create separate supplemental question set to prompt students to undertand the relationships.</td>
<td>This interactive source shows both relative hormone levels and an illustration of the uterine lining and what changes take place. ✓ Illustrates change over time ✓ Have students predict/hypothesize</td>
<td></td>
</tr>
</tbody>
</table>

29
<table>
<thead>
<tr>
<th>Topic</th>
<th>Illustration/Photograph</th>
<th>Video/Simulation</th>
<th>Website/Online Excerpt</th>
<th>Interactive White Board</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fertilization</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>➢ <a href="#">Illustration Fertilization</a></td>
<td>➢ <a href="#">Fertilization (Conception)</a></td>
<td>➢ <a href="#">In Vitro Fertilization Cost, Process, Success Rates</a></td>
<td>➢ <a href="#">Reproduction Process</a></td>
</tr>
<tr>
<td><strong>Fertilization Justification</strong></td>
<td>The illustration vs. photograph clearly shows the differences between these two processes. The illustration was selected because it gives perspective where in the body this occurs. ✓ Have students write about one of the processes. ✓ Do ethics play a role?</td>
<td>An animated video depicting the process the sperm take to reach and fertilize the egg. ✓ What mechanisms are in place to assist this process? ✓ What mechanisms are in place to challenge this process, why?</td>
<td>This source serves as a reference article about the process of In Vitro fertilization. ✓ Have students collect and discuss current event articles around this topic ✓ Bio-ethics debate on this process the risks vs. reward for participants</td>
<td>This interactive illustration lets students label diagrams and answer questions while getting feedback about their progress. ✓ Completed as an individual activity would help as students participate. ✓ Intro activity, possibly too general.</td>
</tr>
<tr>
<td><strong>Embryo Development</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>➢ <a href="#">Embryo Placement in Uterus over time</a></td>
<td>➢ <a href="#">Pregnancy - first trimester</a></td>
<td>➢ [NOVA</td>
<td>The Zoo of You](#)</td>
</tr>
<tr>
<td><strong>Embryo Development Justification</strong></td>
<td>The illustration gives a needed reference point of the embryo in relation to the uterus over time, while the photograph gives perspective of the size of the embryo overtime. ✓ Discuss debate the growing use of technology in embryo care.</td>
<td>This animation clip illustrates and describes what layer is created and how the embryo develops.</td>
<td>This site compares structure and function of the embryo with similar features in other organisms. This intro on comparative embryology also brings up questions of evolution. ✓ Discuss with students how to address the research, theories, and information on comparative embryology/evolution.</td>
<td>These detailed slides illustrate what each week of development looks like and the important functions of surrounding structures. ✓ Have students create a timeline of the top 10 key developments taking place before birth. ✓ Compare to top 10 taking place in month one vs. year one etc.</td>
</tr>
</tbody>
</table>
# Chapter Three: Application to Curriculum

## Unit 3: Human Anatomy and Physiology

<table>
<thead>
<tr>
<th>Topic</th>
<th>Illustration/Photograph</th>
<th>Video/Simulation</th>
<th>Website/Online Excerpt</th>
<th>Interactive White Board</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Digestive System</strong></td>
<td>➢ Digestive system overview vs. details</td>
<td>➢ Digestive System</td>
<td>➢ Digestive Diseases</td>
<td>➢ The Digestive System</td>
</tr>
<tr>
<td>Justification</td>
<td>Structure of system vs. individual organs:</td>
<td>This video clip allows students to view a 3D</td>
<td>Students can research a disorder of the digestive system.</td>
<td>An interactive quiz about the structure and function of the digestive system.</td>
</tr>
<tr>
<td></td>
<td>✓ Identify chemical vs. physical change</td>
<td>view of the body and process of digestion and how it occurs</td>
<td>✓ As a class a resource of disorders can be identified and developed</td>
<td>✓ This would be appropriate for an intro or review activity.</td>
</tr>
<tr>
<td>Excretory System</td>
<td>➢ Excretory System</td>
<td>➢ Urinary system - The nephron</td>
<td>➢ Homeostasis - kidneys and water balance</td>
<td>➢ Gross External Anatomy of the Kidney</td>
</tr>
<tr>
<td>Justification</td>
<td>➢ Digestive System Detail</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Illustrations provide perspective with other systems and needed expansion of the kidney structure.</td>
<td>Describes by structure and function of the nephron</td>
<td>Develop an online worksite to give a working example of homeostasis</td>
<td>Interactive review of structures and functions.</td>
</tr>
<tr>
<td>Endocrine System</td>
<td>➢ Location of Glands</td>
<td>➢ Endocrine system and diabetes</td>
<td>➢ Endocrine Topics</td>
<td>➢ The Endocrine Hormone Game Show!</td>
</tr>
<tr>
<td>Justification</td>
<td>Comparison of glands in male vs. female</td>
<td>A working example of the pancreas and its function</td>
<td>Highlights the purpose of the endocrine system, giving examples.</td>
<td>A way students can review individually or in teams.</td>
</tr>
<tr>
<td>Immune System Response</td>
<td>➢ Immune System Organs</td>
<td>➢ Immune System - Natural Killer Cell</td>
<td>➢ Infectious diseases: timeline</td>
<td>➢ Infectious diseases: immunity</td>
</tr>
<tr>
<td>Justification</td>
<td>Illustrated representation of the organs involved with the immune system response. Description of each.</td>
<td>A highlight of the main type of white blood cell and its function within the immune system.</td>
<td>This source shows the progression and developments over time and expands with articles for each topic.</td>
<td>This interactive site describe and animates how a pathogen is identified.</td>
</tr>
<tr>
<td>Topic</td>
<td>Illustration/Photograph</td>
<td>Video/Simulation</td>
<td>Website/Online Excerpt</td>
<td>Interactive White Board</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>-------------------------</td>
<td>------------------</td>
<td>------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Nervous System</td>
<td>Four types of Nerves</td>
<td>Firing Neurons</td>
<td>The Human Nervous System</td>
<td>Interactive Body</td>
</tr>
<tr>
<td>Nervous System Justification</td>
<td>Summary of the four main types of nerves, general knowledge of the system.</td>
<td>Complex to simple, a break down and tour of a single neuron.</td>
<td>This review explains how neurons are similar vs. different than other cells in our body.</td>
<td>This interactive tool is formating like a game which allows users to connect body parts and their function in the brain.</td>
</tr>
<tr>
<td>Respiratory System</td>
<td>The Respiratory System</td>
<td>Respiratory System-Summary</td>
<td>Healthy vs. Diseased Lung</td>
<td>Gas Exchange During Respiration</td>
</tr>
<tr>
<td>Respiratory System Justification</td>
<td>These images show both an overview of the respiratory system and a cast of the lungs which illustrates its complexity as well as its surface area for taking in oxygen.</td>
<td>Functional summary down to air molecules and how they travel in the body.</td>
<td>The impacts of smoking on the organs of the respiratory system</td>
<td>Students can create their own image or series of images to illustrate this process.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skeletal &amp; Muscular Systems Justification</td>
<td>Muscular System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>These illustrations can be compared and contrasted to real photos.</td>
<td>Overview of main functions of the skeletal system as well as types of bone tissues.</td>
<td>This real life display of human anatomy highlights the structure and function of the human.</td>
<td>For review of the bones and location sthis drag and drop interactive challenges students with realistic illustrations of key structures.</td>
</tr>
</tbody>
</table>


# Chapter Three: Application to Curriculum

## Unit 4: Genetics & Biotechnology

<table>
<thead>
<tr>
<th>Topic</th>
<th>Illustration/Photograph</th>
<th>Video/Simulation</th>
<th>Website/Online Excerpt</th>
<th>Interactive White Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromosomes/ DNA</td>
<td>➢ Chromosome &amp; DNA</td>
<td>➢ How DNA is Packaged</td>
<td>➢ Photograph of tagged sequences</td>
<td>➢ Genes and DNA</td>
</tr>
<tr>
<td></td>
<td>➢ Chromosomal Location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromosome/ DNA</td>
<td>Compares individual chromosome which</td>
<td>How our long, 6ft string of DNA is</td>
<td>This image captures how chromosomes are once cell</td>
<td>Scan from cell size to DNA molecule, interactive web pages</td>
</tr>
<tr>
<td>Justification</td>
<td>unravels to illustrate DNA strand.</td>
<td>packaged in each cell. Describes when during the cell</td>
<td>membrane breaks</td>
<td>about chromosomes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>cycle the DNA condenses into chromosomes.</td>
<td>✓ Different than karyotype</td>
<td>✓ Create a scavenger hunt of key ideas/concepts throughout</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Illustrated and also shows microscope views of this</td>
<td>✓ Have students find upcoming research/current events</td>
<td>webpage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>process.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RNA &amp; Protein</td>
<td>➢ Translation &amp; Transcription</td>
<td>➢ From RNA to Protein Synthesis</td>
<td>➢ Tour of the Basics</td>
<td></td>
</tr>
<tr>
<td>Synthesis</td>
<td>➢ RNA detail</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RNA &amp; Protein</td>
<td>Simplifies the process of transcription</td>
<td>This source illustrates what occurs at the cellular</td>
<td>This illustration breakdown large processes into</td>
<td></td>
</tr>
<tr>
<td>Synthesis</td>
<td>and translation in relation to the cell</td>
<td>level.</td>
<td>their component parts.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and nucleus.</td>
<td>✓ Due to much vocabulary, it would be effective to</td>
<td>✓ Students could be grouped by topic and complete a</td>
<td></td>
</tr>
<tr>
<td>Justification</td>
<td>✓ Students create written text or</td>
<td>have students create a mind map of process and</td>
<td>jigsaw activity with these concepts.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>narration for this image in various</td>
<td>terms.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>steps.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>✓ Break down learning, compare and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>contrast each step.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mutations</td>
<td>➢ Types of Mutations</td>
<td>➢ What is DNA?</td>
<td>➢ What is a Mutation?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>➢ Fruit Flies</td>
<td>➢ Mutation and Haplotype</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mutations</td>
<td>Given a description of types students</td>
<td>Simplified process from amino acid to living</td>
<td>How to mutate a sentence-takes DNA issues to the</td>
<td>A working example of what happens when mutations occur.</td>
</tr>
<tr>
<td>Justification</td>
<td>can inference what it would look like</td>
<td>organisms.</td>
<td>English language.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in the gene sequence.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Unit 4: Genetics & Biotechnology (continued)

<table>
<thead>
<tr>
<th>Topic</th>
<th>Illustration/Photograph</th>
<th>Video/Simulation</th>
<th>Website/Online Excerpt</th>
<th>Interactive White Board</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Punnet Square</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><a href="#">Punnet Square Example</a></td>
<td><a href="#">Gregor Mendel</a></td>
<td><a href="#">Online Science Test</a></td>
<td><a href="#">Punnett Square Calculator</a></td>
</tr>
<tr>
<td></td>
<td><a href="#">Dihybrid Example</a></td>
<td></td>
<td></td>
<td><a href="#">Punnett Squares</a></td>
</tr>
<tr>
<td><strong>Punnet Square Justification</strong></td>
<td>An example that illustrates cause vs. effect and genetic vs. phenotypic results</td>
<td>Introductory video that explains a breif background of history of genetics and intro of punnet squares.</td>
<td>Interactive review, genetics questions for review. Helps studentsgauge their progress</td>
<td>Students are able to interact with the alleles, frequencies, and number of variables in the crosses. Can be used for a self or pair quize checkpoint.</td>
</tr>
<tr>
<td><strong>Genetic Disorders</strong></td>
<td><a href="#">Examples of Genetic Disorders</a></td>
<td><a href="#">Genetic Disorders And Diseases</a></td>
<td><a href="#">What are Genetic Disorders?</a> <a href="#">Newborn Genetic Screening</a></td>
<td><a href="#">Using Karyotypes to Predict Genetic Disorders</a></td>
</tr>
<tr>
<td><strong>Genetic Disorders Justification</strong></td>
<td>A phenotypic representation of a genetic mutation. Image with text.</td>
<td>Discusses what causes a genetic disorder. Audio and visualization, viewer not distracted by supplemental text.</td>
<td>An introduction to common genetic disorders and what causes them Supplemental research to give working examples to genetic variability</td>
<td>This interactive breaks down the process of replication and division to show where errors can occur in the DNA.</td>
</tr>
<tr>
<td><strong>Technology of Genetics</strong></td>
<td><a href="#">Molecular Genetics</a></td>
<td><a href="#">Gregory Stock: To upgrade is human</a></td>
<td><a href="#">Genetically Modified Corn</a></td>
<td><a href="#">Click and Clone</a></td>
</tr>
<tr>
<td><strong>Technology of Genetics Justification</strong></td>
<td>Discuss with students the development of technology in genetics What is our motivation? Ethics?</td>
<td>Discussion on use and extent of technology related to genetics Debate, how will this affect us?</td>
<td>How technology has affected our food supply. How does this affect the environment? Ramifications?</td>
<td>A working interactive example of one aspect of genetic technology.</td>
</tr>
</tbody>
</table>
## Chapter Three: Application to Curriculum

### Unit 5: History and Evolution

<table>
<thead>
<tr>
<th>Topic</th>
<th>Illustration/Photograph</th>
<th>Video/Simulation</th>
<th>Website/Online Excerpt</th>
<th>Interactive White Board</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geologic Time/Fossil Record</strong></td>
<td><a href="#">Geologic Time Comparison</a></td>
<td><a href="#">Human Evolution</a></td>
<td><a href="#">Prehistoric Life</a></td>
<td><a href="#">The Human Lineage</a></td>
</tr>
<tr>
<td><strong>Geologic Time/Fossil Record Justification</strong></td>
<td>Geologic history compared to one day helps put into perspective the age of the discoveries made thus far.</td>
<td>Multiple simulations which illustrate the development of life theories.</td>
<td>Challenge students to find common misconceptions or research to support what we know about the past.</td>
<td>A collection of data and research of evidence of the early humans.</td>
</tr>
<tr>
<td><strong>Darwin Influence</strong></td>
<td><a href="#">Darwin Finches</a></td>
<td><a href="#">Evolution: Darwin: An Origin of Species</a></td>
<td><a href="#">Misconception s about evolution</a></td>
<td><a href="#">Darwin: Who Wants to Live a Million Years?</a></td>
</tr>
<tr>
<td><strong>Darwin Influence Justification</strong></td>
<td>Throughout his life Darwin influenced science based on various theories.</td>
<td>A working, interactive example of how different species can have a common ancestry.</td>
<td>The top misconceptions about evolution and the corrections</td>
<td>A interesting way to represent species and their struggle for life</td>
</tr>
<tr>
<td><strong>Theory of Evolution</strong></td>
<td><a href="#">Comparative Embryology</a></td>
<td><a href="#">Galapagos Finches</a></td>
<td><a href="#">Evolution 101</a></td>
<td><a href="#">Interactive Timeline</a></td>
</tr>
<tr>
<td><strong>Theory of Evolution Justification</strong></td>
<td>This topic could have multiple viewpoints as students have different backgrounds but this image may be a good discussion topic on aspects still debated today.</td>
<td>Types of evolution macro vs. micro evolution</td>
<td>Defines and give working example of evolution in text with supporting illustrations.</td>
<td>This interactive timeline illustrates and reviews progressions in the development of life.</td>
</tr>
</tbody>
</table>
# Chapter Three: Application to Curriculum

## Unit 6: Ecology

<table>
<thead>
<tr>
<th>Topic</th>
<th>Illustration/Photograph</th>
<th>Video/Simulation</th>
<th>Website/Online Excerpt</th>
<th>Interactive White Board</th>
</tr>
</thead>
</table>
| Abiotic vs. Biotic Factors     | ➢ Abiotic vs. Biotic Flowchart  
➢ Examples Compared  
➢ Ecosystem Illustration | ➢ Discovery: Abiotic and Biotic Factors | ➢ Abiotic Biotic Song | ➢ Create Your Own Ecosystem |
| **Justification**             |                          |                 |                        |                         |
|                              | The three images selected show a progression; beginning with an abstract classification to real life examples to a full senery image/representation that allows students the opportunity to apply their learning of these concepts with increasingly less support. These images range from most to least abstract. And although the mode had a differing approach. | This video gives a real life example of biotic and abiotic factors. It also suggests that humans have a large role in controlling desired factors in a variety of settings. What are some additional ways and reasons human influence the environment to create change or control? | The song, “Is it Alive?” was chosen because it is a catchy media representation that explains the basic concept of these factors. It can be manipulated and played with or without the visual images allowing students to create their own signs for abiotic vs. biotic factors. | This simplified interactive allows students to review abiotic vs. biotic factors and create their own ecosystem.  
✓ Build off of this activity and determine what factors and how humans influence or control |
| Biomes/Niches                 | ➢ World's Biomes         | ➢ Biomes of the Earth | ➢ World Biomes         | ➢ Human Influence on Ecology Mapped |
| **Justification**             |                          |                 |                        |                         |
|                              | Students should be able to understand how different biomes have more or less diversity bases on typical biotic and abiotic factors of that environment.  
✓ How do small changes accumulate and create a global effect?  
✓ Environmental Ethics | Location, description, and visual of biomes of the earth.  
✓ Have students hypothesize and rank which is most to least vulnerable to human impacts | Website that tours the world biomes  
✓ Expand by describing abiotic vs. biotic factors  
✓ Food web variables | Planet Earth clips illustrate how human impacts have consequences and in many cases are long reaching.  
✓ Should we consider this new approach? A new classification because of humans? |
## Unit 6: Ecology (continued)

<table>
<thead>
<tr>
<th>Topic</th>
<th>Illustration/Photography</th>
<th>Video/Simulation</th>
<th>Website/Online Excerpt</th>
<th>Interactive White Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Relationships</td>
<td>Example Energy Relationships</td>
<td>Following the Energy Flow</td>
<td>Producers &amp; Consumers</td>
<td>Global energy balance</td>
</tr>
<tr>
<td>Energy Relationships Justification</td>
<td>Challenge students to develop and create their own energy relationship diagram. ✓ Is it efficient or sustainable?</td>
<td>Simplifies the energy flow process. ✓ What environmental variable affect the efficiency?</td>
<td>An example of energy interworkings. ✓ Students will develop their own environmental system showing energy pathways.</td>
<td>Environmental factors that contribute to energy dispersion. ✓ Write: How does this uphold Newton’s Law on Energy?</td>
</tr>
<tr>
<td>Succession and Human Impact</td>
<td>Succession Example</td>
<td>Yellowstone Forest Fire Succession</td>
<td>Ecological succession</td>
<td>Coral Reef Succession</td>
</tr>
<tr>
<td>Succession and Human Impact Justification</td>
<td>Visual representation of the factors that influence the maturation of a plant community. ✓ What other mechanisms of succession is there?</td>
<td>An example of regrowth and succession in this national park</td>
<td>Overview of the types of succession and examples ✓ Find current events highlighting human influenced succession vs. natural</td>
<td>A multisite source that builds the case for succession in the ocean habitat ✓ How will human factors and influence affect this organisms.</td>
</tr>
</tbody>
</table>
Another connection that enhances this resource is the idea that there is a natural progression of the media chosen. Generally, the method or various modes that deliver the media, become gradually more complex, as a user goes across the rows. This complexity can be compared to Bloom’s Taxonomy as the more simple modes such as photographs and illustrative representations lend themselves to basic levels of learning. Although skills such as general knowledge and recall are the base levels of learning they are a foundation necessity for building solid understanding at the next level. Photographs and illustrations can help prompt recall of previous knowledge as well was challenge any previously held misconceptions. While the interactive simulations and videos can function best when they require students to analyze and evaluate a topic, which illustrates the highest level of learning.

However, this idea cannot be applied too liberally as there can be examples of misuse which do not follow this pattern or general trend. There are resources in this compilation categorized as simulations that do not meet the highest learning standards on their own, based only on their nature of being a simulation. All resources are not complete and all resources have the potential to be misused, but with the proper support, structure, and utilization the most benefits can be reaped from these supplemental sources. By incorporating the ‘justification’ category throughout compiling this resource it allows the creator and various users of this resource multiple opportunities to best use the tools.

The overarching ideas that lead to this project and continue to support it have influenced its structure, function, and how it can serve multiple purposes. This
dynamic resource supports the idea that all modes are partial, no one mode is complete, but each as its specific affordance and role in the learning process. These key characteristics highlight the idea that this resource can easily and almost naturally differentiate learning for various students, settings, and abilities. It is not limited by the examples chosen but works with represented diversity to paint a more complete picture for a lesson, unit, or overall view of science. In its design and nature it can easily be edited, updated, and enhanced which is comparable to the scientific process itself. That through the gathering of many resources and viewpoints a strong foundation of knowledge is established. This compilation can function as a working tool kit for both students and teachers, enhancing its usefulness when both comments, resources, and experience utilizing the sources have occurred.
Chapter Four: Conclusions and Recommendations

As this resource was developed and the research collected, a far reaching foundation was built. The photographs, drawings, illustrations, websites, animations, videos, documentaries, and virtual experiments together culminate only small portion of the type of media and technology available. What has occurred is a renewed perspective on the traditional methods of learning and endless possibilities for connecting these two extremes. Through appropriate use in duration and timing engaging digital methods can be optimal learning opportunities. Through revitalizing science education by appropriately infusing media, a renewed interest in reading and writing may take place. By prompting students to be involved with the material, and sometimes be the designers, the hope is that it would be a natural connection and forum to expand on the traditional literacy skills through capturing their interest and fuelling their motivation. As the research for this project proposed, new and changing digital literacies are arriving and possibly the best utilisation would be to infuse these with traditional skills that need improvement.

Securing this approach may be challenging as it incorporates many disciplines, is far reaching, and has multiple variables. However, with the research thus far there is convincing evidence that through the infusion of media with appropriate supports effective, meaningful learning can occur. Interest followed by more research should be directed towards these ideas because the future of education, science and student success calls for this need. Science depends and in many ways uses technology as part of its new contemporary foundation. Without a strong understanding of both technology and science the future developments and growth
would be stunted. Not only does student interest and motivation in science in particular lack, but finding a working formula for incorporating media other subject areas could reap the benefits. If various methods and modes of infusing technology into how we learn is established all learning can benefit, not just science.

Through multimodal learning students can learn to become critical consumers of information. This activates their critical thinking process to always examine, evaluate, and process where information comes from. In this age where technology is extremely accessible, and where this pattern will most likely continue at a fast pace, highlights the need for students to be critical consumers of all information. The nature of this compilation allows students to be critical but to also contribute valued input and sources that they would recommend and why. Being able to justify why a particular source out of multiple similar sources is superior, is an important skill students need in order to become independent and knowledgable consumers of information. Furthermore, if students can reflect on their own personal process of learning they can customize where needed. This means that a student is reflective and comes to understand how best they learn. Having these reflective skills and insight is important, especially when the most ideal learning situation is not always available. By exposing students to multiple ways of knowing and learning a broad skill base is developed as well as the diversity in how one learns.

There are limitations to the process of infusing this concept into the science classroom. Not all classroom have the same access to technology. Beyond resource constraints that are physical or financial, there are time limitations. However, the
Chapter Four: Conclusions and Recommendations

Scope of this project has developed a mid point in that smaller ideas and concepts can be taken from this baseline idea, in the same way that it is intended to be built upon.

As educators strive to develop engaging material this compilation can function to represent content in a diverse, multimodal way which allows a broad spectrum of students to connect and take ownership in their learning process. It is proposed that this resource would be best utilized when comments are added, labs are incorporated, focus questions are edited to create a working and living resource for both student and teacher use. As students are directed towards these resources they may find a better use, a different source, or create new meanings which helps them or others learn. This ideas upholds the research that meanings are made and re-made. It emphasizes that we are all sign and meaning makers. Collectively representing many modes via technology to capture student interest and motivation is the foundation of multimodality, and arguably has a growing need and place in contemporary science education.
References


Kress, G. Before writing: Rethinking the paths to literacy. London: Routledge.


Rias, R. M., & Zaman, H. B. (2011). Designing multimedia learning application with learning theories: A case study on a computer science subject with 2-D and 3-
D animated versions. Asia-Pacific Forum on Science Learning and Teaching, 12 (2).


http://www.internetworldstats.com/stats.htm
Unit 1: Cell Structure of Life, Cells and Cell Processes

Cell Classifications:

![Cell Classification Diagram](http://www.mindfiesta.com/classification-living-organisms)


**Prokaryotes vs. Eukaryotes:**

<table>
<thead>
<tr>
<th>Prokaryotes</th>
<th>Both Prokaryotes and Eukaryotes</th>
<th>Eukaryotes</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>No Nucleus</em></td>
<td><em>Cells have a nucleus</em></td>
<td></td>
</tr>
<tr>
<td><em>Small and simple</em></td>
<td><em>Cells have organelles</em></td>
<td></td>
</tr>
<tr>
<td><em>No organelles</em></td>
<td><em>Can be unicellular or multicellular</em></td>
<td></td>
</tr>
<tr>
<td><em>Are very abundant</em></td>
<td><em>Have a cytoplasm</em></td>
<td></td>
</tr>
<tr>
<td><em>All are unicellular</em></td>
<td><em>Have DNA</em></td>
<td></td>
</tr>
<tr>
<td><em>Cells have a sticky capsule</em></td>
<td><em>Have a cell membrane</em></td>
<td></td>
</tr>
<tr>
<td><em>All cells have cell walls</em></td>
<td><em>Some have flagella</em></td>
<td></td>
</tr>
<tr>
<td><em>Were the first cells</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Live a wide variety of environments</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>All are bacteria</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Wacky History of Cell Theory: (historical/timeline video)
Source: http://www.youtube.com/watch?feature=endscreen&NR=1&v=4OpBylwH9DU

The Cell Theory Song: (audio clip)
Source: http://www.youtube.com/watch?v=KuJqqiATlqw

Interactive Cell Size and Scale: (interactive whiteboard)
Source: http://learn.genetics.utah.edu/content/begin/cells/scale

Animal Cell:

Source: http://www.biologyjunction.com/cell_model_instructions.htm
Example: Human Lymphocyte:

Source:

Plant Cell:

Source: http://micro.magnet.fsu.edu/cells/plantcell.html
Example: Elodea Leaf:

Source: http://www.imagejuicy.com/images/plants/c/calla/2

Cell Organelles- Structure and Function: (video)

Source: http://www.youtube.com/watch?v=LP7xAr2FDFU

Animal Model 1:

Source: http://www.praxismh.ca/learningkits.html

Appendix 4
Unit 1: Cell Structure of Life, Cells and Cell Processes

Animal Cell-Home Made example: (video)

Source: http://www.youtube.com/watch?v=Yu4UziV8QwY

Plant Cell Model 1:

Source: http://vcebiology.edublogs.org/2009/02/12/our-edible-cell-models
Plant Cell Model 2:


Inside A Cell: (interactive whiteboard)

Source: http://learn.genetics.utah.edu/content/begin/cells/insideacell

Cell Models-An Interactive Animation: (interactive website)

Source: http://www.cellsalive.com/cells/cell_model.htm
Unit 1: Cell Structure of Life, Cells and Cell Processes

Active vs. Passive Transport:

Source: https://wikispaces.psu.edu/display/Biol230WFall09/Passive+and+Active+Transport

Active and Passive Transport: (video)

Source: http://www.youtube.com/watch?v=kfy92hdaAH0

Graphics Gallery- Transport:


Appendix 7
Membrane Transport: (animation)

Source: http://programs.northlandcollege.edu/biology/biology1111/animations/transport1.html

Mitosis:

Source: http://alevelnotes.com/Eukaryotic-Cellular-Division-Process/147
Unit 1: Cell Structure of Life, Cells and Cell Processes

Cell Cycle 1:

Source:
http://www.daviddarling.info/encyclopedia/C/cell_cycle.html

Cell Cycle 2:

Source:
http://www.tutorvista.com/content/biology/biology-iii/cell-reproduction/cell-cycle.php

Appendix 9
Colored Cell Image:

![Colored Cell Image](http://bitesizebio.s3.amazonaws.com/content/uploads/2008/01/c12x5mitosis-collage.jpg)

Source:
http://bitesizebio.s3.amazonaws.com/content/uploads/2008/01/c12x5mitosis-collage.jpg

A Sweet Representations of Mitosis and Meosis: (example video)

Source:
http://www.youtube.com/watch?v=BJQ4XALLeM&playnext=1&list=PL9429E61BC7937B65

Mitosis Animation: (animation)

Source:
http://www.biology.arizona.edu/cell_bio/tutorials/cell_cycle/MitosisFlash.html
Unit 1: Cell Structure of Life, Cells and Cell Processes

NOVA- How Cells Divide: (interactive animation)
Source: http://www.pbs.org/wgbh/nova/body/how-cells-divide.html

The Control of the Cell Cycle: (animation)
Source: http://www.nobelprize.org/educational/medicine/2001/cellcycle.html

Cell Cycle- An Interactive Animation: (video clip)
Source: http://www.cellsalive.com/cell_cycle.htm

Photosynthesis Simplified:
Illustration of Input/Output: (animation)

Photosynthesis Rap: (audio/visual clip)
Source: http://www.schooltube.com/video/dc732e59026d90ab949d/

The Research: (interactive whiteboard)
Source: http://homepages.abdn.ac.uk/p.marston/pages/flash/samples/photosyn.swf
Comparison Asexual vs. Sexual:

Source: [http://cuttingbio.tripod.com/Goal_2/SexualAsexual.htm](http://cuttingbio.tripod.com/Goal_2/SexualAsexual.htm)

Advantages vs. Disadvantages:

<table>
<thead>
<tr>
<th>Type of Reproduction</th>
<th>Methods</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sexual</td>
<td>Internal fertilization</td>
<td>Diversity in offspring</td>
<td>Requires a mate to reproduce</td>
</tr>
<tr>
<td></td>
<td>External fertilization</td>
<td>Offspring less likely to have mutations show up</td>
<td>Population increases are limited</td>
</tr>
<tr>
<td></td>
<td>Conjugation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asexual</td>
<td>Budding</td>
<td>Can increase populations rapidly</td>
<td>Lack of diversity in offspring</td>
</tr>
<tr>
<td></td>
<td>Spores</td>
<td>Does not require a mate for reproduction to take place</td>
<td>Because they reproduce offspring genetically identical to parents, the offspring inherit any mutations of the parent.</td>
</tr>
<tr>
<td></td>
<td>Fission</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Appendix 13
Unit 2: Reproduction and Development

Unique Features of Meiosis: (Interactive white board)
Source: http://highered.mcgraw-hill.com/sites/0072437316/student_view0/chapter12/animations.html

Demonstration: (video)

Cycle with main hormones:

Source:
Growth of Follicle vs. Lining:


Ovulation and the Menstrual Cycle: (video/3D animation)

Source: [http://www.youtube.com/watch?v=WGJsrGmWeKE](http://www.youtube.com/watch?v=WGJsrGmWeKE)

Sex Hormones - The menstrual cycle (Interactive whiteboard)

Illustration Fertilization:

Fertilization occurs within fallopian tube

Enlarged view

Oocyte (egg)

Sperm

Source: http://www.webmd.com/infertility-and-reproduction/fertilization

In Vitro Fertilization:

Unit 2: Reproduction and Development

Fertilization (Conception): (3D animation video)
Source: http://www.youtube.com/watch?v=BFrVmDgh4v4

In Vitro Fertilization: Cost, Process, Success Rate

Reproduction Process: (Interactive whiteboard)

Embryo Placement in Uterus over Time:

Source:

Appendix 17
Stages of Human Development:

Source: http://embryology.med.unsw.edu.au/wwwhuman/Stages/CStages.htm

What your baby looks like: (Interactive whiteboard-slides)

Source: http://www.babycenter.com/fetal-development-images-5-weeks

NOVA: The Zoo of You: (Online interactive website)

Source: http://www.pbs.org/wgbh/nova/evolution/zoo-you.html
Digestive System Overview vs. Detailed View:

Source: [http://biology.clc.uc.edu/courses/bio105/digestiv.htm](http://biology.clc.uc.edu/courses/bio105/digestiv.htm)

Digestive System: (video)

Source: [http://www.youtube.com/watch?v=Z7xKYNz9AS0](http://www.youtube.com/watch?v=Z7xKYNz9AS0)

Digestive Diseases: (website/resource)

Source: [http://digestive.niddk.nih.gov](http://digestive.niddk.nih.gov)

Interactive Quiz: The Digestive System: (Interactive whiteboard)

Unit 3: Human Anatomy & Physiology

Excretory System:

Source: http://www.newyoungworld.com/body_systems.php

Excretory System Detail:

Source: http://www.emc.maricopa.edu/faculty/farabee/biobk/biobookexcret.html
Urinary System- The Nephron: (video)

Source: http://www.youtube.com/watch?v=aQZaNXNroVY

Homeostasis- Kidneys and Water Balance:

(online website with quiz questions and demos)

Source:

http://www.abpischools.org.uk/page/modules/homeostasis_kidneys/.cfm?coSiteN
avigaton_allTopic=1

Gross External Anatomy of the Kidney: (Interactive whiteboard)

Source:

al.html
Location of Glands:


The Endocrine System and Diabetes: (video)
Source: http://www.youtube.com/watch?v=Ry5fTZfZHIs

Endocrine Topics: (Interactive slides)

The Endocrine Hormone Game Show: (Interactive Quiz)
Immune System Organs:


Infectious Diseases Timeline: (interactive website)


Infectious Diseases- Immunity: (whiteboard activity)


Immune System- Natural Killer Cells: (video)

Source: [http://www.youtube.com/watch?v=HNP1EAYLhOs](http://www.youtube.com/watch?v=HNP1EAYLhOs)
Four Main Types of Nerves:

**Cranial** *(KRAY-nahl)*
Nerves go from your brain to your eyes, mouth, ears, and other parts of your head.

**Central**
Nerves are in your brain and spinal cord.

**Peripheral** *(puh-RIF-uh-rul)*
Nerves go from your spinal cord to your arms, hands, legs, and feet.

**Autonomic** *(aw-toh-NOM-ik)*
Nerves go from your spinal cord to your lungs, heart, stomach, intestines, bladder, and sex organs.


Firing Neuron: (video)

Source: [http://www.youtube.com/watch?v=GIGqp6_PG6k](http://www.youtube.com/watch?v=GIGqp6_PG6k)

Interactive Body: (interactive whiteboard)

The Human Nervous System: (video)

Source: http://www.youtube.com/watch?NR=1&feature=endscreen&v=4M82WwFACLg

BBC-Human Body: (interactive website)

Source: http://www.bbc.co.uk/science/humanbody/body/interactives/3djigsaw_02/index.shtml?nervous

The Respiratory System:

Source: http://leavingbio.net/respiratory%20system/the%20respiratory%20system.htm
Unit 3: Human Anatomy & Physiology

Cast of Lungs:

![Image of human lungs]

Source:
http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/P/Pulmonary.html

Healthy vs. Diseased Lung:

![Image of healthy and smoker's lungs]

Source:
http://www.freewebs.com/soaring_sphincter_travel_agency/respiratorysystem.htm
Respiratory System-Summary: (video)
Source: http://www.youtube.com/watch?v=hc1YtXc_84A

Gas Exchange During Respiration: (interactive video)

Skeletal System:

Muscular System:


Human Body Worlds-Exhibit:

The Human Anatomy: (video)

Source: http://www.youtube.com/watch?v=8d-RBe8JBVs
Unit 4: Genetics and Biotechnology

Chromosome & DNA:

Source: http://www.southbendclinic.com/ADAM/Cancer%20Center/2/8770.htm

Chromosomal Location:

Source: http://employees.csbsju.edu/hjakubowski/classes/ch331/dna/oldnastructure.html

Appendix 30
Unit 4: Genetics and Biotechnology

How DNA is Packaged: (video)
Source: http://www.youtube.com/watch?v=9kQpYdCnU14

Photograph of Tagged Sequences:

Source: http://usatoday30.usatoday.com/news/health/story/2012-09-05/junk-dna-disease/57604346/1

Genes and DNA: (interactive website)
Source:

http://www.abpischools.org.uk/page/modules/genome/dna2.cfm?coSiteNavigation_allTopic=1
Unit 4: Genetics and Biotechnology

Translation and Transcription:

Source: [http://mssdbio.weebly.com/molgen1a.html](http://mssdbio.weebly.com/molgen1a.html)

RNA Detail:


Appendix 32
From RNA to Protein Synthesis: (video)
Source: http://www.youtube.com/watch?v=NJxobgkPEAo

Tour of the Basics: (interactive)
Source: http://learn.genetics.utah.edu/content/begin/tour/

Transcribe and Translate a Gene: (interactive whiteboard)
Source: http://learn.genetics.utah.edu/content/begin/dna/transcribe/

Types of Mutations:

![Mutations Image]

Source: http://www.uta.edu/biology/henry/classnotes/2457/index.htm
Fruit Flies:

Source: http://science.howstuffworks.com/life/evolution/evolution5.htm

What is DNA?: (video)

Source:

http://www.youtube.com/watch?annotation_id=annotation_815353&feature=iv&src_vid=hnSPG1pZx_Q&v=zwibgNGe4aY

Mutation and Haplotype: (video animation)

Source:

http://learn.genetics.utah.edu/content/extras/molgen/mutation_haplotype.html

What is a Mutation?: (website with examples and comparison)

Source: http://learn.genetics.utah.edu/archive/mutations/index.html
Unit 4: Genetics and Biotechnology

DNA the Double Helix: (interactive whiteboard)

Source: [http://www.nobelprize.org/educational/medicine/dna_double_helix/dnahelix.html](http://www.nobelprize.org/educational/medicine/dna_double_helix/dnahelix.html)

Punnet Square Example:


Dihybrid Example:

Gregor Mendel: (intro video)
Source: http://www.youtube.com/watch?v=d4izVAkhMPQ

Online Science Test: (interactive questions)

Punnett Square Calculator: (interactive website)
Source: http://www.scienceprimer.com/punnett-square-calculator

Punnett Squares: (make your own interactive)
Source: http://www.mhhe.com/biosci/genbio/virtual_labs/BL_05/BL_05.html

Examples of Genetic Disorders:

Genetic Disorders and Diseases: (video)
Source: http://www.youtube.com/watch?v=8s4he3wLgkM

What Are Genetic Disorders?: (interactive website)
Source: http://learn.genetics.utah.edu/content/disorders/whataregd/

Newborn Genetic Screening: (website)
Source: http://learn.genetics.utah.edu/content/health/ngs/

Using Karyotypes to Predict Genetic Disorders: (interactive website)
Source: http://learn.genetics.utah.edu/content/begin/traits/predictdisorder/

Molecular Genetics:
Source: http://www.mayo.edu/mshs/careers/molecular-genetics-technology
Gregory Stock- To Upgrade is Human: (video forum/discussion)

Source: http://www.ted.com/talks/gregory_stock_to_upgrade_is_human.html

Genetically Modified Corn: (video-documentary example)

Source: http://www.teachersdomain.org/asset/tdc02_vid_btcorn

Click and Clone: (interactive whiteboard)

Source: http://learn.genetics.utah.edu/content/tech/cloning/clickandclone/
Geologic Time Comparison:


Human Evolution: (interactive simulations)

Source: http://www.learner.org/courses/biology/units/humev/images.html

Prehistoric Life: (interactive representations/simulations)

Source: http://www.bbc.co.uk/sn/prehistoric_life/redesign.shtml

The Human Lineage: (interactive white board)

Source: http://www.becominghuman.org/node/human-lineage-through-time

Appendix 39
Unit 5: History & Evolution

Darwin:

Source: http://www.ucmp.berkeley.edu/history/evotheory.html

Finches:

Source: http://www.hras.org/sw/sw11-04.html

Evolution/Darwin-An Origin of Species: (interactive simulation)


Misconceptions About Evolution: (website tour/links)

Source: http://evolution.berkeley.edu/evolibrary/misconceptions_teacherfaq.php

Appendix 40
Unit 5: History & Evolution

Darwin-Who Wants to Live a Million Years: (interactive white board)

Source: http://science.discovery.com/interactives/literacy/darwin/darwin.html

Comparative Embryology:

![Comparative Embryology Diagram](http://www.truthinscience.org.uk/tis2/index.php/component/content/article/49.html)

Source: http://www.truthinscience.org.uk/tis2/index.php/component/content/article/49.html

Galapagos Finches: (video)

Source: http://www.youtube.com/watch?v=2k2UxiHREUM

Evolution 101: (website resource)

Source: http://evolution.berkeley.edu/evosite/evo101/IIntro.shtml

Interactive Timeline: (interactive whiteboard)

Source: http://www.pbs.org/wgbh/nova/evolution/brief-history-life.html

Appendix 41
Unit 6: Ecology

Abiotic vs. Biotic Flowchart

Source: http://www.rpdp.net/sciencetips_v3/L8C3.htm

Examples Compared

Source: http://woostermiddle.stratfordk12.org/Content/Living_Things_and_Celss.asp
Ecosystem Illustration

Source: https://wikis.engrade.com/ecologypractice

Abiotic Biotic Song

Source: http://www.youtube.com/watch?v=nQO5x8Q3e8g

Discovery-Abiotic vs. Biotic Factors: (video)


Create Your Own Ecosystem: (interactive whiteboard)

Source: http://mrsbader.com/elearningunits/7Ecosystems/GRD7SCI-BLEU01A01/mme/1-1_Extreme%20Ecosystems/content.swf
World’s Biomes:

![World Biomes Map](http://www.bio.miami.edu/ecssummer/lectures/lec_biomes.html)

Source: [http://www.bio.miami.edu/ecssummer/lectures/lec_biomes.html](http://www.bio.miami.edu/ecssummer/lectures/lec_biomes.html)

**Biomes of the Earth: (video)**

Source: [http://vimeo.com/14622015](http://vimeo.com/14622015)

**World Biomes: (website)**

Source: [http://www.blueplanetbiomes.org/world_biomes.htm](http://www.blueplanetbiomes.org/world_biomes.htm)

**Human Influence on Ecology Mapped: (video)**

Example Energy Relationships:

Source: http://staff.tuhsd.k12.az.us/gfoster/standard/bbiotic.htm

Following the Energy Flow: (simulation)

Source: http://serc.carleton.edu/eslabs/weather/2b.html

Producers and Consumers: (website excerpt)

Source: http://www.biology-online.org/6/2_producers_consumers_2.htm

Global Energy Balance: (interactive whiteboard)

Source: http://earthguide.ucsd.edu/earthguide/diagrams/energybalance/
Succession Example:

Source: http://bot1320.nicerweb.com/Locked/media/ch10/succession.html

Yellowstone Forest Fire Succession: (demo/comparison video)

Source: http://www.youtube.com/watch?v=AQQupOYonRo

Ecological Succession: (website)

Source: http://www.sciencedaily.com/articles/e/ecological_succession.htm

Coral Reef Succession: (video and interactive website)

Source: http://education.nationalgeographic.com/education/activity/coral-reef-succession/?ar_a=1