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Department of Biological Sciences  
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Editor, Grace Tran
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**Abstract Issue**

Abstracts of papers presented at the Fall 2004 Biology 3A Scientific Meeting

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**Note:** author name(s) and abstract titles were printed directly from the abstract form without corrections. The presentation order was determined by the order in which the emailed abstracts were received. All non-emailed abstracts presentation order was also determined by the order in which the hardcopy was received.

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Bacterial Growth Inhibited by Canine Saliva

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It is very common for canines to lick their own and other dogs’ anuses, yet they get sick much less frequently than humans would if engaged in this behavior. So, what mechanism have dogs evolved to protect themselves from bacterial infection contracted from fecal matter? Four dogs—picked as pairs living in the same environment—were selected for this experiment and sterile swabs were used to collect samples from each anus. Bacteria collected from these samples were allowed to propagate on nutrient agar plates. To collect saliva samples from the same four subjects, hands were used to gather saliva from the salivating dogs’ mouths, and paper discs were used to absorb the collected saliva. Differing species of bacterium were isolated and streaked onto sterile agar plates; three absorbent discs were then placed upon each of the spread plates—each of the isolated bacterium was introduced with samples from each of the subject’s saliva. Inhibition of anal bacteria growth occurred from the paper discs soaked in saliva on one plate, and competitive inhibition was seen on 5 other plates; this was due to competition between isolated strains from the anuses and introduced strains originating from the dogs’ mouths. In total, 6 of the 30 test plates presented positive for zones of inhibition.

Introduction

Bacteria are Prokaryotes: small unicellular organisms whose genetic material is not enclosed in a nuclear membrane; they can usually be found in one of three shapes: bacillus (rod-like), coccus (spherical), or spirillum (spiral). These organisms generally reproduce by dividing into two equal daughter cells, a process called binary fission, and the organic materials they use for nutrients are obtained from dead organisms or from a living host; the parasitic forms of bacteria—which often proliferate and thrive in the fecal matter of other organisms—can be extremely harmful to their hosts.

As can be imagined, to avoid becoming ill, some animals avoid contact with their feces; humans would constantly be sick if not for this avoidance. Yet many animals have forgone the behaviors that would be thought necessary to circumvent sickness; dogs for instance have evolved a characteristic trait of licking their own and other dogs’ anuses. Yet in spite of that, illness attributed to enteric or fecal bacteria proves more uncommon than could be expected. Why is this? What mechanism have dogs evolved to protect themselves from infection? Might dogs carry different bacteria than humans?

Tests have been performed in relation to these questions; a 2004 study done by Guardabassi, Loeber, and Jacobson studied the occurrence of antimicrobial-resistant staphylococcus intermedius strains in thirteen dogs, as well as in their owners. Thirteen individuals whom did not have daily contact with dogs served as the control group. Dog and human Staphylococcus intermedius isolates were identified by pulsed field gel electrophoresis to determine their identity. S. intermedius occurred significantly more in the dog owners than in the control group. The results showed that six out of thirteen (46%) of the owners carried strains identical to those isolated from their dogs. And although S. intermedius is not an enteric bacterium, this study shows that transference of bacteria occurs between different organisms, i.e. between dogs and humans.

So then, how is it that the same types of bacteria can be found in dogs and humans, but can have a more detrimental affect on the latter? This brings about the question: How is it that humans become seriously ill if they consume fecal matter, yet dogs do not? This is the thought that brought about the following experiment, testing if dog saliva possesses any inhibitory qualities to hinder a bacterium’s ability to colonize.

Materials and Methods

Deionized water and nutrient agar powder were combined in a large flask and placed in an autoclave to sterilize for 15 minutes at 121° C and 15 PSI. After allowing the resulting solution to cool, it
was dispersed equally into forty sterile petri dishes. Four dogs—picked as pairs living in the same environment were selected—and sterile swabs were used to collect samples from each anus (each anus was swabbed twice). Collected samples were brought back to the lab in the sterile swabs’ paper wrappers, and streaked onto the agar plates. Plates were then placed in an incubator for forty-eight hours at 37° C. After this incubation period, each of the visibly different bacterial colonies were isolated and propagated onto individual agar plates; these plates were incubated for forty-eight hours. Then, to collect saliva samples from the same four subjects, hands were used to gather saliva from the salivating dogs’ mouths, and paper discs were used to absorb the collected saliva. After the plates were spread with each of the isolated anal bacteria, three absorbent discs were placed upon each of the spread plates—each of the isolated bacterium was introduced with samples from each of the subject’s saliva. The plates were then placed in an incubator and allowed to incubate for forty-eight hours. After this incubation period, test plates were examined. And finally, plates were allowed to aerate for 1 week in a ventilated room at room temperature (approx. 22° C).

**Results**

Inhibition of bacterial growth occurred from the paper discs soaked in saliva on one plate, and inhibition was seen on five other plates; this due to competition between isolated strains from the anuses and introduced strains originating from the dogs’ mouths (Figure 1). In total, 6 of the 30 test plates presented positive for zones of inhibition.

![Figure 1. Agar plate demonstrating zone of inhibition.](image)

**Discussion**

Possible explanation of the inhibition zones displayed by the saliva may be given to the fact—as another experiment has shown—that dog saliva contains an increased pH level, and higher lysozyme and peroxidase activities, as compared with human saliva (Tenova, Illuka, and Vaha-Vahe, 2000). And, although the flushing effect attributed to saliva has proven to be an important protective factor—as it removes exogenous and endogenous microorganisms and their products (Tenovuo, 1998)—this current experiment hints towards canine salivary antibiotic factors. That is not to underscore the importance of a steady supply of saliva to guarantee for a continuous supply of immune and non-immune factors in the mouth (Tenovuo, 1998), but to aid in validating the 1998 study done by Vetvik et. al. which showed that antibody levels in air-dried saliva does not decrease, but on the contrary can increase over time. It is believed by the conductors of this present experiment that both a constant influx of saliva (to replenish immune factors and provide a flushing effect), as well as a chemically inhibitory trait possessed by saliva, may provide inhibitive effects on bacterial colony growth; hence protection from infection.

In addition, it is quite possible that a symbiotic relationship has formed between certain types of bacteria and dogs; that which allows for a viable living environment in the mouth of dogs for the bacterium, and the inhibition of certain pathogenic bacteria harmful to dogs by the bacterial symbiont.

**Acknowledgements**

Special thanks to Dr. Anthony Huntley for providing his seed-of-idea for this experiment, and to Professor Kathleen Moloznik for sharing her knowledge and expertise. For without whom none of this would have been possible.

**Literature Cited**


Difference in Erythrocyte count, Blood Pressure, and Heart Rate in Smokers and Non-Smokers

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According to the Center for Disease Control, 46.2 million people smoked last year in the United States alone. For years, the surgeon general has tried to warn us about the effects of smoking, and yet this addiction continues to plague millions of Americans. Cigarette smoke contains foreign substances that are inhaled through the respiratory system and distributed throughout the body via the circulatory system. One foreign substance absorbed is carbon monoxide. Hemoglobin has a greater affinity for carbon monoxide than oxygen. When carbon monoxide is in the blood, the oxygen carrying capacity is compromised. This study was done to test the hypothesis that smoking individuals will have a lower red blood cell count than non-smokers. A certified lab drew blood intravenously, from 10 smokers and 10 non-smokers, while blood pressure and pulse was taken in a medical clinic. The individuals were asked for consent to use their information and the data was collected. The results received indicated that the subjects who smoked did have lower red blood cell counts on the average. The mean count for smokers was 4.248 million per $\mu$L and the mean count for non-smokers was 4.588 million per $\mu$L. After comparison with a t-test in Microsoft Excel, a p-value greater than 0.05 showed no significant difference between the two groups.

Introduction

In a nation where health and fitness is such an icon with the media and our everyday lifestyle, it is incomprehensible to think that approximately 46.2 million Americans still smoke (Porter, 2003). In the year 2000 alone, 4.83 million deaths were attributed to smoking related diseases such as COPD (chronic obstructive pulmonary disease) and cardiovascular disease (Ezzati, 2004). Yet we as Americans still think it is the “cool” thing to do. Smoking does it’s damage after a smoker inhales the numerous toxic chemicals in cigarette smoke. One of those chemicals is carbon monoxide. Carbon monoxide has a much greater affinity for hemoglobin than oxygen. It therefore binds to the hemoglobin, “kicking out” the oxygen. Smokers can have an average of 15% lower oxygen percentage than non-smokers (Moxham, 2000). Our hypothesis for this research is to show that smokers would have a lower red blood cell count than those who do not smoke. Since the body is not able to carry as much oxygen on the red blood cells already within the body, the blood should adapt to the lack of oxygen. With less oxygen, fewer red blood cells would be utilized by the body, thereby lowering the red blood cell count in smokers.

Methods and Materials

All subjects were asked to volunteer in this study. After consent was given, subjects were taken to the lab (Labcorp) to have their blood drawn intravenously from the antecubital space. This was done by wrapping the arm tightly with a rubber tourniquet, just above the antecubital space and allowing the blood to pool in the lower forearm. A 20-gauge needle was used to puncture the vein and draw the blood into a vacutainer. This blood was sent off for evaluation by a certified lab technician. After each subject had completed their blood draw, they returned to the doctor’s office and had their blood pressure and pulse taken. Blood pressure was taken using a standard adult size sphygmometer and a simple stethoscope. The cuff was filled with air to tighten around the bicep so as to restrict the flow of blood to the lower arm. Pressure was slowly released until the flow of blood to the lower arm could be heard by the stethoscope in the antecubital space. This was heard, the gauge on the sphygmometer was read and written down as the systolic pressure. Pressure was continually released slowly until no audible sound of blood flow was heard through the stethoscope. This reading was written down as the diastolic pressure. Heart rate was counted.
by placing two fingers on the radial pulse and counting the heart rate for a full minute. Once the red blood cell counts and blood pressure/pulse readings were recorded, data was entered into Microsoft Excel for analysis.

Results
A total of 20 subjects, 10 smokers and 10 non-smokers, volunteered for this study. Sex and age were not considered. The mean red blood cell count for smokers was $4.588 \pm 0.45$ (s.d.) million per µL (Figure 3). The mean red blood cell count for non-smokers was $4.248 \pm 0.40$ (s.d.) million per µL (Figure 4). Normal red blood cell count ranges in adults is 4.2-5.9 million per µL (Merck Manual, 1999). After comparing the two groups using a t-test, a p-value of greater than 0.05 was obtained, showing no significant difference between the two groups. When comparison of the heart rates were observed, the mean value for the non-smokers was 77.3 ± 14 (s.d.) beats per minute. The mean heart rate for smokers was 72.7 ± 8 (s.d.) beats per minute. After comparison using a t-test, a p-value of 0.2 showed no significant difference in pulse rates. No significant difference was noted in blood pressure during this study.

Discussion
When comparing the difference between the red blood cell count in smokers and non-smokers, there only appeared to be a very slight difference. In non-smokers, the mean value was $4.588 \pm 0.45$ SD million per µL, while the mean value for smokers was $4.248 \pm 0.40$ SD million per µL. After a t-test, a p-value of 0.05 proved our hypothesis that the red blood cell count would be lower in smokers than non-smokers.

After completing this study and referring to other case studies that have been done in this similar area, it was noted that previous studies have found that smokers should have a higher red blood cell count than non-smokers. This was related to the increase in production of red blood cells in the bone marrow since the carbon monoxide in cigarette smoke was overtaking the hemoglobin and creating an environment with less oxygen. The body needs to compensate for this lack of oxygen, so it makes more red blood cells to carry more oxygen (Merck Manual, 1999). One reason for the difference seen in this study and previous studies is the amount of participants. If this study could have included more than 20 subjects, the results might have been different and possibly coincided with previous studies on this subject.

Other factors that was not included in this study, such as preexisting diseases and illnesses could have altered the outcome of the red blood cell count, pulse and blood pressure. For example if some of the subjects tested had a disease which increased the red blood cell count such as polycythemia vera or hypertension, which is high blood pressure, this would change the results of the outcome.

In future studies on this subject, a greater number of volunteers would help show in more detail any significant difference between the two groups. Furthermore, a screen of all past medical history of each subject would help rule out subjects that do not qualify for the study and help researchers understand the results better.
Literature Cited


Effect of Ethanol on the rate of Operculum Contraction in Goldfish

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Alcohol depresses the functioning of the brain by stimulating inhibitory gamma-aminobutyric acid A (GABA$_A$) receptors. These receptors are located throughout the brain. They are ubiquitous on the cranial nerves in the medulla that control operculum contraction in fish. Stimulation of GABA$_A$ receptors on these nerves inhibits the nerves thereby inhibiting contraction of the operculum. In this experiment, goldfish were immersed in various concentrations of ethanol. The opercular contraction rates (OCRs) of the fish were observed in solutions of ethanol and compared with the OCRs for the fish in water. It was expected that the OCRs of the goldfish would decrease with immersion in increasing concentrations of ethanol solutions due to stimulation of GABA$_A$ receptors by alcohol. Although the average OCR decreased with increasing alcohol concentrations, there was too much variation among the data for the results to be significant. T-tests indicated that the results were not 95% significant.

Introduction

Alcohol is a central nervous system depressant in humans. The purpose of this experiment is to determine whether alcohol also acts as a depressant in fish. Depression of the central nervous system was measured by observing the rate of contraction of the operculum. The operculum is a muscle that contracts to ventilate the gills. Contraction of the operculum is controlled by cranial muscles innervated by a dorsal group of cranial nerves termed branchial nerves (Taylor et al, 1999). The efferent cell bodies of these branchial nerves are located in the medulla of the brainstem (Figure 1). Located on dendrites and cell bodies of cranial motor neurons are gamma-aminobutyric acid A (GABA$_A$) receptors (Rekling et al, 2000). GABA$_A$ receptors are inhibitory. Stimulation of these receptors hyperpolarizes the neuron cell membrane by opening ligand-gated Cl$^-$ channels. The hyperpolarization occurs as a result of a net influx of Cl$^-$ down its concentration gradient. Ethanol is an agonist at these receptors (Weiner et al, 1997). The hypothesis driving this experiment is that stimulation of GABA$_A$ receptors on branchial nerves in the medulla by ethanol will inhibit the firing of these nerves. This will slow the rate of innervation of the operculum.

Figure 1. Diagram of distribution of components of cranial nerves involved in control of ventilation in a shark (Squalus).
Materials and Methods

A goldfish was placed in 200 ml of deionized water in a 250 ml beaker. The goldfish was allowed 6 minutes to equilibrate to its new environment. Subsequently, the number of opercular contractions performed by the fish during one minute were counted and recorded. This measurement was repeated twice for a total of three trials. The goldfish was then placed into a holding tank for at least ten minutes. This procedure was repeated on the same goldfish three more times using 200 ml solutions of 0.95% ethanol, 1.4% ethanol, and 1.9% ethanol. The procedure performed on this goldfish was repeated on nine more fish to obtain results for a total of ten fish.

Results

The average opercular contraction rate (OCR) of the goldfish in water was 84.1 +/- 22.8 contractions per minute (CPM). The average OCRs of the goldfish while immersed in solutions of ethanol were 77.5 +/- 17.5 CPM, 73.3 +/- 9.1 CPM, and 66.7 +/- 9.1 CPM in 0.95% ethanol, 1.4% ethanol, and 1.9% ethanol respectively (Figure 2). The average OCR of the goldfish was lower in solutions of alcohol than in pure water. It was lower by 6.6 CPM in 0.95% alcohol, 10.8 CPM in 1.4% alcohol, and 17.4 CPM in 1.9% alcohol. This corresponds to percent decreases in the OCR of 6.7% +/- 11% in 0.95% ethanol, 8.4% +/- 21.3% in 1.4% ethanol, and 17.3% +/- 16.0% in 1.9% ethanol (Figure 3).

![Figure 2. Goldfish Average Operculum Contractions per Minute in Water, 0.95% ethanol, 1.4% ethanol, and 1.9% ethanol.](image)

![Figure 2. Percent Decrease in Goldfish Opercular Contraction Rate relative to Water Due to Immersion in 0.95% ethanol, 1.4% ethanol, and 1.9% ethanol.](image)
Discussion

The significant behavioral changes exhibited by the goldfish at higher concentrated solutions of ethanol indicate that ethanol had significant effects on the physiology of the goldfish at these higher concentrations. As expected, the OCR decreased with increasing concentrations of ethanol. Although this trend was consistent with the hypothesis, t-tests illustrated that these results were not significant. Therefore, it cannot be ruled out that the results consistent with the hypothesis were not due to random variation.

There was one interesting experimental observation worth exploring. 90% of the goldfish went to the surface of the 1.9% ethanol solution to gulp air several times during the one-minute trials. None of these fish performed this behavior in deionized water. This behavior suggests that the goldfish were lacking oxygen. However, with a concentration of alcohol of only 1.9%, the amount of oxygen available in the solution should not be significantly reduced. Moreover, since the OCR was not significantly reduced by alcohol, it can be ruled out that operculum contraction inhibition was causing the fish to gulp air. To investigate this phenomenon, one should first determine the amount of oxygen available in water and a solution of 1.9% ethanol. If these values are comparable, then it must be a physiological effect of the ethanol that is causing the fish to gulp air. Perhaps the ethanol is blocking the uptake of oxygen by the fish. Or maybe the alcohol is tricking the fish into believing that they are in a hypoxic state. This would occur if the ethanol blocked oxygen receptors located in the brains of fish. In any case, this effect of ethanol on goldfish warrants further study.

Literature Cited


We hypothesize that the practice of yoga lowers both heart rate and blood pressure significantly more than free relaxation. Deep breathing and complex poses practiced during Yoga trigger the parasympathetic division of the autonomic nervous system to release specific neurotransmitters that induce relaxation. Heart rate and blood pressure from 10 male subjects were recorded after 20 minutes of free relaxation, then after 20 minutes of yoga. The experiment supported the hypothesis that yoga drops heart rate significantly more than free relaxation. Results did not, however demonstrate significant difference in blood pressure.

Introduction

Stress is unavoidable, however too much stress can be harmful to overall health. It is known to cause Hypertension (high blood pressure), leading to a number of serious ailments such as coronary heart disease, congestive heart failure and stroke (Chobanian, 1992). Exposure to stressful situations also increases heart rate. An elevated heart rate can be dangerous by further exaggerating hypertension. A noticeable increase in heart rate can lead to more stress, leading to even higher blood pressure, creating a dangerously viscous cycle. (Franklin Institute, 2004). The medications available to control hypertension are expensive and have many side effects; therefore alternative methods to treat and prevent hypertension are being tested.

The Autonomic branch of the Peripheral Nervous System (PNS) normally regulates involuntary body functions such as digestion, immunity, blood pressure and heart rate. Sensory and motor information is relayed back and forth from the Central Nervous System (CNS) which includes the brain and spinal cord, to the PNS which articulates with effector organs, muscles and glands. The parasympathetic system, represses the sympathetic nerve response. The sympathetic system raises blood pressure through vasoconstriction that redirects blood to arms and legs to enable movement in response to threat. The parasympathetic system, which is stimulated during times of relaxation, releases the neurotransmitter Acetylcholine (Ach) (Smith-White, 1999). Ach has both excitatory and inhibitory effects on the body. In cardiac muscle, Ach causes the SA node to hyperpolarize. Hyperpolarization decreases action potentials, therefore reducing the heart rate. In contrast to cardiac muscle, Ach opens Na+ ligand gated channels on the post synaptic neuron depolarizing smooth muscles and glands causing increased contraction. By forcing the relaxation of voluntary movement and stimulation, the parasympathetic nervous system conserves energy and promotes healing, digestion and peristalsis (Sears, 1999).

The word Yoga literally means “union”, symbolizing the complete conscious influence over all bodily functions. Originating from the Indus-Sarasvati civilization in Northern India around 5000 years ago (EMedicine, 2004), the ancient art of yoga was taught to promote health, ease stress and induce relaxation through a series of “poses” that center on elaborate stretches and breath control. Advanced yoga followers believe they can consciously manipulate all aspects of the Autonomic System through these learned techniques. The simplest of these controls experienced by beginners, include regulation of heart rate and blood pressure (Yardi, 2001). Each complex pose is designed to target specific sites by increasing blood supply to the area and improving venous return to the heart, thereby lowering blood pressure. If the body tissues receive sufficient oxygen, the heart rate decreases.

Along with increased blood circulation from specific poses, breathing can be consciously altered. Slow deep breathes increase oxygen saturation and perfusion, and decrease muscle sympathetic activity (Bernardi, et al., 2002). Yoga utilizes deliberate breath response along with complex poses to maintain homeostasis by increasing blood flow and depressing the sympathetic nerve response.

The purpose of the experiment was to determine if indeed there was a significant difference between relaxed heart rates and blood pressure values taken after yoga relaxation, and after the same period of free relaxation.
Materials and Methods

Subjects
Ten male subjects of good health from the ages of nineteen to twenty-nine were used for this experiment. All ten subjects were athletic, non-smokers, and naïve to the practice of yoga.

Materials/Tools
Heart rates and blood pressures were recorded using an ARDEN digital blood pressure monitor, provided by Arden Corp. Living Yoga, yoga for beginners, provided instructional yoga via videotape, with instructional performance by internationally acclaimed yoga teacher Rodney Yee. Two firm blankets were used for support during yoga practice.

Experimental Measures
Each subject performed the experiment on a separate occasion in the same environment. The experiment was conducted in a five day period between the hours of 9-11 Am., using two subjects per day. Before testing, resting heart rates were recorded for all subjects. First, each subject first ran fifty stairs for six minute duration. Thirty seconds after run completion, heart rate and blood pressure were recorded. Twenty minutes of free relaxation was allotted, and then heart rate and blood pressure were again documented. A second run was then performed by each subject, and heart rate/blood pressure was again recorded. Directly after run number two readings were taken, each subject was to perform 20 minutes of yoga relaxation. At the time of yoga completion heart rates and blood pressures were recorded.

Free & Yoga Relaxation Conditions
Free relaxation was twenty minutes of undisturbed rest after each subject performed run number one. Neither sleep nor any strenuous activities were allowed during this time. Each subject was observed to ensure all conditions were undisturbed and controlled.

Yoga relaxation was twenty minutes of undisturbed yoga performance. Each subject was observed, without interruption, while following instructional yoga videotape that involved meditative breathing techniques, strengthening, and relaxation of the entire body. Heart rates and blood pressures were recorded at the end of the video, while subjects were sitting in relaxation pose as directed by the video.

Statistical Analysis
A paired t-test for sample means at the 95% confidence level was conducted to determine if significant differences were present for systolic and diastolic blood pressure after free relaxation vs. after yoga relaxation, and also for heart rate after free relaxation vs. after yoga relaxation.

Results
Results showed that there was a significant difference in the mean heart rates for free relaxation vs. yoga relaxation, being that p<.05 at the 95% confidence level. The mean between the free relaxation heart rates (70 ± 1 beat per minute) and the yoga relaxation heart rates (52 ± 1 beat per minute), showed that heart rate during yoga was significantly lower than heart rate during free relaxation (Figure 1). Data also showed that yoga relaxation mean heart rates were lower than that of mean resting heart rates.

No significant differences were found for systolic and diastolic blood pressures with free relaxation vs. yoga relaxation, being that both p-values were greater than .05 at the 95% confidence level. Mean systolic blood pressures for free relaxation and yoga relaxation were both 116 ± 8 mmHg. Diastolic blood pressures for free relaxation (68 ± 1mmHg) and for yoga relaxation (69 ± 1mmHg) were also similar (Figure 2).

Figure 1: Free Relaxation vs. Yoga Relaxation Mean Heart Rate Values.

Figure 2: Free Relaxation vs. Yoga Relaxation Mean Systolic and Diastolic blood pressures.
Discussion

Our heart rate data supported half of our hypothesis that yoga relaxation would drop mean heart beats per minute significantly lower than free relaxation. Yoga relaxation decreased heart rate an average of 18 beats per minute lower than the same amount of time allocated to free relaxation. We found that blood pressure was not affected by yoga therapy. However, blood pressure reduction following the two relaxation techniques did not show a significant difference. Both yoga relaxation and free relaxation lowered systolic and diastolic pressures back to basal metabolic values equally. Heart rates and blood pressures were recorded before and after 20 minutes of yoga. Results were compared with data collected prior to, and following 20 minutes of free relaxation. Results showed that the average heart rate after the yoga session was 52.3 beats per minute. The average heart rate following free relaxation was 70.6 beats per minute. A t-test was run to determine statistical significance. A p-value greater than 0.05 at the 95% confidence level determined that there was a significant difference between the final heart rates of yoga subjects compared with free relaxation. The experiment demonstrated evidence that yoga stimulates the parasympathetic nervous system to substantially decrease heart rate while inducing relaxation in all 10 males.

It appeared that the parasympathetic system did not however, significantly lower blood pressure values. The average systolic blood pressure following yoga was 116.1 mmHg, and 116.9 mmHg for free relaxation. Diastolic readings gave an average of 67.4 mmHg post yoga, and 68.9 mmHg, after free relaxation. Though heart rate was significantly altered through relaxation, the experiment demonstrated that Yoga relaxation would not be a suitable therapy for the treatment of hypertension A study in Turkey determined the prevalence of alternative medicines in patients with acute illnesses (Bavbek, et.al. 2004). Many Turkish people regularly used treatments such as herbs, yoga, acupuncture, massage, Turkish-baths, and psycho religious methods for treating their diseases. Among these subjects, more people who used these alternative therapies were eventually admitted to hospitals, compared with those who took conventional medications.

Contrary to traditional belief, our study demonstrated that certain aspects of the autonomic nervous system, such as heart rate can be voluntarily manipulated through the practice of yoga. During the controlled periods of meditation and stretching, heart rate was altered significantly, but blood pressure changed the same rate as free relaxation.

Perhaps more than 20 minutes of yoga relaxation time should have been allocated to the study given typical yoga classes last 30 minutes. Results may also have been different if the subjects were included into a live classroom setting as opposed to the video tape. If we were to research this project further, a larger group of subjects monitored for a longer amount of time (perhaps years) could be studied to determine if yoga has a permanent effect on heart rate and blood pressure.

Literature Cited


The Effect of Varying Soil pH Levels on the Growth of Fungus

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A study was performed testing the effect of soil pH on fungal growth. Fungal growth is most active in acidic mediums. It was hypothesized that fungi would have a higher growth rate in a slightly more acidic soil. Basidiomycota has the ability to grow in soil with increasing pH, but it ideally grows in soil with a pH level of 5.6-5. A 7-day study was administered in which the hyphae and spores of a nonspecific basidiomycota fungal sample were cultivated in three soil environments with varying pH levels: 6.5, 7.0, and 7.5. The soil was checked for growth and tested for pH uniformity daily. An ANOVA test was administered on the results of the three samples where p=0.417, which is statistically insignificant (p>0.05). Zero growth was recorded for each of the samples for 6 days. On the seventh day growth was recorded in the control sample. Although a complete hyphal network can produce fruiting bodies within hours, sporulation and fertilization can take upwards of about 2 weeks. A variation in soil pH did not seem to affect the growth rate of the fungi within the 7-day period. However, over a longer period of time, pH variation may begin to affect the growth of fungi.

Introduction

Typical fungal growth starts out as mycelia, which are complex networks of moist fibers. The individual fibers are known as hyphae. Hyphae make up the actual body of fungi. When the hyphae swell, the mycelia produce the fruiting bodies. Well-established mycelia can produce fruiting bodies within an hour or two (Pleasant, 2004). The fruiting bodies of basidiomycota are known as basidiocarps. The mycelia are responsible for secreting enzymes that decompose organic materials such as wood (Pleasant, 2004).

Temperature and moisture, along with soil pH are all important factors in fungal growth (Pietikäinen, et al, 2004). Basidiomycota grow best in temperatures between 30-36°C (Emelyanova, 2004). Basidiomycota has the ability to grow in soil with increasing pH, but it ideally grows in soil with a pH level of 5.6-5.8 (Emelyanova, 2004). With this information, it is hypothesized that fungi will grow in a slightly more acidic soil.

Methods and Materials

Soil preparation

This study was performed over a period of 7 days from November 22, 2004 to November 29, 2004. The samples of soil were obtained from a residential area in Laguna Niguel. Three individual samples were taken from the original soil sample and placed in large foil containers. The pH of the soil was tested using a store bought soil pH tester. Once the pH of each soil sample was determined Whitney Farms brand dolomite lime and Whitney Farms brand granulated sulfur were added to two samples to alter the pH of the soil. The samples were prepared and altered to read slightly acidic and slightly basic. Granulated sulfur was added to one sample altering the soil to a pH of 6.5. To alter another sample’s soil pH to 7.5 the soil was treated with dolomite lime. The remaining sample was left at a pH of 7.0, which was used as the control. Store bought compost was then mixed into each sample of the soil to aid the fungi in decomposition. Wild basidiomycota was then subsequently mixed into each sample of soil.

Fungal sample collection

The basidiomycota were obtained from a fungi sampled from a residential lawn area in the city of Laguna Niguel. The fungi were dug out of the ground making sure to keep mycelia and fruiting bodies of original fungi intact.

Planting and storing

Mycelia and spores from the basidiomycota were added to the soil. Approximately 2 clumps of mycelia and 3 mushroom caps were added to each sample. The samples were then moistened and placed into a warm dark environment at about 30°C.
**pH regulation and data collection**

pH was tested using the soil pH tester twice a day, once in the morning and once at night, for 7 days. The fungal growth progress was recorded twice everyday, once in the morning and once at night, for 7 days. The soil was moistened as necessary, approximately once a day with about 15 to 20 ml of water. Fungal growth was recorded by measuring the number of fruiting bodies that had developed.

**Results**

The Fungi were cultivated for 7 days in a controlled environment. There was zero growth for the first 6 days. On the seventh day growth was detected in the control sample as seen in Table 1. An ANOVA test was administered on the data where p=0.417. This was statistically insignificant.

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Table 1. Amount of growth, number of fruiting bodies.

**Discussion**

Generally, fungal growth rate is comparatively high in acidic mediums. The maximum specific growth rate of hyphae of *Aspergillus oryzae* has a broad range from 7 to 3 pH (Carlsen et al., 2000). It was hypothesized that fungi in acidic soil would have the most abundant growth rate. In spite of the fact that with an established hyphal network fruiting bodies can grow within hours; initial sporulation and fertilization can take upwards of 2 weeks. After executing the study over 7 days, little or no growth of fungi was recorded. When planting and incubating the fungi, errors might have occurred, such as minor fluctuations in temperature or using an insufficient amount of mycelia or hyphae which may have hindered the results of this experiment. In the time allotted to the study only the control was able to grow under the given conditions. The results obtained from this experiment were inconclusive. Since no growth was recorded in either of the treated soil samples there can be no conclusive result to support the hypothesis. Despite the efforts taken to incubate the fungi in a 30°C environment the temperature was not strictly monitored. There may have been minor fluctuations in temperature throughout the study, which may have influenced the successful growth of the fungi. In further studies more time should be allotted to the fungi to promote growth. Another study must be done to obtain more data and gain conclusive results to support this hypothesis.

**Literature Cited**


Effects of 1,3,7-Trimethylxanthine and N-Dimethylethylamine Hydrochloride on *Pogonoymyrmex barbatus* Tunneling Patterns

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The study conducted showed the effects that stimulants had towards *Pogonoymyrmex barbatus* tunneling patterns. The stimulants that were used in this research were 1, 3, 7- trimethylxanthine and Dimethylethylamine hydrochloride. Our hypothesis suggests that the 1, 3, 7- trimethylxanthine stimulant would have the greatest effect on tunneling production and the Dimethylethylamine hydrochloride group would have the least tunneling production. The method of inducing these stimulants to *Pogonoymyrmex barbatus* was through ingestion (using bread crumbs saturated with the various stimulants). A control group of ants were also used in the experiment, which were fed regular bread crumbs. Over a one week period an observation was made of the amount of tunnels and tunnel branches that each ant farm had created. The results supported the hypothesis; ants with the 1, 3, 7- trimethylxanthine had a greater amount of tunneling paths created compared to the control and Dimethylethylamine hydrochloride group. A statistical difference was observed in the data analysis, of *P* = 0.047 (1 tail).

**Introduction**

Caffeine, or 1, 3, 7-trimethylxanthine, is related structurally to uric acid. It is among the most widely used drugs because of its ubiquitous occurrence in commonly consumed dietary sources, which include tea, coffee, cocoa beverages, candy bars, and soft drinks. Caffeine was used mainly in the Arab world until the 15th century. It reached Europe during the 16th century, and its consumption spread rapidly. Many drugs contain caffeine, and the use or abuse of caffeine is a major public habit that may be as important a factor as heredity and environment, in the etiology of physiological and psychological disorders. Caffeine is a potent central nervous system (CNS) stimulant and much of its "psychological" activity may be related to this action of the drug. Its effects on the nervous system are obviously adverse at high doses, but may not be obvious that at lower doses, when used in moderation; it may have beneficial effects (Suleman and Lorenzo, 2004). In addition to its CNS effects, caffeine has significant effects on the cardiovascular system, gastric acid secretion, and catecholamine (adrenaline) release. In large doses, it has been shown to be a mutagen in animals, plants and bacteria, and has been shown to exhibit teratogenic properties in various animal species. The purpose of this study is just that, whether caffeine has any beneficial effects or not (Fernandez, 2004).

Diphenhydramine hydrochloride belongs to the general class of drugs called antihistamines having the chemical name 2-(Diphenylmethoxy)-N, N-dimethylethylamine hydrochloride. Dimethylethylamine hydrochloride occurs as a white crystalline powder, is freely soluble in water and alcohol and has a molecular weight of 291.82. The molecular formula is C₁₇H₂₁NO • HCl. Diphenhydramine hydrochloride may be prescribed for sleep. The drug decreases allergic response by blocking histamine. It competes for cell receptor sites with histamines, neurotransmitter molecules that the body produces to help keep awake (Ordain, 1991). Abnormal release of histamines produces allergic reactions such as sneezing and skin rashes. Diphenhydramine hydrochloride has also been used to alleviate the symptoms of Parkinson's disease (Menze and Hellmann, 1999).

Since the study was conducted on red harvester ants (*Pogonoymyrmex barbatus*) rather than humans, there had to be some understanding of the harvester ants' neural biology and observe if there is any correlation with a human’s nervous system. The nervous system of ants consists of a long nerve cords that runs from head to the rear with branches leading to the parts of the body, similar to the human spinal cord (Life Studies, 2003). In ants, most of the pharmacological effects of adenosine in the brain can
be suppressed by relatively low concentrations of circulating caffeine. Adenosine decreases the neuronal firing rate and inhibits both synaptic transmission and the release of most neurotransmitters. Caffeine also increases the turnover of many neurotransmitters, including monoamines and acetylcholine (Lea, 1996).

The goal of the present study was to determine the effects of 1, 3, 7-trimethylxanthine and N-Dimethylethylamine hydrochloride on *Pogonomyrmex barbatus* tunneling patterns. The study has informed readers about the importance of the stimulant effects on *Pogonomyrmex barbatus* behavior.

**Methods & Materials**

*Pogonomyrmex barbatus* (N=−500) were divided into three separate ant farms. The ants were allowed to stabilize with their individual environments for 24 hours. After this period, each group was introduced to a different stimulus chemical in their dietary source. No Doz© caffeine pills (200mg/dosage) and Sominex© sleeping aid (25mg/dosage) were diluted separately into 2ml of deionized water. The solutions were poured onto 1cm bread disks and fed to the ants. Group 1 received No Doz©, group 2 received Sominex©, and group 3(control) received bread disks saturated only in deionized water. The ants were fed three bread disks every 48 hours for one week. Pictures were taken using a digital camera at initial and post tunneling. Data was collected by counting the final amount of tunnels on both sides of the farm and the amount of branching for each tunnel.

**Results**

Figure 1 demonstrates the dynamic differences in tunneling and branching patterns with the introduction of different stimulus in *Pogonomyrmex barbatus* food source. The data suggests that there is greater tunneling and branching with the ingestion of 1, 3, 7-trimethylxanthine and an acute reduction, over the control, with the ingestion of the dimethylethylamine hydrochloride. Results indicated a superficial difference between tunneling patterns comparing the control with dimethylethylamine hydrochloride, however an extreme difference in branching patterns. A statistical difference was observed in the data analysis, of P = 0.051 (1 tail).

![Graph showing tunneling and branching patterns](image)

**Discussion**

The data supports the hypothesis, 1, 3; 7-trimethylxanthine has a greater impact on tunneling production than N-Dimethylethylamine. Through previous studies there has been evidence that 1, 3, 7-trimethylxanthine increases body metabolism, which could suggest that the reason for increased tunneling activity is due to just that.

To further studies, a larger sample would be used in order to receive a more accurate outcome. The use of more variable stimulants could also be used or possibly different product lines with the same stimulant effect. Also, the study could be furthered to understand tolerance levels in specific stimulants. Tolerance to a drug refers to an acquired change in responsiveness after repeated exposure to the drug. Tolerance can be considered in 2 ways. First, tolerance might indicate that the dose necessary to achieve the desired euphoric or reinforcing effects increases with time, thus encouraging increased consumption of the drug.
Second, tolerance to the aversive effects of high doses of the drug may occur, also leading to increased consumption of the drug over time (Suleman and Lorenzo, 2004).

**Literature Cited**


The Effect of Exercise on Human Dive Response

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Diving response is the reduction of the rate of the heart during diving. There are several key components of the diving response; including apnea, bradycardia, peripheral vasoconstriction, and redistribution of cardiac output. The dive response is found in humans during facial immersion at rest. This experiment is to determine if humans undergo the dive response while exercising. On an electrocardiogram (EKG), heart rate was recorded on twenty subjects who were asked to hold their breath for fifteen seconds, three times per condition. The four conditions were breath hold: in air, with face submerged in water, in air while exercising, and with face immersed in water while exercising. The hypothesis is that the subjects will undergo bradycardia while exercising during facial immersion. The data collected on the twenty subjects’ shows that heart rates decrease after facial immersion. The value for the difference in heart rate between the normal resting heart rate and the normal resting heart rate while under water was t-value 2.843, and it was significant. The value for the difference in heart rate between the heart rate undergoing exercise and the heart rate undergoing exercise while under facial immersion was t-value 0.891, and it was not significant.

Introduction
It has been shown in experiments performed by Elsner and Gooden on the dive response that people have a physical response to diving. A dive reflex in terrestrial vertebrates consists of bradycardia and shunting of the blood from non-essential organs such as skin, muscle, and viscera to the essential organs of brain and heart (Haney, 2003). In order to assure that the brain and heart are constantly supplied with oxygen, even as the heart rate is reduced (bradycardia). These responses allow longer diving duration and improved diving capacity without the risk of asphyxia. The metabolic correlation of this response includes the gradual development of oxygen limiting conditions in tissues, with accumulation of anaerobic metabolism (Mottishaw, Thornton, and Hochachka, 1999).

In mammals that are specifically designed for diving, such as seals, the magnitude of the heart rate is reduced more than non-diving mammals, such as humans. During diving, harbor seals rely on oxygen stored in their lungs, blood and muscles that are managed through cardiovascular adjustments, including bradycardia, and peripheral vasoconstriction, collectively termed the diving response (Butler and Jones, 1997). Because of the diving response seals are able to spend about 75-85% of their time at sea submerged (Fedak et al., 1988). Although, not as developed as seals, humans also rely on oxygen stored in their lungs, bradycardia, and a reduction in cardiac output.

In experiments by Physiologists Gooden, Elsner, and Campbell, human subjects were tested to find whether or not they have a response similar to seals while diving. It was found that the dive response is produced in humans when the areas of the face which are controlled by the ophthalmic division of the trigeminal nerve are immersed in water. In humans, the dive response has been associated with several stimuli including facial immersion, apnea, and facial chilling (Gooden 1994). There has also been testing on seals to see what change the seals heart rate undergoes while exercising. Prior to this experiment, there has been no testing on humans to determine if bradycardia is still prevalent along with exercising while undergoing facial immersion. This experiment is to determine if humans undergo the dive response while exercising during facial immersion.

Materials and Methods
The n-value for this experiment was 20. The twenty subjects, in the age range of 19-28 years old, volunteered for this experiment. The subjects were
connected to an electrocardiograph (EKG) transducer by attaching electrode pads to the left arm, right arm, and the ground pad in between the scapula on the posterior of the subjects’ upper chest. The physiograph on the EKG recorded the subjects’ heart rate on a graphing paper at a rate of 1.25 cm/sec. The subjects were asked to hold their breath for fifteen seconds at four different conditions, and allowed to recuperate for a minute in between trials. Each condition was tested on the EKG for each subject; three trials were performed per condition to get a mean average. For the first condition, breath hold in air, the subjects were asked to hold their breath for 15 seconds while standing. For the second condition, breath hold with face immersed in water, the subjects were asked to put their face in cold water while holding their breath and resting. In the third condition, breath hold in air while exercising, the subjects were asked to pedal on an immobile workout bike at a rate of 10-20 mph and hold their breath for fifteen seconds. The last condition, breath hold with face immersed in water while exercising, the subjects were asked to immerse their face in a clean basin filled at about 2/3 with water while pedaling on the workout bike at a rate of 10-20 mph. The heart rate of each subject was measured in beats per minute (bpm).

### Results

Results for resting breath hold and resting immersion were used as the set control. Results were calculated by an ANOVA test. The result for the normal resting heart rate was slightly higher than the result for the resting heart rate while immersed in water. The average rate per minute for the normal resting heart rate was 79.8 bpm, while the average rate per minute for the resting heart rate while face immersed in water was 73.1 bpm. The average heart rate per minute while under going physical exertion was 99.1 bpm, slightly higher than the average heart rate undergoing exercise while face immersed in water, which was 97 bpm (Figure 1).

The mean value for the normal resting heart rate was taken and subtracted by the mean value for the normal resting heart rate while immersed in water and the difference was 6.7 bpm. The same was done for the heart rate undergoing physical exertion and heart rate undergoing physical exertion while immersed in water, the difference was 2.1 bpm. By taking these two results and comparing them it is noticeable that the heart rate did go down for each, however not significantly. The t-value for the non-exercising test was 2.843 and it was significant. The t-value for the exercising test was 0.891 and it was not significant.

![Figure 1. Mean at four different conditions.](image)

### Discussion

The data collected from the twenty subjects showed that the heart rate changed according to the four different sets of conditions; breathe hold in air, with face immersed in water, in air while exercising, and with face immersed in water while exercising. The data concluded was supported by research findings, such as the Gooden experiment on *The Mechanism of the Human Diving Response*. Heart rate showed a decrease when the exercising subjects faces was immersed in water. However, this decrease was not significant enough to support the hypothesis, which was that, subjects will undergo bradycardia while exercising during facial submersion. Therefore the differences in heart rates were not significant.

There are some variables that can account for possible sources of error. One possible source of error would be that the resistance of the bike was changed due to the different subjects’ cardiovascular ability. This might have offset the results due to the different levels of physical exertion. Muscles are managed through cardiovascular adjustments, including bradycardia, and peripheral vasoconstriction (Butler and Jones, 1997). This explains why people were tired while riding the bike and undergoing facial immersion. The subjects underwent vasoconstriction and bradycardia which made it harder for subjects to continue exercising. Another possible source of error was that four subjects were tested at different time intervals due to time restraints. This could have caused an offset of the overall data because they might have had a different level of caffeine or sugar intake, which would increase the heart rate.

Further research is required, with a higher number of subjects, to determine if the subjects will undergo bradycardia while exercising during facial immersion. Resistance level should be calculated based on the subject and their physical ability to exercise. Controlled food intake should be monitored.
**Literature Cited**


Comparisons of Lactate Accumulation after Extensive Exercise and Premature Lactate Accumulation after Lactate Injection in *Hemidactylus frenatus*

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Anaerobic glycolysis is a major source of energy for activity in reptiles. In this experiment, lactate and premature lactate accumulation in house gecko (*Hemidactylus frenatus*) was measured by the time it took the geckos to reach exhaustion, righting response and change in respiration rates. Lactate accumulation was measured after extensive exercise on the treadmill and injection of 0.9% NaCl (saline) solution, while premature lactate accumulation was measured after injection 80 mM solution of lactic acid which was adjusted to 300 mOsm of NaCl (lactate) solution. The result showed that the null hypothesis was rejected and significant differences were found among the three groups. Further test determined that significant differences were found during the time it took for the geckos to reach exhaustion. The differences were among the lactate injection and no injection group, and the lactate and saline injection group.

**Introduction**

Glycolytic metabolism is utilized by many ectothermic vertebrates as a way of producing energy which is maintained during daily activities. It is supported by substantially elevated aerobic and anaerobic metabolic activities which work concurrently with one another. Since most ectotherms are limited in their ability to utilize aerobic metabolism additional support is provided by an anaerobic metabolism to rapidly produce ATP in the muscles. While utilization of anaerobic metabolism can provide the opportunity for higher levels of performance, it can also lead to a variety of metabolic consequences. Exhaustion, rapid fatigue and loss of activity are metabolic consequences caused by glycogen depletion and lactate accumulation. Muscle glycogen depletion can limit the intensity and duration while lactate accumulation can cause incapacitated results. Therefore a recovery period following intense activity is needed to allow adequate break down of lactic acid build up within the muscles.

Laboratory research on lactate production and removal during activity and recovery are significantly different among mammals and reptiles (Gleeson, 1996). In mammals, lactate is quickly transported and oxidized from glycolytic muscle fibers to oxidative muscle fibers (Brooks, 1986). In contrast, reptiles tend to rely upon glycolytic pathways which results in greater amounts of lactate production over short-term intervals. Numerous studies have indicated that reptile can maintain high anaerobic scope, maximal rate of lactate formation, and anaerobic capacity, total lactate formed during exhaustive exercise or activity.

Although some lactate can accumulate in less intense activities most lactate accumulation is produced during intense exercise such as escaping from predators, foraging for food and agonistic encounters with other ectotherms (Pough and Andrews, 1985). Previous experiments have indicated that natural activity in the field by *Anolis bonaiensis* (Bennett et al., 1980) and *Dipsosaurus dorsalis* (Bennett and Dawson, 1972) involved a degree of anaerobic metabolism and resulted in the accumulation of lactic acid. But little research has shown whether premature lactate accumulation, caused by lactate injection, will produce similar results. The main aim of this experiment is to study the lactate accumulation and righting response after extensive exercise and lactate injection in average house geckos (*Hemidactylus frenatus*). It is expected that there will be a significant difference between the lactate accumulation and prelactate accumulation.

**Materials and Methods**

*Animal care*

House gecko (*Hemidactylus frenatus*) weighting 1.49-3.00g (N=9, mass 2.16±0.57, mean±S.E.M) were purchased from LLL Reptile Company in Oceanside, California. The geckos were housed in a glass aquarium with bark substrates. The environment was kept between 75-80°F by having a 24-h heat lamp outside of the aquarium and a heat rock inside the aquarium. They were fed 15 crickets three times week and water was provided accordingly. In order to prevent regurgitation of prior meal during
rigorous anaerobic exercises, food was withheld for a 24-h period prior to experimentation and only water was provided.

Training and exercising protocol

One week prior to experimentation, each gecko was individually trained to run on a motor-driven treadmill. At the beginning of the session, each gecko ran while incased in a small Plexiglas box. As fatigue set in, the box was removed and the geckos were stimulated to sprint by gentle prodding of their hind limbs and tail. Overall treadmill speed was continuously adjusted to match each gecko’s sprinting speed. The environment was kept between 75-80°F by a space heater.

During the experimentation session, each gecko was removed from the aquarium and placed in a separate isolated cage for five minutes prior to treadmill run. This was to prevent miss measurement of respiration rate by allowing each the geckos to reach resting respiration rate. After five minute, resting respiration rate was determined by counting the number of time the thorax raised within a one minute interval. Then each gecko was subjected to a sprint session on the treadmill. A stop watch was used to determine the amount of time that it took to reach exhaustion.

Injection protocol

An 80 mM solution of lactic acid that was adjusted to 300 mOsm of NaCl (lactate) solution, and a 0.9% NaCl (saline) solution were mixed in the laboratory prior to injection. Each injection was administered consecutively one day after the first injection or treadmill run (no injection) to allow the adequate breakdown and expulsion of prior solution. Intraperitoneal injection (I.P.) was administered by a 30 gauge (BD Micro-Fine™ IV) insulin syringe. Specific amount of solution was determined according to each gecko’s weight by using equations found in the article: The roles of acidosis and lactate in the behavioral hypothermia of exhausted lizards by Erica Wagner et al, 1998.

During the experimentation session, each gecko was removed from the aquarium and isolated in order to measure respiration rate. Then each gecko was injected with an appropriate amount of solution. After lactate and saline injections each gecko was subjected to a sprint session on the treadmill. Lactate injection was made prior to saline injection.

Righting protocol

As geckos start to show signs of fatigue from the exercise, test for righting response was done by flipping the geckos on their back and observing whether they are able to right themselves on the surface of the treadmill. If they were able to right themselves, the geckos were subjected to further exercise on the treadmill until they were completely exhausted. When the geckos are unable to right themselves on the surface of the treadmill, they were placed on their back into a clear Plexiglas cylinder. While in the cylinder, the time for righting was measure as the cylinder is slowly rotated. After the geckos were able to right themselves, their recovering respiration rate was determined. Righting response was tested following sprinting session with no injection, with lactate injection, and with saline injection. The mass of each gecko was obtained after the sprinting session where no injection was made.

Statistical analyses

Results among the three exercise injection groups were compare with repeated-measures one-way analysis of variance (ANOVA) followed by a paired post-hoc test. Differences were considered significant at P<0.05. All data were expressed as a mean±S.E.M.

Results

Time to exhaustion

Exhaustion in house geckos is caused by lactate accumulation in muscle and blood. It is brought on by maximal activity endured within a specific amount of time. The time it took to reach exhaustion was determined among house geckos that underwent saline injection, lactate injection and no injection (Table 1). No significant difference (repeated-measure ANOVA) was established between the saline injection and no injection groups. But the time to exhaustion was significantly difference (repeated-measure ANOVA) when lactate injection was compare with saline injection and no injection groups (Figure 1).

Time to right

Following exhaustion, house geckos appeared thoroughly fatigued and unresponsive for a specific amount of time. Righting response was determined by the amount of time it took for the house geckos to break down the lactate. The time it took for the geckos to right themselves was determined among house geckos that underwent saline injection, lactate injection and no injections (Table 1). No significant difference (repeated-measure ANOVA) was established in righting response among house geckos that underwent saline injection, lactate injection and no injection (Figure 1).

Change in respiration
Resting respiration rate prior to experimentation was determined and compared with recovering respiration rate subsequent to experimentation. Resting and recovering respiration rates were determined among house geckos that underwent saline injection, lactate injection and no injection (Table 1). No significant difference (repeated-measure ANOVA) was established in the change in respiration rate among house geckos that underwent saline injection, lactate injection and no injection (Figure 1).

Table 1. Table displaying the means±S.E.M values for exhaustion time, righting time, and the change in respiration within the three injection groups. *Statistical significant between saline injection group and lactate injection group. **Statistical significant between non injected group and lactate injection group.

<table>
<thead>
<tr>
<th>Injection</th>
<th>Time to exhaustion</th>
<th>Time to right</th>
<th>∆ Respiration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saline injection</td>
<td>207±26*</td>
<td>40±9</td>
<td>-5±4</td>
</tr>
<tr>
<td>No Injection</td>
<td>222±26**</td>
<td>39±7</td>
<td>-6±6</td>
</tr>
<tr>
<td>Lactate Injection</td>
<td>115±12</td>
<td>41±10</td>
<td>-19±8</td>
</tr>
</tbody>
</table>

Figure 1. Bar graph displaying the means±S.E.M values for exhaustion time, righting time, and the change in respiration within the three injection groups. *Statistical significant between saline injection group and lactate injection group. **Statistical significant between non injected group and lactate injection group.

Discussion

In the time the time it take to reach exhaustion results showed a significant difference was established when the lactate injection group was compare with saline injection and no injection groups. But the result of the righting time showed no significant different among the three groups. Also no significant difference was established in the change in respiration rate among house geckos that underwent saline injection, lactate injection and no injection. However, resting respiration rate prior to experimentation was less than the recovering respiration rate subsequent to experimentation, this lead to a negative drop in respiration rates.

This experiment indicates that rigorous activity by house geckos many involve a degree of anaerobic metabolism and result in the accumulation of lactic acid. The similarity in lactate accumulation between the lactate injection group and the no injection group suggest that anaerobic metabolism makes a significant contribution to daily activity in this lizard. The Anolis bonairensis (Bennett et al., 1980) and Dipsosaurus dorsalis (Bennett and Dawson, 1972) experiments support the association of lactic acid
formation with vigorous activity under field conditions. Although these anoles may undergo significant bouts of anaerobically supported activity, it is not possible on the basis of these observations to quantify their frequency or energetic contribution. The rate of lactic acid turnover and elimination under these circumstances is not known. The lactic acid may have been formed in only a single burst of activity or may be the result of low-level continuous production. Anaerobic metabolism certainly accounts for only a minor proportion of the total daily energy utilization of these lizards. Anaerobic energy utilization, however, permits a behavioral capacity beyond that provided by aerobiosis. Consequently, its importance cannot truly be measured in caloric or temporal terms alone.

**Literature Cited**


METABOLIC MADNESS: HOW ROLLERCOASTERS AFFECT HEART RATE. Adrena Gharibjanians and Melinda B. Tanabe. Dept. of Biology, Saddleback College, Mission Viejo, CA 92691, USA.

*Homo sapiens sapiens* have a metabolism which consists of all the chemical and physical activities within an organism. The metabolic rate can be indirectly associated with the heart rate. As the heart rate increases, more oxygen is delivered to the cells throughout the entire body via blood vessels. Cells can then undergo ATP synthesis to perform all the necessary metabolic activities. In our experiment, fifty males and fifty females between eighteen and thirty were randomly selected in order to determine which gender had a higher metabolic rate after the rollercoaster ride, “Ghostrider,” at Knott’s Berry Farm. The heart rates of each individual were measured before and after the rollercoaster ride, and the weight of all the individuals was recorded. Also, a distinction between smokers and nonsmokers was made among the individuals in the sample. The results showed that the averages resting heart rate in nonsmokers (before the ride) was 75.14 beats/min and was 91 beats/min in smokers. The difference between the resting heart rates in smokers and nonsmokers results from the fact that nicotine increases the heart rate \([p = 5.937 \times 10^{-9}]\) which requires more oxygen. After smoking, carbon monoxide passes into the blood stream. Carbon monoxide then attaches to the oxygen receptor sites, not allowing oxygen to get into the red blood cells. As a result, the heart rate of the smoker increases, becoming generally higher than the heart rate of the nonsmoking individual. The data show that the range of metabolic rate after the rollercoaster ride was higher in men than in women. One of the reasons for this is the presence of androgens, male hormones. This male sex hormone is produced in the testes and is responsible for typical male sexual characteristics. Androgens code for muscles in men, which is why females normally have less muscle than males. Muscles are responsible for most of the body’s metabolic activity; they allow the organisms to produce more ATP, which will lead to the increase in heart rate as more oxygen is consumed. As a result, males have a higher metabolic rate than females.

EFFECTS OF EXERCISE ON RESPIRATION AND PULSE RATE IN HORSES. Kelley Siegert. Department of Physical Therapy. Saddleback College: Mission Viejo, CA, USA.

Twenty horses were studied for the effects of exercise on their respiration and pulse rate, both before and following exercise. Horses were divided into two groups based on age: the young group being less than 15 years, the old group being 15 years or older. All subjects had similar workloads as therapy horses, and are of comparable equivalence in fitness. Respiration and pulse rates were taken before exercise began. Exercise consisted of 20 minutes work on the lunge line, comprised of a 5 minute warm up at walk, 10 minutes of work at the trot and canter, and a 5 minute cool down. Respiration and pulse were taken again immediately following exercise. Results indicated that the older group of horses had a greater change in both respiration and pulse rate following exercise than did the younger group. The younger group had a mean pulse rate of 37.4 beats per minute prior to exercise, and a mean of 40.7 beats following exercise, while the older group moved from a mean of 39.2 to 43.6 following exercise. A t-test showed a critical value of 0.000185, indicating a significant difference in the disparity between the two groups. For respiration, the younger group showed a mean of 10.3 breaths per minute prior to exercise, and a mean of 13.5 breaths post-exercise. The older group jumped from a mean of 11.6 breaths per minute to 15.7 following exercise, a seemingly larger gap than the younger group. A t-test confirmed this postulation by giving a critical value of 0.000149, leading one to believe that this difference in the two group’s changes is also of significance. In conclusion, while horses in the older group did exhibit a greater increase in pulse and respiration rate, both groups showed a marked increase in these rates following exercise. Exercise did have a significant effect on both pulse and respiration rates in young and old horses, resulting in an increase following a work out.
DESERT PLANTS ABILITY TO ADAPT TO HUMID ENVIRONMENTS (*Aloe ferox*). Alex Schenck. Dept. of Biology. Saddleback College, Mission Viejo, CA 92672.

Over millions of years, plants have adapted to their environment. Some plants have adapted so they can live in salt water or live in extreme cold. Desert plants have adapted as well. They do not require a lot of water to survive and can live in extreme heat. The spines of cacti are about the same as a simple leaf, but most of the photosynthesis is carried out by the fleshy green stems. These stems are modified to store water. If a desert plant was exposed to high humidity then the plant should grow and develop much more efficiently than if it was still in its regular dry environment. For this experiment, a large desert succulent plant *Aloe ferox* was split out into three separate plants and placed in three different pots. One plant was exposed to high amounts of humidity; whereas the other plant was not watered at all during the experiment. The third plant was watered every time the soil became dry, which is the recommended watering rate. Data was collected for five weeks. The plant exposed high amounts of humidity had a between Day Seven and the Twenty First Day. After the twenty first the growth slowed down and did not grow much after the third week. The control plant remained constant and only had a slight total growth. The plant exposed to low amounts of humidity didn’t have any significant growth and lost total mass. Desert plants can survive in environments with high humidity for a certain amount of time. Their growth will plateau, when they are completely saturated with water and will not grow until the water already collected is used.

COMPARISON BETWEEN EFFECTS OF DIFFERENT SOIL COMPOSITIONS AND WAVELENGTH OF LIGHT ON *MESCLUN* LETTUCE GROWTH RATE. Kyle Stansifer. Dept. of Biochemistry, Saddleback College, 28000 Marguerite Pkwy., Mission Viejo, CA 92692-3635.

Varying soil compositions as well as wavelength of light have been associated with different germination and growth rates of plants. Ten *Mesclun* lettuce seeds were germinated in each peat moss (control), vermiculite (heat-expanded mica), and common clay soil from Southern California to assess the prediction that vermiculite causes most efficient plant growth due to its composition. Plants were watered and fertilized while vertical heights were recorded for fifteen days. Five days after initial planting, half the seeds in vermiculite and clay soil were placed under red cellophane (670nm) under the prediction that these seeds would grow taller than those under normal sunlight. *Mesclun* lettuce seeds grown in clay soil had the highest average height of 3.62cm under normal sunlight; peat moss was 1.97cm and vermiculite was 3.06cm. Clay had the best results because of its microscopically small mineral particles that allow a greater volume of nutrients and moisture to be available to seeds compared to that of vermiculite, which consists of much larger particles. Under red light of 670nm, seeds in both vermiculite and clay soil grew more rapidly compared to seeds under normal sunlight in the same soils. These results occurred because chlorophyll *a* and *b*’s combined absorption for 670nm is one of the highest within the action spectra, which directly increased photosynthetic rates within the *Mesclun* plants. These data suggest that *Mesclun* lettuce seeds grow most efficiently in clay soil under red light due to excellent moisture control, nutrient consumption, and high photosynthetic rates.
WATER’S ABILITY TO COPY AND MEMORIZE THINGS AFFECTS THE WELLBEING OF THE HUMAN BODY.  Sara Liechty.  Dept. of Biology, Saddleback College, Mission Viejo, CA.

Without water, life could not exist. The human body, for example, is made up of seventy percent water. Just as the entire universe is made up of vibrations, so are water molecules. Water takes on the characteristics of the negative effects of pollution and disease. The human race is constantly being the subject for damage and destruction caused by water. Words and thoughts are also made up of vibrations. In this experiment, the effects of typewritten words on water were studied. The objective was to see how well water copies and memorizes our thoughts, just as it does pollution and disease. Half of these messages were negative, such as “You Fool!” and the other half were positive, such as “Love and Gratitude.” The water from each bottle, which was labeled a certain message for a day, was frozen and then studied under a dissection microscope. Just as snowflake crystals are all different, so were the frozen water samples of each labeled water bottle. The results not only showed differences between each water sample, but also showed similarities. The bottles labeled with the positive messages formed beautiful, clear and defined crystals. The bottles labeled with the negative messages formed more blurred, dark, and unusually shaped crystals. These results showed how words have an effect on water. Since human beings are made up of mostly water, thoughts and words just may have an effect on the wellbeing of the human body.

GROWTH VARIATION IN GRASS GESTATION. Mojisola T. Ogunleye. Dept. of Biology, Saddleback College, 28000 Marguerite Parkway, Mission Viejo, California.

Lawn grasses come in several varieties, which grow at different seasons of the year. The soil and/or fertilizer used on the grass is the determining factor of its quality. The hypothesis states that grass that is grown with fertilizer grows better than without. The grass that was grown was Tall Fescue (*Festuca arundinacea*), which is a deep-rooted, cool season grass. The grass was separated in two groups: group A and group B. Group A grew on my left window sill with fertilizer, and Group B grew on my right window sill without fertilizer (five jars per group). The grass grown with fertilizer performed better (average p= 3.6 inches; group A) than the grass without (average p= 3.4 inches; group B). This small but significant difference, shows that in order to have lush, healthy grass the soil must be nourished with the right fertilizer. I used triple 15, which has equal amounts of sulfur, phosphorus, and nitrogen so that it grew at a quick rate and provided the right amount of nutrients to the grass roots have an effect on water. Since human beings are made up of mostly water, thoughts and words just may have an effect on the wellbeing of the human body.

Chickens have four membranes in each egg that they lay. A main reason for this is to protect the chicken’s offspring from contamination and disease. The hypothesis was that water would be able to diffuse more through the second membrane of a chicken’s egg, called the chorion, than Coke and Sunny Delight. The procedure in this experiment involved adding an acetic acid (vinegar) solution to dissolve the calcium carbonate (that makes up the outer shell of the egg) in order to test the permeability of the chorion membrane. After the outer shell dissolved, nine eggs were placed in water, nine in Coke and the other nine eggs in Sunny Delight for two hours at room temperature (25°C). Before the eggs were placed into the solutions they were weighed in grams to find the mass, and then weighed again after two hours. The differences in the mass conveyed which solutions were able to diffuse through the chorion membrane of the eggs most efficiently. The results showed that the average amount of water passed through the chorion was 2.4097 grams, 1.2473 grams of Coke, and for Sunny Delight 0.6236 grams. There is a statistical significant difference between each solution. This data shows that water is a more diffusible solution because the eggs that were placed in the water were heavier when they came out than the other eggs that were placed in Coke or Sunny Delight. Therefore solutions that are more hypotonic, such as water, are more likely to diffuse into the egg because the inside of the eggs consist of hypertonic solutions.


The *Dionaea muscipula*, also known as the Venus flytrap, like other plants relies on photosynthesis to synthesize organic substances. However, the Venus flytrap is found in regions with sandy, nutrient poor soil. The plant makes up for this lack of nutrients by trapping and digesting insects between its lobes. The different wavelengths of light tested on the *Dionaea* were between 450nm-500nm (blue light), and 650nm-700nm (red light). After exposing separate groups of plants to each specific wavelength over a 24 hour period, the traps were then triggered and timed in seconds. The results show a higher average closing rate within the group exposed to the blue light. The average closing rate measured in degrees per second reached .84 in the plants exposed to blue light, and .41 in the plants exposed to red light. The data recorded supports the idea that the wavelengths between 450nm-500nm are better absorbed by the pigments found within the Venus flytrap, which directly links to the increase in trap closure rate to the plants exposed to the blue light. This is mainly due to a higher absorbance of blue light than red light by *Dionaea*, which will cause the plant to produce more ATP through photosynthesis and cellular respiration. Higher amount of ATP present in the plant will result in a quicker rate of closure. Other possible factors which could affect closing rate are ambient temperature, and condition of the plant.
THE EFFECTS OF MUSIC ON PULSE RATE. Stephanie Eckl and Somara Marino. Dept. of Pre Dental and Biology, Saddleback College, Mission Viejo, CA 92692, USA

The rate at which the heart beats can be measured as pulse rate. This rate can be affected by the autonomic nervous system. Due to stimulation of the autonomic nerves pulse rate can either increase or decrease. This experiment studied how two different kinds of music, classical and heavy metal affect pulse rate. One hundred individuals listened to classical “Air on the G string” by Johann Sebastian Bach for three minutes. After two minutes, radial pulse rates were taken for one minute until the end of three minutes. This was then repeated for the heavy metal music, “Facing What Consumes You” by Hatebreed. Subjects listening to heavy metal music (75.07 ± 0.730 BPM) had a higher pulse rate than classical music (71.04 ± 0.789 BMP). Heavy metal music stimulates the sympathetic nervous system releasing norepinephrine, which increases the pulse rate. The classical music excites the parasympathetic nervous system into releasing acetylcholine thus slowing pulse rate.

EFFECTS OF pH ON OPERCULAR PUMPING RATE OF CARASSIUS AURATUS (GOLDFISH). Wyatt Sum and Ashley Waugh. Department of Microbiology and Biochemistry, Saddleback College 28000 Marguerite Parkway, Mission Viejo, CA 92692.

Acid/base balance is essential to overall health, immune system efficiency, and normal metabolism. Too high or low pH can have a fatal affect on the fish, but within livable conditions we believe that the more acidic or basic the environment will increase the metabolic rate of the fish. This experiment studied the effects of pH on the opercular pumping rate of Carassius auratus (goldfish) within livable environments. The experiment was conducted by first individually counting the opercular pumping rate of ten goldfish at a pH of 7.4 for a period of two minutes for a control. Eight goldfish were then placed in acidic environment of pH 6.4 and their opercular pumping rate was taken individually for a period of two minutes. The same procedure was conducted at a basic environment with pH 8.4. Our results suggest that the opercular pumping rate increased in both acidic and basic environment. The mean pumping rate for acidic, neutral and basic were: 245±56.3, 181±26.8 and 286±68.4 respectively. This rise in metabolic activity might be due to epithelial hyperplasia, which is the swelling of the skin and gills. This swelling reduces the amount oxygen that can be diffused through the gills. As a result respiration must increase to compensate for the lack of oxygen.
PLANT GROWTH IN VARIOUS WATER SOLUTIONS (*Epipremnum aureum*). Virginia Nonaca and Natalie Selstad. Dept. of Biology, Saddleback College, Mission Viejo, CA

Plants growing in fertilized water should grow longer than plants in non-fertilized deionized water. Vines of *Epipremnum aureum* were cut into thirty, 15.24cm stems and placed into three different types of water. Although all contained 3 liters of deionized water (DI), one contained 60/ml of salt and one contained 2/ml of highly concentrated Schultz Liquid Plant Food. Over a four-week period, the stems were placed in an evenly and well-lit, indoor area. The water for all three solutions were changed on the second week as to prevent from contamination from outside factors such as dust, dirt and other pollutants in the air. As the original water solutions were drained, the buckets were once again filled with the original solutions and the stems placed appropriately. The growth and health of the stems in the plain DI water maintained the best (an average increase of 1.55cm. \( \pm 1.61 \) cm) because of the plant’s need to be in moderate rooting conditions. Although the stems in the fertilizer solution did grow at a consistent rate (an average increase of 1cm. \( \pm 0.96 \) cm), their roots did not grow as long or stiff as the stems in the DI solution—an unexpected result. The stems in the salt-water solution not only became increasingly weak and wilted over the four-week period, but the bottom of the stems drowned in the salt became black. Upon measuring the salt-water solution stems on the last week, it was determined that all stems had shrunk an average –0.41cm. \( \pm 8.433 \times 10^{-2} \). It is not necessary to have any extra nutrients when growing the vines in DI water because the overall vitality of the plant maintained better without it.

THE EFFECT OF PERCENT BODY FAT ON RESTING HEART RATE. Dena Fisher and Ashley McDuell. Department of Biology, Saddleback College, 28000 Marguerite Parkway, Mission Viejo, CA 92692-3635 U.S.A.

It is commonly believed that exercise improves cardiovascular function by increasing the pumping efficiency of the heart. In general those who exercise have a lower percent body fat compared to those who do not exercise regularly. Since there is evidence that both low percent body fat and heart rate are positively associated with high levels of exercise, it was predicted that low percent body fat would be positively associated with low heart rate. In the experiment calipers were used to calculate percent body fat on 100 human test subjects of varying levels of fitness. On male subjects measurements were taken from the suprailiac and the subscapula regions, while female subject’s measurements were taken from the suprailiac and tricep regions. Heart rates were measured at the radial pulse for 60 seconds to determine resting heart rate. Test results showed a significant correlation (\( P = 2.24 \times 10^{-4} \)) between low heart rate and low percent body fat. The mean heart rate for test subjects whose percent body fat fell into the category of acceptable, good, or extremely good was 75.06 beats per minute (n=54); while the mean heart rate of test subjects in the overweight and obese categories was 84.00 beats per minute (n=46). These findings indicate that on average overweight and obese individuals have higher heart rates when compared to individuals who are at acceptable, good, or extremely good body fat percentages.
**Effects of Engine Oil and Detergent on the Respiration Rate of Anacharis canadensis.** Gabriel Tran and Jeff Haut. Dept. of Biology and English, Saddleback College, 28000 Marguerite Pkwy, Mission Viejo, CA 92692

The danger of pollution in our world today is very severe, as is seen by the dumping and spills of oil and other substances that are affecting the ecosystem of countless organisms. In this experiment, the effects of oil and laundry detergent on the respiration rate of the aquatic plant elodea (*Anacharis canadensis*) was tested by allowing the plant to respire in a pollutant for twenty minutes, and measured how much sodium hydroxide was needed to change the pH away from acidic to basic. The results showed that while the detergent did not show a significant difference ("controlled" 4.4 ± 1.8, "detergent" 3.1 ± 4.1 drops of NaOH) the oil did show a significant difference in the respiration rates ("controlled" 4.4 ± 1.8, "oil"10.2 ± 18.2, p=.0009 drops of NaOH). The elodea in the detergent did not give any results, possibly because not enough detergent was used to be considered a hazardous pollutant. The findings from the oil elodea were successful because the oil did not mix with the water. The oil lowered the respiration rate by cutting off the O2 flow to the water, thereby reducing the amount of O2 the plant could receive from the water. The results show that if enough pollutants are added to a large body of water, it could cause hazardous damage to aquatic life.

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**THE EFFECTS OF PHOTOSYNTHESIS ON BROCCILI (Brassica oleracea) BY DIFFERENT COLORS OF RADIATION.** Billy Park and Melanie Upstone. Dept. of Biology, Saddleback College, 28000 Marguerite Pkwy, Mission Viejo, CA 92692.

Photosynthesis is the physico-chemical process by which plants use light energy to drive the synthesis of organic compounds. In plants the photosynthetic process results in the release of molecular oxygen and the removal of carbon dioxide from the atmosphere that is used to synthesize carbohydrates (oxygenic photosynthesis). Photosynthesis provides the energy and reduced carbon required for the survival of virtually all life on our planet, as well as the molecular oxygen necessary for the survival of oxygen consuming organisms. In this experiment, the photosynthesis on *Brassica oleracea* was studied to conclude if *Brassica oleracea* covered in red wrapping would sprout more than *Brassica oleracea* covered in green wrapping. The soil surrounding the roots of eight-day old plants was given water on a two-day basis. Three pots with ten *Brassica oleracea* seeds were each covered with a green wrap, red wrap and a clear wrap for the study of photosynthesis. Plant height was measured in centimeters for each plant growth during the next seven days. The results showed there was no significant growth on *Brassica oleracea* between each wrapping. There was no statistical difference, while with the red wrappings; there was a 0.2 centimeters overall growth over the green wrapping. There was no significance difference between the red wrapped, green wrapped and clear wrapped. The main reason for the increase in the red wrapping might be the red absorbs more light at an absorbance of 620 nanometers than the green wrapping because as *Brassica oleracea* undergoes photosynthesis, green light is reflected rather than absorbed.
PHOTOSYNTHETIC RATES OF *Elodea canadensis* AND *Spinacia oleracea* AT VARIOUS WAVELENGTHS. John Phillips and Matthew Davies. Dept. of Biological Sciences and Dept. of Business Administration, Saddleback College, Mission Viejo, CA 92688, United States.

*Elodea canadensis* is a common, freshwater aquatic plant that is placed in many household aquariums and *Spinacia oleracea* is a common terrestrial plant that is consumed by mammals. Each respective plant lives in its own environment, so different wavelengths of light affect each plant differently. *E. canadensis* should absorb red wavelengths of light the best because of the aquatic habitat that it lives in and *S. oleracea* should absorb blue wavelengths of light the best because of its terrestrial habitat. For this experiment, the photosynthetic rates of *E. canadensis* and *S. oleracea* were tested for red, green and blue light by utilizing a manometer set-up. A chlorophyll extract was taken from *E. canadensis* and *S. oleracea* and spectral analysis was performed. For *E. canadensis*, the mean corrected oxygen production for blue light was 0.014 mL/20 min, green light was 0.006 mL/20 min and red light was 0.050 mL/20 min, and for *S. oleracea* the mean corrected oxygen production for blue light was 0.039 mL/20 min, green light was 0.005 mL/20 min and red light was 0.022 mL/20 min. The spectral analysis showed that *S. oleracea* had a mean absorbance of 1.388 at 460 nm, 0.193 at 520 nm and 0.319 at 680 nm. *E. canadensis* had a mean absorbance of 0.796 at 460 nm, 0.151 at 520 nm and 0.189 at 680 nm. *E. canadensis* produced maximum amounts of oxygen under red light because blue light is reflected by the water in which it lives and *S. oleracea* produced maximum amounts of oxygen under blue light because of its water-free, terrestrial environment. *E. canadensis* and *S. oleracea* had similar spectral analysis results due to the fact that they are both green plants that contain chlorophyll a and both plants have xanthophylls which are accessory pigments.


Elimination of a carbon dioxide source and thus inhibition of cellular respiration for a four mm diameter leaflet of *Elodea canadensis* caused an alteration of the cyclotic movement of chloroplasts. Cyclotic movement was recorded by observing chloroplasts at 0 minutes, 10 minutes, 20 minutes, 30 minutes, and 40 minutes following the placement of a leaflet in distilled water on a depression slide covered with a glass cover slip. Three chloroplasts’ speeds were measured inside a single cell for ten different plants yielding a sample size of 30. The average speed of the chloroplasts consisted of 0.01118 microns/sec at 0 minutes, 0.5548 microns/sec at 10 minutes, 0.1092 microns/sec at 20 minutes, 0.1145 microns/sec at 30 minutes, and 0.1026 microns/sec at 40 minutes. There was a significant difference in the speed of the chloroplasts between each group (ANOVA, p= 0.0001). A post-hoc test (Bonferroni correction) showed significance between times zero minutes, ten minutes, and twenty minutes with p< 0.01. One possible explanation for the increase then decrease in cyclotic movement is the differential ATP production by the mitochondria. The inhibition of ATP production eliminates the power source for motor proteins in the cell. Therefore, the results from this experiment suggest a correlation between motor proteins and cyclotic movement.
GERMINATION IN DARK VS. LIGHT ENVIRONMENT (*Phaseolus lunatus*). Dana Bondarenko. Dept. of Nursing, Saddleback College, 28000 Marguerite Pkwy., Mission Viejo, CA 92692

When seeds germinate they need to have certain nutrients to thrive and become a plant. For germination to be successful there needs to be a few factors in place such as sunlight and water. If these factors are missing or are insufficient, the seed will either not grow at all or be very weak. For photosynthesis to occur there needs to be light present. The *Phaseolus lunatus* was placed in a container and put into a light environment and a second sample was placed into a dark environment with the same temporal conditions as the light sample. The average germination for the light sample was 3.5 mm a day. For the dark sample the average germination was 2.2 mm a day. The seeds were also examined for fungal growth. The light sample developed significantly less mold than of the dark sample. In the dark sample every seed was infected with mold. The results show that the rate of germination in the *Phaseolus lunatus* is greater and healthier in the sunlight than of the dark sample. The light sample was in natural sunlight for most of the duration while the dark sample was kept in a dark place with no sunlight present at all.

THE AFFECTS OF VARIOUS SODIUM CHLORIDE SOULTIONS ON GERMINATING POA PRATENSIS SEEDS. Ellyne Dudkowski. Department of Pharmaceutical Chemistry, Saddleback College, 28000 Marguerite Parkway, Mission Viejo, California 92692, USA.

Grass (Poa pratensis) Seeds germinate with sunlight, water, and fertile soil. Germinating seeds are accelerated by various minerals deposits within the soil. Seeds in a lower concentration of sodium chloride water are predicted to germinate quicker than the seeds in a higher concentration of sodium chloride water. Various sodium chloride solutions of zero percent, five percent, ten percent, and fifteen percent were the variables used in this experiment. The sodium chloride concentrations contained twenty-five Poa pratensis Seeds in each container, with a total of one hundred seeds. The seeds were housed in an indoor controlled environment under a hundred and twenty watt Agro Heating Light for eight hours a day during a four week duration. No progress was reported in the first week. The second week yielded the 0% sodium chloride solution (0 germinating seedlings), the 5% sodium chloride solution (3 germinating seedlings), the 10% sodium chloride solution (2 germinating seedlings), and the 15% sodium chloride solution (0 germinating seedling). The third week yielded the 0% sodium chloride solution (5 germinating seedlings), the 5% sodium chloride solution (15 germinating seedlings), the 10% sodium chloride solution (21 germinating seedlings), and the 15% sodium chloride solution (4 germinating seedling). The fourth week yielded 0% sodium chloride solution (17 germinating seedlings), the 5% sodium chloride solution (23 germinating seedlings), the 10% sodium chloride solution (25 germinating seedlings), and the 15% sodium chloride solution (11 germinating seedling). An average of the 0% solution was 5.5 seedlings ± 0.6, the 5% solution was 10.3 seedlings ± 0.6, the 10% was 12.0 seedlings ± 0.6, and the 15% average was 3.8 seedlings ± 0.6. The data proves that low sodium chloride solutions accelerate the time for germination of Poa pratensis Seeds.
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HOW TEMPERATURE AFFECTS THE METABOLIC RATE OF GOLDFISH (Carassius auratus) AND RED GLASS BARBS (Puntius conchooids). Raquel Rosales. Dept. of Veterinary Medicine, Saddleback College, 28000 Marguerite Parkway Mission Viejo CA 92629-3635.

Both Goldfish and Red Glass Barbs are fresh water fish and are both ectotherms having their body temperature vary with the temperature of the water they are in. Goldfish, native to Eastern Asia, can withstand a wide range of temperatures preferring temperatures between 10˚C and 20˚C while the Red Glass Barb, being a tropical fish, does best at a temperature around 20˚C. If the assumption is made that the rate in which their operculum opens and closes is proportional with its metabolic rate, then the increase/decrease of their metabolic rate can be determined with the increase and decrease in temperature. With this in mind the operculum rate of ten goldfish and ten red glass barbs were counted at three different temperatures, about 10˚C higher and lower than at room temperature (around 21˚C) for two minutes. With goldfish the average operculum pumps at the average temperatures of 10.67˚C, 20.29˚C, and 31.63˚C were 114.3, 233.5, and 362.1 operculum pumps respectively. The average operculum pumps for red glass barbs at the average temperatures of 12.23˚C, 22.15˚C, and 32.16˚C were 329.6, 560.2, and 709.2 operculum pumps respectively. In both types of fish the operculum rate decreased with temperature decreased and increased with temperature increase. The increase in operculum rate with the increase in temperature, it can be assumed that the metabolic rate of both types of fish increased and so it can be concluded that with the increase in metabolic rate the enzyme activity and reaction rates increased as well.

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WHICH FRUIT HAS THE MOST DNA? Andrea G. Acosta and Rudy Scalisi. Dept of Biology, Saddleback College, Mission Viejo, CA 92692, United States

The chromosome number a species should determine the quantity of DNA extracted. Comparing bananas (Musa X paradisiaca L.), apples (Mulus sp.), and oranges (Citrus sp.) the fruit generating the greatest amount of DNA is directly related to the amount of chromosomes each fruit has. The chromosome number for bananas is 33, apples are 34 and oranges are 18. In order to test our hypothesis we obtain 50g of each fruit and added a homogenation buffer in a beaker, placed the beaker in a 60˚C water bath for 15 minutes, then let solution drop to 23˚C. The solution was the blended and let stand for 30 minutes, and then strained through cheesecloth. Five milliliters of the strain solution was saved and later added to 3 mL Dische diphenylamine boiled for ten minutes and placed on a spectrophotometer at A600 to quantify the amount of DNA. The remaining solution that was strained had 100 mL of cold ethanol causing any DNA to precipitate. Initially the DNA absorbance samples of apples was 1.895 and the oranges was 1.768 (bananas have not yet been analyzed). However the DNA precipitated from each apple and orange samples suggested that oranges have more DNA. Thus far initial conclusions agree with our hypothesis that the higher the chromosome number the more DNA present.
OPERCULAR PUMPING RATE OF GOLDFISH DEPENDENT ON FOOD. Michael Hinson and Yury Penaloza. Dept of Biology, Saddleback College, Mission Viejo, CA. 92692 United States

The opercular pumping rate of goldfish is the measurement of the operculum opening while the buccal cavity contracts providing a proportional rate of oxygen demand and an indirect measurement of metabolic rate. The opercular pumping rate can be affected by varying factors such as ambient temperature of their environment and high levels of stress. It was predicted that direct consumption of food would increase the opercular pumping rate compared to those whom did not feed. Twenty goldfish were isolated in their own environment; ten were fed twice a day 0.05 g of food while ten were not fed for two days. After allowing a two minute relax time after feeding, the opercular pumping rate was taken for two minutes on all twenty fish. Opercular pumping rates were higher in the fish that were fed (234.8 pumps / 2 min) compared to the fish that were not fed (192.9 pumps / 2 min). There is a statistical difference between the two groups (P(T<=t) two tail = 2.77 E-09.) These differences can be accounted to the fact that the goldfish that were fed had to spend more energy to physically eat the food, to break down the food, and absorption of the food.

ZOOXANTHELLAE RETENTION AND EXPULSION IN ANTHOPLEURA SP. UNDER VARYING LIGHTING CONDITIONS. Rachael A. Calkins. Saddleback College, Mission Viejo, CA 92692

Zooxanthellae are photosynthetic, unicellular, non-motile, planktonic algae classified as dinoflagellates. Zooxanthellae live in mutual symbiosis in the gastrodermis of corals and other invertebrates (chiefly cnidarians). Excess photosynthate produced by the zooxanthellae supplement these invertebrates’ diets (main products include: glycerol, glucose and alanine). However, due to their lighting requirements, their host’s depth can be greatly limited; all currently known species of zooxanthellae are found in waters to 100 meters or less. Many corals, and even clams, are almost completely dependant on these algae for their primary energy source. Conversely, most species of anemones can survive entirely on small organisms caught by a discharge of nematocysts from their outreaching tentacles. It’s common to find healthy colonies of temperate bleached (those without zooxanthellae) solitary anemones in sea caves that receive close to no ambient light. Anthopleura sp. (common to the inter-tidal north-eastern Pacific coastline) was chosen for this research for that principle. Unlike other cnidarians, anemones have extraordinary regenerative abilities, in spite of (apparently) lacking zooxanthellae they can survive and even thrive. The results of this experiment show that the expulsion rate of zooxanthellae by captive Anthopleura sp. is greatly increased under poor lighting. In many cases anemones under ambient room lighting for over one month would contain less than 20% of their original zooxanthellae. Results from this experiment will serve as a model for coral ecology and will provide evidence for reasons behind the bleaching and loss of zooxanthellae in both temperate and tropical corals around the world.
LIPASE INVESTIGATION ON DIFFERENT MILKS. Elaine Tsang and Michelle Tran. Dept. of Biology, Saddleback College, 28000 Marguerite Parkway, Mission Viejo, CA 92692. It was hypothesized that enzyme activity increases with substrate concentration. In this experiment, the activity of lipase was investigated upon different substrate concentrations. Three types of milk (whole fat milk, reduced fat milk and low fat milk) were used as they contained different amounts of fats. The experiment was kept at room temperature (22°C) and the enzyme concentration stayed the same. 10mL of milk, 3mL of sodium carbonate and 5 drops of phenolphthalein were mixed in a test tube. Once the 10mL lipase was added, timing was started and the solution was mixed thoroughly. Timing was stopped when the color changed from pink to white. The entire experiment was carried out 10 times for each type of milk and the average times for the color change to occur were calculated. The results showed that lipase in whole fat milk took the least time for reaction (5.2±1.03s), where in reduced fat milk was a bit longer (15.5±2.80s) and that in low fat milk took the longest time (42.5±4.60s). This was because whole fat milk contained the greatest amount of fat and so they can access the active sites of lipase more frequently. The sodium carbonate made the original solution alkaline (pink). When lipase reacted with lipids in milk, fatty acids and glycerol were produced. The fatty acids neutralized the alkalinity of the solution, so the color changed from pink to white. This proved lipase activity increases with the concentration of the substrate.


The house mouse, (Mus musculus) is generally a very active animal and is known to reach their highest metabolic rates at night. In this experiment, the diets for mice were manipulated and the conversion of energy provided from each nutritional diet was studied. The food trays for each mouse consisted of a specific dry food diet. The control group was given LM Classic Blend Hamster Food that was low in energy with about 12% protein and 4% fat. The experimental group was given Katee Fort-Diet. In this pelleted diet, energy was much higher with 21% protein and 4.5% fat. Energy conversion, the amount of time the mice could run on the wheel, was measured over the next ten days. Mouse weights were taken every morning and running times were collected every night, at the peak of the animal’s metabolic rate. The results showed that the mice with the normal diet, lower in protein, spent a shorter length of time, on average, on the wheel (73.6 ± 9.98 sec) compared to the mice with the higher protein diet (262.3 ± 14.62 sec). The results support the hypothesis that a higher protein diet increases the energy level. The higher the protein, the larger the protein molecule, which takes more energy to process through each mouse and in turn increases the potential energy for metabolic rate.
MOUSE (*Mus musculus*) METABOLISMS IN VARYING LIGHT ENVIRONMENTS.
Stacie Aarsvold. Dept. of Biology, Saddleback College, 28000 Marguerite Pkwy., Mission Viejo, CA 92692.

This experiment tested mice metabolic rates in different light conditions. The hypothesis tested was metabolic rates would be the lowest in the half and half light environment. Ten mice were tested three times. Once after living for one week in a 12 light: 12 dark photoperiod environment where they were exposed to twelve hours of light and twelve hours of darkness every day. They were then tested after living in an environment that was light all the time for one week. They were tested once more after living in an environment that was dark all the time for one week. Mice in the 12L: 12D environment had the lowest metabolic rate (4.1 mls/O₂/gm/hr). There was no difference between the continuous light environment (11.9 mls/O₂/gm/hr) and the continuous dark environment (13.7 mls/O₂/gm/hr). These results support the idea that mice or other nocturnal animals may increase metabolic rate as they could potentially enter a manic state when exposed to unusual light conditions. This also helps to explain changes in behavior and eating habits.

THE EFFECTS OF VARIOUS WAVELENGTHS ON THE PHOTOSYNTHETIC RATE OF *ELODEA*. Ciara Cooper and Natalie Kral. Dept. of Biology, Saddleback College, 28000 Marguerite Pkwy., Mission Viejo, CA 92692, United States

Photosynthesis, the conversion of carbon dioxide and water into glucose and oxygen, is catalyzed by light energy. Different wavelengths of light absorbed by the plant’s pigments greatly alter the photosynthetic rate. In this experiment, the effects of red, green, and blue wavelengths on the photosynthetic rate (oxygen production) of *Elodea* were studied. *Elodeas* were subjected to the various wavelengths for forty-eight hours. The results showed red wavelengths (9.32) with the highest oxygen production, and green (6.48) with the lowest, a significant difference between the two variants (p< 0.05). Pigments prefer red and blue wavelengths over that of green, which is thus reflected, resulting in the green appearance of the *Elodea*. 
THE RELATIONSHIP BETWEEN STIMULANTS FOUND IN RED BULL AND METABOLIC RATES IN MUS MUSCULUS. Terha Trost, Debbie Contreras, and Matt Briskie. Dept. of Biology, Saddleback College, 28000 Marguerite Parkway, Mission Viejo, Ca, 92692-3635, United States.

Organisms self-regulate metabolic rates to maintain homeostasis. The addition of caffeine, taurine and glucuronolaceteone, the key ingredients found in Red Bull energy drink, to an organism’s diet increases the rate of metabolism. Oxygen-carbon dioxide gas exchange is essential for metabolism. Thus, the rate at which this gas exchange occurs correlates to the rate of metabolic reactions. This experiment used a respirator to measure the rate that oxygen was consumed by mice. The control group consisted of ten mice and an experimental group consisted of the same ten mice after proportional amounts of Red Bull were ingested. The experimental group had a higher metabolic rate (10.71 ± 0.5 mls O$_2$/gm/hr) when compared to the control group (6.53 ± 0.5 mls O$_2$/gm/hr). The increase in the rate of oxygen consumption in the presence of Red Bull stimulants occurred in order to comply with the oxygen demanded by the metabolic reactions necessary for the stability of the organism.


The symbiotic relationship that has evolved between angiosperms and hummingbirds was shown experimentally; this study examined if flowers containing a regular supply of nectar, high in sugar concentration, obtain more frequent and longer visits from hummingbirds. Flowers which attract the highest number of pollinators increase their reproductive success by increasing the probability of pollen dispersal. Four identical Gardensong® hummingbird feeders were filled with varying sucrose solutions to 400 ml. The control was filled to 400 ml with tap water, feeder two was filled with a 10% sucrose solution, and feeders 3 and 4 were filled with 20% sucrose solutions. Five drops of red 40 food coloring were added to all four solutions after being brought to a boil for homogeny and allowed to cool. An organic variable was added to feeder 4 containing the 20% sugar solution by daily smearing of flowers from Antirrhinum majus, a flowering plant known to attract hummingbirds. Feeders were set 10 inches apart and 30 minute video recordings were taken daily at 10:00 a.m. for 10 days from 11/15/04 till 11/25/04. Videos were analyzed for the time spent at each feeder along with the number of bill probes into each flower. Seven unique hummingbirds were observed and three different hummingbird species were recorded. Results support hypotheses; (p = 0.042). The mean duration of visits to the control feeder was 3.3 ± 1.99 seconds. The times increased by 53% for the 10% feeder (6.88 ± 1.65 sec) and by 84% for the 20% feeder (20.8 ± 19.9 sec), when compared to the control. Hummingbirds had the longest visits (27.1 ± 14.6 sec) at the 20% feeder with the organic variable, an increase of 88% from the control and a 23% increase when compared to the 20% feeder. Results suggest organic feeders with a 20% sugar solution attract hummingbirds the best. Angiosperms with higher nectar sugar concentrations have a greater potential for reproductive success due to an increased number of visits and duration spent at flowers by hummingbirds upon which pollen can adhere to the birds and be dispersed to other flowers. Hummingbirds need protein as part of their diet from insects; the organic variable may attract insects and hummingbirds by olfactory mechanisms.
REACTION RATES OF YEAST (*SACCHAROMYCES CEREVISIAR*) IN VARYING SUCROSE CONCENTRATIONS.  Adam McAtee and Mike Beck.  Dept. of Biological Science.  Saddleback College, Mission Viejo, California, 92692, USA

The process of yeast (*Saccharomyces cerevisiars*) reacting with sucrose molecules and breaking them down into carbon dioxide gas and ethyl alcohol is one type of alcohol fermentation.  It is our hypothesis that when yeast is added to sucrose solutions at varying concentrations (10%, 20%, and 30%), alcohol fermentation rates (carbon dioxide production in ml/min) will increase.  In this experiment, yeast solutions of constant concentration were introduced into these three varying sucrose concentrations and placed in an incubator at a constant temperature of thirty-seven degrees Celsius, and monitored for a period of thirty minutes.  The mean rates of carbon dioxide at the end of the thirty minutes were 3.37 ± .69 ml for 10% sucrose solution, 3.84 ± .45 ml for 20% sucrose solution, and 4.01 ± 1.12 for 30% sucrose solution.  These results are not significantly different (p = .20).  Therefore fermentation rates do not change significantly when sucrose concentrations change.  One reason for this may be that during the first thirty minutes sucrose is plentiful, and increasing the concentration will not make the yeast react with it any faster.

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The Effects of Light Color on Oxygen Production in Spinach, Red Cabbage and Hosta “abiqua drinking gourd” plants.  Kirby Jacobs,  Department of Biology, Saddleback College, Mission Viejo, CA 92692

Abstract
Photosynthesis is a major part of nature and without it there would be no oxygen left on Earth.  Therefore it is important that we understand why and how it works.  The key component of photosynthesis is chlorophyll a pigment that reflects green light and absorbs red and blue.  In this experiment, the effects blue, green and red light on three different plants, *Spinacia oleracea, Brassica oleracea,* and *Hosta “abiqua drinking gourd,”* were observed.  The air was removed from 10 mm diameter disks and the photosynthetic rate was observed by how many disks regained their air and floated to the surface of the solution.  The results showed that leaf color had little effect on the pigments used in photosynthesis.  Research showed that the pigments that give leaves a color other than green are accessory pigments that absorb light that is then passed on to be used in photosynthesis.