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## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greetings From Your President</td>
<td>........................................ 4</td>
<td>Philip Tate</td>
</tr>
<tr>
<td>HAPS 2005—St. Louis, MO</td>
<td>........................................ 6</td>
<td>Lucia Tranel</td>
</tr>
<tr>
<td>EDU-Snippets</td>
<td>Practically Practical EDU-Snippets</td>
<td>Roberta Meehan and Richard Faircloth, Ph.D.</td>
</tr>
<tr>
<td>Flavor for Your Classroom</td>
<td>New Light of Retin-A as a Topical Treatment for Photodamaged Skin</td>
<td>Sarah Cooper</td>
</tr>
<tr>
<td></td>
<td>Stem Cells and Cloning: What Does it Mean to Be Human?</td>
<td>Joseph D. Gar</td>
</tr>
<tr>
<td>Teaching Tips</td>
<td>A Method to Mimic Short-Answer/Essay Style Test Questions in A&amp;P Within</td>
<td>J. Russell Butler, Ph.D.</td>
</tr>
<tr>
<td></td>
<td>An Objective Test Framework</td>
<td>Gail Jenkins</td>
</tr>
<tr>
<td></td>
<td>Awarding Student Creativity in Anatomy and Physiology Courses</td>
<td>Murray Jensen</td>
</tr>
<tr>
<td></td>
<td>Observation of Decomposition of Rat Carcasses in Different Environments</td>
<td>Laura Keller and Sarah Cooper</td>
</tr>
</tbody>
</table>

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Thanks to Dr. Murry Jensen for his students’ art that appears on the cover as well as on page 17. See also Dr. Jensen’s article on student art on page 17.
HAPS-EDucator is the official publication of the Human Anatomy and Physiology Society (HAPS) and is published four times per year. Major goals of the Human Anatomy and Physiology Society are: to promote communication among teachers of human anatomy and physiology in colleges, universities, and related institutions; to present workshops and conferences, both regional and national, where members can obtain information about the latest developments in the health and science fields; and to encourage educational research and publication by HAPS members. HAPS was established in 1989.

Annual membership dues are $50 for full time faculty, and $35 for part-time and retired faculty. Annual membership renewals shall be due on January 1, April 1, July 1, or October 1. New members shall renew on whichever date most closely follows the date of their initial membership. HAPS Hotline: (800) 448-HAPS (4277). Information on membership, meetings, and more! Send correspondence to: HAPS, 8000 Bonhomme, Suite 412, St. Louis, MO 63105. Check out our new webpage at: http://www.hapsweb.org/

SUBMISSIONS TO HAPS-EDucator

Papers for publication, requests for information, positions available and wanted, and letters to the editor are welcome. Articles may be submitted to the editor by e-mail attachment as Microsoft Word or Word Perfect file or on 3.5” double density disks—please include a hard copy as a backup. If references are included, please follow the methods suggested in Scientific Style and Format: The CBE Manual for Authors, Editors, and Publishers. 6th Edition, Style Manual Committee (Council of Biology Editors) Cambridge, Cambridge University Press. 1994.

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DEADLINES FOR SUBMITTING MATERIAL TO HAPS-EDucator: April 15 (Summer issue); August 1 (Fall issue); November 1 (Winter issue); February 1 (Spring issue).

CONTACT THE HAPS-EDucator Editor: Susan Baxley, Troy University, Montgomery Campus, College of Arts & Sciences, P.O. Drawer 4419, Montgomery, AL 36103-4419, (334) 241-5473, (334) 241-8665 fax. sbaxley@troy.edu
This will be my last “Greetings From Your President” for the HAPS-EDucator. Like taxes, this article due on April 15th. So it is rather peculiar timing. My term as President is not over for another two and a half months from the date of my writing, yet here I am writing for the Summer issue. This juxtaposition of having to write about the last few months and the next few months is an opportunity to reflect on past progress and future goals.

HAPS has joined with the American Association of Anatomists (AAA) and the American Association of Clinical Anatomists (AACA) to form the Coalition of American Societies for Anatomy (CASA). The CASA Task Force on the Use of Human Materials will meet for the first time this summer. Also, AAA has made available to HAPS members a special electronic membership in AAA, and AACA is offering HAPS colleagues reduced registration fees for their conferences.

There have been several changes in HAPS committees. The Partners Association Committee was created to foster better communications between HAPS and other related organizations. The responsibilities of the Membership Committee will be expanded from membership recruitment to also include membership service and retention. The Steering Committee will separate from the Board of Directors (BOD) and have a committee chair, allowing the Steering Committee to work independently of the BOD on short and long term planning for the Society. The Core Curriculum Committee will become the Curriculum and Instruction Committee to emphasize the teaching concerns of HAPS.

The foundation for the organization and functioning of HAPS is our Constitution, Bylaws, and Policies and Procedures (P&P) Manual. The Board of Directors and the committee chairs have been working on revisions of these important documents. The voting to ratify the revised Constitution and Bylaws will occur at the Annual General Meeting in Calgary. Work on the P&P will continue this summer and fall with the goal of BOD approval at the 2005 January meeting.

So that the membership can know the activities of the BOD, the minutes of BOD meetings will soon posted on our Web site under HAPS Governance. The BOD relies upon committee reports during these meetings. The committees’ reports have been combined into one document and placed on our Web site.

The HAPS web site has seen change with online membership registration, the ability to conduct surveys, electronic access to past issues of the HAPS-EDucator, and the addition of a cadaver laboratory design document. Links to data acquisition equipment, distance learning resources, and other related organizations have been added and the HAPS list server was transferred from Imperial Valley Community College’s computer to our own computer provider.

The BOD has implemented several measures to save money. We have increased the use of email to promote transfer of rapid communication and reduce printing and mailing costs. This spring, letters from the Regional Directors went to all the members in their respective regions who have listed email addresses. We are investigating conducting future officer elections via electronic polling. Another cost savings measure was moving the abstracts for update seminars and workshop presentations from the mailed conference registration materials to our Web site.

On the conference scene, there have been three regional conferences this fall and spring: the Northeast Regional Conference hosted by Judy Osborn, the Western Regional Conference hosted by Tom Lehman, and the Midwest Regional Conference hosted by Mike Timmons and Sam Chen. The 18th Annual Conference Committee, chaired by Izak Paul, and our Marketing Manager, Donna White, are working hard on what promises to be a successful and profitable conference at Calgary, Alberta, Canada.

Just this brief overview of highlights shows that the HAPS organization is busy. Many activities are going on to support the HAPS mission of “Promoting Excellence in the Teaching of Human Anatomy and Physiology.” As I think about the future, I am wondering how technology and distance learning will fit into the HAPS mission. Since I first started teaching, we have gone from an era in which computers were used to do work to one in which computers are used to teach. Advances in computers and software have produced an affordable technology that is useful for effective teaching. Many of us are now using this technology in varying degrees in our courses, and this use is likely to increase.

Distance learning, of course, is not a new concept. But, computer technology, software, and the Internet have produced something never before seen. Many colleges and universities are offering courses that are taught partially or completely on the Internet. It is even possible to complete all of the course work necessary for a baccalaureate degree over the Internet.

As Internet distance learning was developing, it met with some resistance. In the anatomy and physiology arena, for example, some thought that Internet distance learning could not replace the

Philip Tate, HAPS President
traditional activities found in the laboratory, such as dissection, the handling of models, or the manipulation of equipment. It is not my intent to rekindle arguments about the suitability of Internet distance learning. I believe that HAPS instructors who are teaching using distance learning. I encourage them to share with us their experiences and perspectives, perhaps an article for the HAPS-EDucator or a conference workshop. Please read the HAPS position statements on Distance Learning and the HAPS Course Guidelines for Undergraduate Instruction of Human Anatomy and Physiology, which has details on lab instruction. (To see these documents, go to the Members’ Area of the HAPS Web site.) Do you agree or disagree with these position statements? What can we as a Society do to establish standards or goals? Please share your thoughts with the Curriculum and Instruction Committee, or better yet, join the committee.

Serving as your President has been quite an experience, much work, and rewarding in so many ways. It has truly been an honor. It has also been a pleasure to work closely with so many dedicated HAPS colleagues. HAPS would not exist without the contributions of our Board of Directors, committee chairpersons, committee members, HAPS Headquarters staff, and volunteers. I thank each and every one of them for the help they have provided to me and to HAPS. In particular, I can’t imagine having been President without the support, encouragement, and constructive criticism of the other members of the Executive Committee, Gail Jenkins, Sandy Lewis, and Mike Glasgow. Working together as a team has formed bonds of friendship that will last a lifetime.

As I look toward the meeting in Calgary and the end of my term, I remember how happy Mike Glasgow was when he handed the gavel to me at the Annual General Meeting in Philadelphia. As he assumed the mantle of Past President, and I began my term as President, I wondered, “Why did Mike look so happy?” According to a Taoist saying, “Those who speak, do not know. Those who know, do not speak.”

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$ HAPS Grants and Scholarships $

The HAPS Board of Directors has awarded the following grants and scholarships for 2004.

**Faculty Grant Recipient 2004**

Chaya Gopalan, St. Louis Community College,

“Research Techniques in Biology Courses to Facilitate the Understanding and Exploration of Anatomical and Physiological Relationships”

**Robert Anthony Scholarship Recipients 2004**

Ken Hoekstra, Langara College, Vancouver, BC

Muffie Slater, Elgin Community College, Elgin, IL

Sherry Stewart, Navarro College, Corsicana, TX.

(Previously announced)

$ Call for Proposals 2005 $ 

Any questions regarding grants and scholarships contact the 2005 HAPS Grants and Scholarship Committee Chair: Dr. Richard Faircloth at (410)-777-2272 or e-mail at Rfaircloth@aacc.edu

The 2005 Call for Proposals and applications will be available at www.hapsweb.org after July 1, 2004

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HAPS 2005

Make Your Plans to Explore St. Louis in 2005

- St. Louis skyline and the Arch
- The historical Union Station—once a railroad station, now a great place to shop
- A Lewis and Clark collage; see the exhibit at the Lewis and Clark museum
- The Metrolink Light Rail stop; use the Metrolink to get around in St. Louis
II. Nervously Practical

Pat Bowne (Alverno College, Wisconsin, Pat.Bowne@alverno.edu) sent us a great idea for demonstrating some of the characteristics of neurotransmitters.

To demonstrate how neurotransmitter actions depend on receptor subtype and can be affected by drugs, you need several student volunteers, several lidded coffee cups or mugs of different styles, and nerf or tennis balls of two different colors that will fit into the coffee cups.

The students are the cells, and each of them has a neurotransmitter receptor (the coffee mug, without its lid). Since the coffee mugs are of different types, they represent different subclasses of receptors and make the students respond differently when you put the neurotransmitter (one color of tennis balls) into the mugs. You can let students make up their own responses or assign them cell types and label the receptors, making them figure out from their books what their responses ought to be.

If the person in which these cells are living does not have enough neurotransmitter, that means not all the students get tennis balls put them into their coffee mugs; therefore, some will not respond. You would treat this person by administering an agonist (the other color of tennis balls). Then all the ‘cells’ would be stimulated and able to respond. If the person makes too much neurotransmitter so that the cells are over-stimulated, you can treat with an antagonist; either a competitive drug (put something like a wad of paper into the coffee mug) or a receptor blocker (put the lid on the coffee mug). Because the mugs are of different styles, a lid will only fit one type of mug, and this demonstrates how you can have blockers for specific subtypes of receptors.

III. Melodically Practical

David Evans (Penn College, Pennsylvania State University, devans@ptc.edu) sent us numerous neural mnemonics of the constant consonant variety.

Three c’s: corpus colossum connects (cerebral hemispheres)
More c’s: cerebral cortex consciousness

A few cerebral lobe association centers:
1. frontal is for fiddlin’ and feelin’ (conscious motor control and control of emotions)
2. temporal is for tunes (primary auditory)
3. parietal is for pressure and palate (primary somesthetic and gustatory areas)
4. occipital is for optics (primary visual)

The three F’s and an R of the limbic system: food, flight, fight, and reproduction

Meanwhile, Robert Rawding (Gannon University, Pennsylvania, rawding001@gannon.edu) was busy going hand and foot with mnemonics. And so he shared….

Hand (wrist, actually): “Some Lovers Try Positions That They Can’t Handle” (Scaphoid, Lunate, Triquetral, Pisiform, Trapezium, Trapezoid, Capitate, Hamate)
Foot: “MILC? No Thanks Cow” (Medial, Intermediate, Lateral Cuneiforms, Cuboid, Navicular, Talus, Calcaneus)

III. Those Practical Rubber Bands

Ken Saladin (Georgia College & State University, ksaladin@altele.net), who is never at a loss for a wonderfully simple and effective idea, gave us a very practical way to demonstrate isometric and isotonic contractions.

One way to demonstrate this is to have a weight of about 500-1,000 g suspended from a rubber band. Set the weight on the table and lift it with the rubber band. At first there is a stretching of the rubber band (like the series-elastic components in vivo) with no movement of the weight, then the weight begins to rise from the table. This demonstration may help students visualize what is going on in vivo.
IV. Paper Practicals

Simple paper—with an occasional piece of tape and a marker—can do wonders for showing students how or why certain structures are the way they are.

A. The Heart of the Matter

Mildred Galliher (Cochise College, Arizona, gallihem@cochise.edu) described an oldie-but-goodie technique for explaining the heart valves.

I seem to recall that a lab exercise we used to use (about 30 years ago) had the students take three sheets of notebook paper and hold them together in a ring (to represent the three flaps below the right AV orifice). Other group members would then push the paper flaps toward the center (from below) to demonstrate the closing of the right valve. No matter how hard they pushed, a small opening seemed to remain. When they used two sheets of paper to represent the bicuspid valve, it was easy to get complete closure (no gap). The punch line was that the 2-flap valve seemed to be more efficient. Of course, this did not take into account either pressure or crescent (left) vs. circular (right) “deformities” during the pumping cycle.

(We think this could definitely launch an interesting discussion, particularly if the instructor were ready to throw in some of the physiological concerns—such as pressure, volume, shape, heart disease, and physical condition. RM/RF)

B. The Ectodermal Neural Tube

Roberta Meehan (Troy University, Montgomery Campus, Alabama, biology@ctos.com) added a few of her own issue.

Here is a simple way to demonstrate that the nervous system is ectodermal in origin. I take a piece of paper and tape it so as to form a cylinder. I usually add a staple for good measure. I tell the students that this is the primitive body tube. The outside is the ectoderm. I then hold the tube with both hands and pinch it in longitudinally so it forms a tube within a tube. This inner tube, I tell them, is the neural tube, which will give rise to the brain and spinal cord. I ask them if it now makes sense how the nervous system could be of ectodermal origin.

C. Tracheal and Esophageal Paper

Another one from Roberta.

I use paper tubes to demonstrate the trachea and esophagus. I make two tubes (longitudinal paper) before class but do not stick them together until the demonstration. I draw a series of “C Rings” with black markers on one of the tubes, making them dark enough for everyone to see. This is the “trachea.” I then take a post-it note (or whatever other kind of paper I have around) and put it on the anterior of the “trachea.” This is the “epiglottis.” First I ask why I only drew the “C Rings” about 3/4 of the way around the trachea. When they figure out why that might be important, I take the other tube, the “esophagus,” and stick it on the posterior of the “trachea.” (Remember to bring paper clips to hold the “trachea” and “esophagus” together.) Once I have my system in order, I can demonstrate the need for the “C-Rings” as well as for the need for their open side. I can also demonstrate the functioning of the epiglottis as food crosses over the opening to the trachea, as well as the functioning of the trachea when the esophagus is not in use.

V. Practically Homeostatic

One last one from Roberta! This is a modified version of a problem I have used in different forms for quite a few years to sum up the homeostatic mechanisms of the body.

Phredd, a moderately out of shape man, lives at approximately sea level and has not been out of the area in more than a year. Phredd has some time off so he decides to go hiking in the Rockies. Phredd flies to Denver, picks up his rental car, and heads for Mt. Evans (elevation 14,000+ ft.), stopping first to buy a 12-pack of beer, several bags of pretzels and chips, and a half dozen ham and cheese sandwiches.

Phredd stops at a rest area, drinks two beers, and eats some chips and one of the sandwiches. He puts the rest of the food and drink in his backpack.

At the base of Mt. Evans, Phredd, drinks a couple of more beers, eats a few more “things” from his cache, and sets out for his climb up the mountain.

Phredd stops several times along the way to drink some more beer and eat some more from his goodie bag.

By some gift of fate, Phredd does reach the top of Mt. Evans. His beer and snacks have all been consumed. He collapses and, fortunately, a ranger is there who promptly calls for an airlift.

The major problems Phredd has faced are: oxygen deprivation, vascular insufficiency, sodium/potassium imbalance (which can have an effect on which systems??), renal difficulties, neuromuscular difficulties, endocrine difficulties, integumentary problems, and dehydration.

1. What OTHER difficulties or systemic problems do you see? Consider mountain sickness.
2. Aside from Phredd’s utter stupidity, what is the cause of each of these problems?
3. Look at each of the systems of Phredd’s body and explain what is happening? Why?
4. How is Phredd’s body trying to compensate for each deficiency? How are checks and balances countering each other?
5. What, in particular, are aldosterone and ADH doing?
6. What about the hydrogen/bicarbonate action—renal and respiratory?
7. Assume Phredd is not dead by the time the evacuation unit gets there. What are the paramedics going to do? Why?
8. Phredd does not need a lecture on being an idiot. He has figured that part out. How would you educate him on getting ready for his next hike up Mt. Evans?

VI. And We Hope You Will…. Keep those cards and letters coming! We thank you all for your EDU-Snippet contributions. The next deadline for us is August 1, 2004. Submit your ideas now and maybe you too will see your EDU-Snippet in print!
A previous article on the use of Retin-A™ (topical tretinoin) for the treatment of sun damaged skin, described evidence that Retin-A™ was an effective agent for increasing the mitotic activity of surface skin cells, increasing the turnover of follicular epithelial cells, which was of interest primarily in the treatment of acne, and increasing the amount of collagen in the reticular layer of the dermis. However, the mode of action for tretinoin was unknown. A great deal has now been learned about the structural and molecular changes that can be induced by Retin-A™ that account for the numerous clinical benefits achieved by this agent. In this article, I would like to take a new look at topical tretinoin, its place in skin treatment today, and its mode of action.

The role of long-term exposure to the ultraviolet rays of the sun in skin damage is well-documented. Both UVA and UVB have been implicated in producing chronic cumulative changes in skin. In addition, chronological aging can damage skin. Most dermatologists believe that photo-aging does more damage than chronological aging. For the most part sun damaged skin, which typically displays deep wrinkles, and thickening and cracking of the stratum corneum with accompanying flaking and scaling, is seen superimposed over the sagging and fine wrinkling associated with chronological aging.

Benign epidermal growths such as seborrheic keratoses (scaling plaques), precancerous actinic (from sun damage) keratoses, and the more serious basal cell, squamous cell, and melanoma skin cancers, have been linked in many studies to long term exposure to ultraviolet radiation. A major skin alteration seen in histological examination of tissue is the accumulation of elastic fibers in the papillary region of the dermis, a condition known as solar elastosis. It is believed that solar elastosis gradually replaces normal collagen tissue in the papillary region. This greatly changes the architecture of sun damaged skin over time.

The most serious photodamage is believed to result from direct damage to the DNA of skin cells. The response to this damage is pyrimidine dimers that can cause a variety of mutations in sun damaged skin. Following chronic exposure to UV light, changes may be seen in the elastin, collagen, papillary dermis, reticular dermis, and lymphocytes of the skin. Elastin tends to completely degenerate into amorphous masses, and these thickened, ineffective masses of elastin fibers proliferate in the dermis. There is a marked decrease in both collagen fibers and collagen bundles in the dermis.

In the papillary region of the dermis, there is a loss of small blood vessels, which are replaced by abnormal, highly visible capillaries known as telangiectatic capillaries. Fibroblasts and mast cells increase in the reticular region of the dermis, an increase in chronic inflammation is evidenced by an increase in cellularity in that region. The number of lymphocytes and Langerhans cells in the dermis is markedly decreased.

There are many topical preparations on the market today for the treatment of skin damaged by the environment, e.g., ultraviolet radiation, smoking, wind and chemical exposure, and skin damaged by chronological aging. These treatments include the retinoids, derivatives of vitamin A (i.e., Retin-A™), which are the most studied group and the most commonly used series of treatments for photodamaged skin. In 1996, the Food and Drug Administration approved Renova™, which is an emollient form of tretinoin, specifically for the treatment of the aging face. Glycolic acid and lactic acid are the alpha-hydroxy acids most commonly found in skin treatment products. Salicylic acid, a beta-hydroxy acid, is currently under investigation to determine its overall effectiveness in skin treatment. Other agents being studied include vitamin C, vitamin K, and topical hormone treatments.

A closer look at the most recent studies of tretinoin shows both clinical and histological evidence that some of the effects of photo-damage in skin can be reversed with this product. Among the structural improvements are normalization of the atypical cells of the epidermis including increased numbers of mitochondria, ribosomes, and endoplasmic reticula. The studies also noted are enhanced survival of keratinocytes, effects of anti-inflammation, deposition of new dermal collagen and, very importantly, formation of new blood vessels. This formation of new blood vessels not only improves the color of aging or damaged skin but also improves the flow of nutrients to the treated skin, giving it a much needed boost in the repair process. Stimulation of epidermal cell turnover causes keratinocytes to be more quickly removed from the stratum corneum, which improves the texture of the skin surface. Accumulated melanin in the basal layer, which causes “old age spots” is transported and shed, which tends to even out the overall pigmentation of the skin.

The history of tretinoin is an interesting one. In the late 1960’s researchers at the University of Pennsylvania discovered that
Flavor - continued from page 9

tretinoin was useful in treating acne. However because the early formulations of tretinoin were fairly irritating and had a lightening effect on darker skin tones. Thus dermatologists did not initially accept tretinoin. It was not until the 1970’s that the potential for treatment of photo-damaged skin with tretinoin was recognized and investigation into this possibility got underway. One factor that prompted research in this area was that female patients being treated with tretinoin for acne were indicating to doctors that their skin looked better overall (i.e. smoother and less wrinkled with less blotchiness) as their acne improved.  

In 1986, Dr. A.M. Kligman and his associates at the University of Pennsylvania released the first results of their studies on photodamaged skin. These studies demonstrated that topical tretinoin could produce a smoother, less wrinkled and less pigmented appearance to the skin after only a few months of treatment. These original studies were not controlled, but did include a great deal of histological evidence to document their claims. Since that time many controlled clinical and histological studies have been done that have confirmed and extended the original studies. The results of these studies culminated in the historic FDA decision to approve tretinoin for treatment of aging skin in addition to its use as an acne treatment product.  

Today we know that retinoids such as tretinoin can regulate genes in two distinct ways by means of well-documented retinoid receptors in cell nuclei. Two classes of receptors have been identified so far: retinoic acid receptors (RARs) and retinoid X receptors (RXRs). RARs bind both all-trans-retinoic acid and 9-cis-retinoic acid (two clinically useful retinoids), whereas RXRs bind 9-cis-retinoic acid but not all-trans-retinoic acid. The distinction is important in the formulation of synthetic retinoids since the response to retinoids depends on the type of receptor that is targeted by the treatment agent. Cellular response is thought to be very complex, most probably the result of a cascade of gene activation. Since their discovery, the nuclear receptors for retinoids have been grouped together with steroid hormone receptors on the basis of their similar mechanism of action. One way that retinoids regulate genes is to activate transcription by binding to ligand-dependent retinoid receptors. Binding of the retinoid causes a shape change which exposes a DNA binding site on the receptor. The activated receptor then controls cell function by stimulating the expression of specific genes. Alternately, retinoids can suppress other transcription factors.  

This knowledge, though far from being completely researched, is an area of investigation today, not only for skin care treatments but also for cancer research. For instance, some of the skin damage caused by UV light results in the breakdown of collagen in the dermis, which is followed by the tissue’s imperfect attempt at repair. Ultraviolet light activates a series of phosphokinases which, in turn, activate c-Fos and c-Jun genes that activate the AP-1 transcription factor. AP-1 then causes the activation of several proteinases including collagenase, gelatinase, and stromatolysis, all of which contribute to the breakdown of collagen. Recent research indicates that tretinoin results in a 70% inhibition of AP-1 binding to DNA resulting in there is a significant reduction in proteinase activation. Based on this evidence, it is thought that tretinoin may actually be able to reduce photodamage to skin as well as to enhance tissue repair.  

With respect to photodamaged skin, the most severely damaged skin (rough scaling surface and mottled appearance) appears to display the greatest improvement following to tretinoin treatment. Greatest clinical improvement is also related to the concentration and frequency of tretinoin used. Topical formulations of tretinoin are available, by prescription only, in strengths of 0.025%, 0.05%, and 0.1% Renova®. The treatment approved by the FDA for the treatment of aging skin is a 0.05% emollient cream which seems to be well tolerated by users and is preferred by most users. Sometimes treatment is started at the lowest possible dose until the person’s skin adjusts, and then concentrations are increased to the highest tolerated dose for that person.  

The product insert indicates that sensitive individuals may experience some skin redness, swelling, or temporary crusting. However, the clinical response does not correlate with the magnitude of skin irritation that takes place with the treatment, which means that the improvement is not just a result of chronic irritation of the skin surface.  

People who use tretinoin for damaged skin can usually expect to see smoothing of surface roughness in one to two weeks. The skin takes on a rosy glow, as a result of new blood vessel formation, in 4 to 6 weeks. Old age spots typically begin to fade in 4 to 8 weeks of treatment. Fine lines and wrinkles diminish after about 4 months of treatment. Some of these changes may persist for up to 4 years. Long-term benefits generally require continued longer-term treatment.  

In addition, Dr. Kligman found that pairing tretinoin with alpha hydroxy acids seemed to boost its effectiveness. His research indicated that the two products, applied at different times of the day, produced greater benefits than the use of tretinoin alone at night, while not increasing the side effects. The two products used together appeared to effectively target the early signs of skin aging such as fine lines and uneven pigmentation. Generally priced in the $100 range for a 45-gram tube, tretinoin is not an inexpensive treatment. Most health insurance does not cover tretinoin for people over the age of thirty-five when the effectiveness of tretinoin for the treatment of acne generally declines and people of a certain age begin to request it for its “anti-wrinkle” benefits.  

Many of the histological markers of photodamaged skin have been identified. The major histological changes that occur in skin as a result of tretinoin treatment appear to be specific and directed at restoring skin structure and function. The most rapid clinical improvement is usually seen in the first six to twelve months. Most plastic surgeons agree that treatment needs to be continuous for the best results to be achieved and maintained.  

References  


1 HAPS-EDucator - Summer 2004 - page 10
New technologies have given us never before seen powers of intervention in human life and the environment, powers so immense that regulation and supervision are needed, in both research and in the utilization of research results. From the beginning of the use of new technologies, an important point of discussion has been the concept of the quality of life, focusing on the problems that modern medicine and biotechnology must solve in order to grant the highest health standards to the largest possible number of people. Some of the main issues concerning the boundaries of life are: the status of an embryo, human cloning, genetic trials on humans, artificial fertilization, contraception, sterilization, abortion, euthanasia, organ transplantation, and suicide. There is a strong difference of opinion between those who hold various bioethical perspectives. On the one hand, there are those claiming individual autonomy as supreme, and, on the other hand, those stressing the existence of changeless and universal laws in human nature, laws that must be recognized and observed in order to promote both individual and common good. This review article explores the debate on stem cell research and cloning, the positive and negative consequences of the research, and the ethical issues presented by the research.

Embryonic stem cells, found within embryos prior to implantation, have the potential to create tissues that can be given to patients whose own tissues are missing or diseased. The possibility of using embryonic stem cells for cell-replacement therapy in diseases like diabetes mellitus is under investigation. Stem cells from a number of different lineages are being used for research to see how these therapies can be accomplished.

There has been concern by some on how stem cells are obtained for such scientific research. Since deriving stem cells from early embryos in the blastocyst stage (about 14 days old) implies that the embryos are destroyed, the use of human embryonic stem cells has created fierce debate.

Generically, stem cells are immature cells that develop into the mature, differentiated cells to make up the adult body. Fertilized eggs are the ultimate totipotent cells capable of producing all cell types. It can be argued that animal development is a progressive loss of totipotency (cells that can give rise to a new individual if provided with appropriate maternal support), followed by pluripotency (cells capable of giving rise to all tissues of the body plus many of the cells that support pregnancy but are unable to produce a new individual on their own), and finally differentiation into specific cell types. Embryonic stem cells are pluripotent whereas trophoblast stem cells can differentiate only into the trophoblast lineage. It is now possible to coax blood stem cells and neural stem cells to become some other types of mature cells. A stem cell continues to grow and proliferate, maintaining a pool of cells for possible use, and given the correct signals, a stem cell can differentiate into a particular specialized cell type.

Recent studies suggest that tissue-specific stem cells can differentiate into cell lineages other than the tissue of origin, and mesenchymal stem cells derived from adult marrow have been shown to proliferate extensively without loss of differentiation potential. Thus, they may be an ideal cell source for therapy of inherited or degenerative diseases. It has also been shown that a substantial number of organ fibroblasts appear through a novel reversal in the direction of epithelial cell fate, highlighting the potential plasticity (ability of an adult stem cell from one tissue to generate the specialized cell type or types of another tissue) of differentiated cells in adult tissues under pathologic conditions.
Flavor - continued from page 11

Parkinsonism is a condition caused by the loss of midbrain neurons that synthesize dopamine. Research has shown that embryonic stem cells proliferate extensively and are capable of generating dopamine neurons, an encouraging result for cell-replacement therapy for Parkinsonism.8

Few recent scientific advances have provoked such all-around discussions among scientists and the general public as the topic of human cloning. The theoretical process of cloning is fairly straightforward. Cloning of mammals from adult somatic cells has been done in mice, sheep, cattle, and pigs. In cloning, genetic material from an individual is obtained and inserted into an ovum from which the genetic material has been removed, and that ovum, behaving like a fertilized egg, could develop, when implanted into a womb, into an individual with the exact genetic makeup as the individual from which the genetic material was obtained—a clone.3

In other words, a nucleus from a mature cell is transferred into the cytoplasm of an enucleated egg and becomes reprogrammed to execute embryogenesis again.4 When actually carried out, cloning has many problems, and its overall success rate has been quite low due to high losses during embryonic and fetal development.4 Currently, much of the research effort surrounding somatic cell cloning is directed towards trying to improve the rate of production of live clones, although such efforts have met with little success so far. The thinking is that incomplete epigenetic reprogramming of the somatic nucleus may be the cause of developmental failure of cloned animals thus far.11 It is thought that cloning mammals from differentiated somatic cells requires the erasure or reprogramming of epigenetic imprints that “mark” the DNA, thereby rendering the somatic nucleus totipotent.11

The most commonly used definition of cloning is reproduction of an entire organism, although the term simply means to make an identical copy.12 Proponents of reproductive or live-birth cloning propose using this type of cloning to help infertile couples have a child, or to reproduce a child who has died, whereas those in favor of therapeutic or experimental cloning propose using clones for harvesting organs. In the stem cell and cloning debates, bioethical considerations are a critical factor in the struggle to decide the right paths to take in the uses of these new discoveries.3 The real root of the debates about stem cells, embryos, and cloning research is the question of the moral status of the human embryo.12 At one end of the spectrum is the view that from conception the embryo is fully a person with all the rights any person has, most notably the right to life. At the other end of the spectrum is the view that the early embryo is simply a cellular mass which demands little, if anything, of us morally.

An embryo is characterized as a cell or group of cells which is totipotent and which, in its natural environment, has the potential to develop into a human individual3. How we view the embryo, stem cells, and cloning are issues for moral, philosophical, and theological discussions. National review bodies have refused to find that embryos are, themselves, persons with intrinsic rights, and have recommended that research be permitted with spare embryos for medical or scientific purposes.5 Scientific evidence might eventually accumulate one way or the other, but the basic questions will continue to challenge us as new legislation is approved and decisions are made regarding embryos, stem cells, and cloning.12

Proponents of embryonic research point to the many embryos left over from fertility treatments and argue that, from a moral point of view, it is better to use these embryos than to create embryos especially for research. However, improvements in fertility treatments will reduce the number of spare embryos available for research, and the door should be left open for the creation of embryos for research when the number of spare embryos is no longer sufficient.7 Research with human embryonic stem cells is undertaken because of their assumed potential for advances in tissue transplantation, pharmaceutical testing, and embryology. In much of the current moral debate, it is assumed that the interests of patients with degenerative and debilitating diseases outweigh the moral status of embryos. In my view, it is a mistake to think of the early embryo either as a person or merely as a clump of cells. No matter our view, it is essential to acknowledge that the embryo is certainly a developing form of human life and as such deserves respect.

As aptly stated by Prentice,12 is a human being something that one “makes,” “chooses,” or “has,” or someone to be welcomed and taken care of? Some people are concerned that embryos are being killed to remove their special cells and feel that embryos represent potential persons with rights that include the right to live and not to be killed, even to save the life of another person. Although, scientifically, an embryo is a human being who is just starting out on the developmental journey,12 a life that is not viable outside the womb should not be recognized as fully human and, thus, accorded the rights and protections this classification entails.

Human cloning may be viewed as something against nature, and the results of cloning as something different than, for example, spontaneous single ovum twins.3 In practice, this type of biologic autonomy may have minimal ethical implications, except where human cloning is used to create a clone for harvesting organs rather than respecting and treating the clone as an individual human being with all the rights of any other human, including the right of informed consent.3

It is unethical to endanger human life, and most health policies originate from the importance given to humans and in the institution of family within society. Family is the social body founded on the defense of the communion of persons within family.1 It is possible that some day Parkinsonism, Alzheimer’s Disease, and other debilitating disorders could be cured through stem cell research. Potential cures should not be prevented from happening due to governmental or other interventions in biological research. If the slippery slope argument becomes a standard rationalization used to prevent research on stem cell and cloning, the door would have been unnecessarily closed on these reasonably acceptable tools for medical advancement. A code of ethics for scientists should suffice.

References


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A Method to Mimic Short-Answer/Essay Style Test Questions in A&P Within an Objective Test Framework

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Introduction

One of the student criticisms about our “Introduction to Human Anatomy and Physiology” course is that it is all memorization. Such courses typically measure student learning or mastery of the subject material by tests that ask them to list, define, describe, identify or label structures they have memorized, testing predominantly at Bloom’s ‘knowledge’ cognitive, competence level (Bloom et al. 1956). While we expect a basic level of factual learning from our students, to expect analysis and evaluation (critical thinking) of subject matter by students with little background knowledge of the subject seems intellectually inappropriate. However, society needs and expects individuals to think critically, solve complex problems, and analyze, read, and comprehend effectively. The teaching of science offers an excellent opportunity for students to gain a factual knowledge base of a discipline as well as develop and challenge their analytical, reasoning, and evaluative skills.

Objective tests are predominantly used at our institution because of the large volume of information presented to our A&P students, and the large size of our sections (50 or more students). Objective tests employing multiple-choice, fill-in-the-blank, and matching type questions have several advantages: (1) they can be graded rather quickly, (2) they allow students to answer more questions as compared to essay style tests, (3) the students’ writing skills, such as spelling, grammar and neatness do not obfuscate answers nor does teacher bias influence grading, and (4) the answer keys are unambiguous.

The main disadvantage of objective tests is their over-emphasis or reliance on factual recall while educators and society expect and reward individuals who can think critically. Another disadvantage is that objective tests often assess skills other than those the instructor intended (e.g., cause and effect relationships when the instructor intended only recall) or they may not reveal students’ thinking processes. Finally, objective tests usually assign points (usually 2) only to the correct answer and zero points to the other detractors (answers), an all or none configuration. In many cases though, the detractors may be partially true or minor variations of the best answer. When students choose one of these detractors, they might understand 90% of the concept, but not receive any credit.

There are techniques, however, that can be employed to enhance critical thinking skills on objective tests. Testing can include case-study type questions, incomplete scenarios, and/or problem/solution evaluation questions. The types of critical-thinking questions I have used in A&P objective tests include interpretation of graphs (bone density), calculation of molarity, or calculation of forces involved in different musculo-skeletal lever systems.

I have constructed another technique which uses objective, critical-thinking questions that may enhance students’ critical-thinking skills through the study of Human Anatomy & Physiology. I have designed objective questions that might mimic essay type questions without involving calculators, tables or graphs.

My objectives for designing essay-mimicking type objective questions were three-fold. First, I wanted students to focus on a question for longer than is typical of objective questions. Second, I wanted students to analyze and evaluate answers for both discrete information and the relationship between the answer and the questions. Third, I wanted students to receive partial credit for choosing detractors that are good choices but not the best answers. In an effort to replicate an essay/short-answer test protocol and still maintain the ease of grading, I designed multiple-choice questions with answers of varying weights. The goal was to make the student focus on reading comprehension and evaluate the different answers in terms of accuracy and completeness based on assigned readings and lectures. The student would then be forced to recall more than a single PowerPoint™ slide of information at one time.

Teaching Tips - continued on page 15
Methods

A test was designed with two sections. The first section contained 22 multiple-choice questions (2-points each); the second section contained five multiple-choice questions designed to mimic short-answer/essay questions (10-points maximum). First, students received partial credit for choosing a detractor that was not the best response. The credit for the detractor was weighted relative to how accurate it was (relative to the best answer). A criterion I followed to allocate points to the “wrong” detractor was to subtract two points for each factual error and subtract one point for an error of omission. Because of the effort involved just to read the questions and answers, no detractor received fewer than four points. The questions were designed to incorporate analysis and evaluation, recall of information and understanding of concepts.

To grade student responses, I designed a database using Microsoft Access™. The database contained six tables, (one for the student answers and one each for the five questions), one form, and one query. The student table contained 13 fields and as many rows as the number of students in the course. The question tables were simple, two-field tables: one field for the letter for each of the four answers and one field for the points allocated for each answer. The form was designed so that student names, identification (ID) numbers, and responses could be quickly typed into the student table. The form was connected to the student table and was the data input interface for the student table. Because the question tables were so small (two columns and four rows) I simply typed the point allocations corresponding to each answer for each question into the tables themselves. The query linked the student table containing the student responses to the question tables that contained the point allocations for each of the answers. By running the query, the student responses were paired with the point allocations for each answer for each of the five questions. Running the query produced a ‘table’ view that was subsequently exported (copied and pasted) into Excel (Microsoft Excel 2000™).

One of the short-answer/essay mimicking questions was designed with a short stem (the question or statement to which students must respond) and four paragraph length answers (Fig. 1). This question required students to recall more information than is typical of objective style test questions. Students had to evaluate and distinguish between the different answers. A second example of a short-answer/essay type question required the student to apply knowledge learned in class, infer from that knowledge the correct answer, and speculate on reasonable extrapolations to choose the best answer (Fig. 2).

I used the form I created in Access™ to type student responses to the questions into a database table (Fig. 3). This table was then linked to the five, two column question tables in a query window in Access™. When the query was run, a new table was produced that contained both the student responses and the corresponding points for those responses for each of the five questions (Fig. 3). This last table was exported to Excel™ for grade analysis.

Results

Students needed at least five minutes per question for the short-answer/essay mimicking style questions. Most of the students completed the test in less than 60 minutes. The students averaged 74% on the entire test (n = 76). On the first part of the test (22 multiple-choice questions) the class average was 73%. On the 2nd part (the short-answer/essay mimicking questions) they averaged 75%. The two means, for part one and part two, were not significantly different (two-tailed, t-test; p = 0.05, t-critical = 1.956; calculated t-statistic = 1.248; df = n – 2). The overall trend was that students who performed better on part one tended to do better on part two or vice-versa. (Pearson Product Moment Correlation, r = 0.35, P < 0.01, n = 76).

Discussion

There are several advantages to designing multiple-choice questions in A&P that mimic short-answer/essay questions. The questions can be rapidly graded using computer technology or by hand. In addition, the students can be asked questions that contain larger blocks of information than is typically asked in objective, multiple-choice tests. For example, many lectures at the collegiate level rely on computer technology and slide shows to disseminate information. The pedagogical guidance for designing this type of lecture is to limit the information per slide. Often, however, students record and study the lecture on a slide-by-slide basis and tend to learn (memorize?) each slide as a separate entity. They may fail to see the connections between the slides and fail to understand the system as a whole. Typically, multiple-choice, objective style tests questions are short and ask students to recall relatively concise facts. Thus, students may only learn the knowledge “bites” present on each slide. Although knowing the details is necessary, it is not sufficient in helping students gain an understanding of relationships within and among body systems, and the hierarchy or nesting of the information found in Human Anatomy and Physiology. By designing short-answer/essay mimicking questions, the instructor can better expect students to learn the connections between facts and to be rewarded for seeing the larger picture.

A third advantage is that students receive partial credit for learning parts of the information. Individual students learn and process information in different ways; knowing that they might receive some credit could motivate students since their efforts in studying and answering test questions will be partially rewarded.

A final advantage is that students will have to focus on a particular question and utilize a variety of cognitive skills beyond recall to succeed in selecting the best response. In this way, the science course can go beyond student mastery of a body of facts to a course introducing and assessing problem-solving skills. I am interested in promoting critical thinking by utilizing Human Anatomy and Physiology as the intellectual motivation for doing so. Not only is Human A&P individually relevant because it is the discipline regarding the human body, it also intellectually far-reaching as the intricacies of the body can be used to introduce and discuss theories and disciplines such as complexity, bioinformatics, synergism, integration, feedback mechanisms, systems, and networks. This testing method offers one such opportunity.

Reference

Describe a typical long bone.

a) A typical long bone consists of a diaphysis that contains a medullary cavity containing yellow bone marrow. The diaphysis ends contain spongy bone and interface with the diaphysis at the epiphyseal plate. Periosteum covers the bone except for the epiphyseal articular cartilage. The structural unit of compact bone is the osteon. An osteon is an elongated cylinder parallel to the long axis of the bone. The structural units of an osteon are Haversian canals, lacunae, concentric lamellae, osteocytes, and canaliculi. Organic components include cells and osteon, the organic part of the matrix. Hydroxyapatites make up much of the bone mass and are mineral salts, mainly calcium phosphates, which form crystals around osteon collagen fibers giving bone its hardness.

b) A typical long bone consists of an epiphysis that contains a medullary cavity containing yellow bone marrow. The diaphysis ends contain spongy bone and interface with the diaphysis at the epiphyseal plate. Periosteum covers the bone except for the diaphysis articular cartilage. The structural unit of compact bone is the osteon. An osteon is an elongated cylinder parallel to the long axis of the bone. The structural units of an osteon are Haversian canals, lacunae, concentric lamellae, osteocytes, and canaliculi. Organic components include cells and osteon, the organic part of the matrix. Hydroxyapatites make up much of the bone mass and are mineral salts, mainly calcium phosphates, which form crystals around osteon collagen fibers giving bone its hardness.

Fig. 1. A recall and evaluation style question. Answer “d” was the best answer and was worth 10 pts. Detractors “a – c” had varying inaccuracies included in the paragraph. Inaccuracies are underlined and the best answer (10 pts) is italicized. The points allocated were 8 for ‘a’, 6 for ‘b’, and 7 for ‘c’.

A new viral infection emerges that affects parts of the Integumentary system. This virus infects the basal layer of the epidermis resulting in inhibition of epithelial cell division, inhibition of sudoriferous glands, breakdown of keratin throughout the epidermis, and inhibition of melanin synthesis. Of the following scenarios, which one describes the most likely set of symptoms of this viral infection?

a) The infected person would likely have a difficult time cooling off because of reduced sweat production; they would likely get sun burned easier than normal. They probably would tend to get superficial cuts and abrasions more easily than normal and their skin might become patchy and thin in sections.

b) The infected person would likely have a difficult time cooling off because of reduced sweat production; their skin would tend to get thicker. They would likely get sunburned more easily than normal, and their skin would tend to develop a tough, hard exterior.

c) The infected person would likely have wet, clammy skin because of the over-stimulation of sweat production; their skin would be thick and they would tend to tan more easily than normal in the sun. Their skin would likely resist small cuts and abrasions more than normal, and the surface epidermal layers would be very tough.

d) The infected person would likely have wet, clammy skin because of the over-stimulation of sweat production; they would likely get sun burned more easily than normal. They probably would tend to get superficial cuts and abrasions easier than normal and their skin might become patchy and thin in sections.

Fig. 2. An inference, analysis, and evaluation style question. Answer “a” was the best response and was worth 10 pts. Detractors “b – d” included inconsistent reasoning or highly unlikely outcomes of this contrived viral infection. Inconsistencies are underlined and the best answer (10 pts) is italicized. The points allocated were 6 for ‘b’, 4 for ‘c’, and 6 for ‘d’.
Awarding Student Creativity in Anatomy and Physiology Courses

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Students in anatomy and physiology courses typically take exams and quizzes, dissect things, memorize long lists of bones and muscles, and perform other tasks that can seem mundane to many students. In my entry-level course I require all students to complete a “Do Something Cool” assignment in an attempt to promote creativity and also to reward alternative learning styles. To be honest, some projects are terrible! But some are extremely clever and make other students say, “Cool!”

Project Instructions (from the course syllabus)
Project - Do Something Cool
(15 points but if you have a good project you will get about 20 points)

Creativity is often not rewarded in science classes, but this project is different. Your assignment is simply to “do something cool” that is related to anatomy and physiology. Be creative! Art work, dance, rap, etc. are all possible. There are two items to think about in this project. First, what is the content of your project, e.g., heart disease? And second, what is the media of the message e.g., a drawing? You will be graded on both items! If you are concerned about the details of this project, talk to Murray! One of the easiest projects is to create a web page on some topic and many example web pages can be found on the GC 1135 web page. You may work either in a group, or on an individual basis. This is a chance to do something different! Have fun with the freedom. See Murray or the TAs for ideas and help.

Two of the best projects from the Spring 2004 Semester were submitted by Rosalind Tao and Simon Tsang. Rosalind, a sophomore who is enrolled in a pre-pharmacy program, created the drawing of the skull that appears on the cover of this HAPS-EDucator, and Simon, a freshman who intends to major in marketing, created the images seen to the right. There are several years of cool projects archived at: http://www.gen.umn.edu/faculty_staff/jensen/1135/example_student_projects/.

Observation of Decomposition of Rat Carcasses in Different Environments

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In Human Anatomy and Physiology courses, students usually spend their time examining the manner in which the body is put together, working their way through organismal levels starting with the cell and ending with integrated body systems. Increasingly, Sarah has noticed that students are also keenly interested in forensic issues. They are as interested in how the body comes apart after death as they are in how it is organized during life. To examine the decomposition process, Laura Keller, a Senior Thesis student in biology at Arcadia University, devised an experiment by which she could examine first hand the decomposition rates of rat carcasses in different environments. We present this experiment since the overall experimental design worked extremely well, and the results were in accordance with data from similar experiments that have been done in the past. We pass this information along because performing decomposition studies in different geographical regions is vital to the ability to accurately predict postmortem interval based on knowledge of each unique environment.

The main factors affecting decomposition rate are temperature and insect availability, both of which have a direct relationship to a specific environment. Decomposition studies cannot be done without awareness of forensic entomology, the application of insect life cycle information to the investigation of crime. Forensic entomology is a relatively new field, having been studied for only the last 150 years. However, it is so accurate a predictor of time of death that it is now admissible as evidence in a wide range of cases. Many studies have been done in which carcasses of pigs and humans have been buried and allowed to decay naturally. In their book, Death’s Acre, Dr. Bill Blass and Jon Jefferson describe the body farm that currently exists behind the University of Tennessee Medical Center. Human corpses (often donated) are observed as they pass through processes of decay. The collection of data and insects from these corpses has shown that although there are predictable stages of decay, the length of these stages depends entirely on the environment in which the carcass is left.

Decomposition is a complicated process that involves enzymatic digestion and bacterial action as well as environmental circumstances. Environmental conditions such as soil content and rainfall affect the quantity and rate of insect attraction to the corpse. In the absence of large scavengers, insects are the most important factor in total decomposition of a corpse. “In warm weather, conducive to fly growth, maggots can consume 60 per cent of a human body in less than a week.”

The decomposition of organic matter, known as putrefaction, is due to both anaerobic and aerobic activity. In addition, the decay of corpses involves the autolysis of cells by internal chemical breakdown, tissue autolysis from liberated enzymes, and external processes introduced by bacteria and fungi from both the cadaver intestine and the outer environment. Putrid liquefaction of tissues is caused by bacterial enzymatic materials, which break down proteins, carbohydrates, and lipids into their basic components and also cause gas formation. Tissues are digested until they become moist and gas-ridden, and eventually liquefy down to the skeleton.

There are five generally recognized stages of putrefaction. Stage 1: Fresh—no decomposition odor or swelling. Stage 2: Bloated—the abdomen becomes bloated and odorous. This stage ends when the carcass deflates. Stage 3: Active Decay—strong odor, skin pierced with feeding insects; flesh removed from first points of attack such as mouth and eyes. Stage 4: Advanced Decay—most of the flesh is gone and the odor is disappearing. Stage 5: Remain—only bones, hair, and dried skin remain and there is no odor. These stages are not clearly distinguishable from one another and they often occur in a sequence of overlapping phenomena until the corpse is completely destroyed. Because these stages are variable in length and not entirely separate, events they can be used only in estimating postmortem interval when combined with environmental and circumstantial elements.

The rate at which a corpse enters these stages is especially dependent on temperature and rate of insect attraction. Very high or very low temperatures can slow down the decay of organic matter by inhibiting bacterial proliferation. Temperature also directly affects the rate of insect development and activity. Warmer temperatures increase the number and type of insects in association with the corpse, and any increase in insect activity produces faster decomposition. Insects that accomplish decomposition have specialized sense organs specifically stimulated by organic putrefaction gases, enabling them to find the corpse very quickly.

Insect behavior is so predictable that in recent years, judges have allowed the use of forensic entomology in cases ranging from high profile murders to wildlife violations.

The first documented use of insects as forensic indicators dates to exhumations done in the 1800’s in Germany and France. Doctors in these countries observed that exhumed bodies were filled with many types of arthropods. The important role of maggots in decomposition was noted by Orfila, a French doctor, in 1831. In 1855, another French doctor named Bergeret gave the first modern forensic entomology case report, including an estimation of postmortem interval. Throughout the rest of the 1800’s, doctors attempted to use entomology as a forensic tool, but their estimates of postmortem interval were often wrong due to their ignorance of insect life cycles.

In the 1900’s, the use of forensic entomology advanced as autopsies were more commonly done and studies involving many

Teaching Tips - continued on page 19
bodies from different environments and in different stages of decay were documented. In the 1950’s, forensic entomology began to be successfully used to determine postmortem interval for the first time. Since then, basic research and advanced application of forensic entomology in the US, Russia, Canada, France, Japan, England, and India has opened the way to routine casework in this field. The techniques of forensic entomology allow experts in the field to collect strong entomological evidence and provide useful information about “time since death, season of death, geographical location of death, movement or storage of the remains following death, time of decapitation and/or dismemberment, submersion interval, specific sites of trauma on the body,” as well as evidence collected at the crime scene that would otherwise be hard to detect, such as drug use by the victim or criminal.8

The two major insect groups that feed on carcasses are, most importantly, Diptera (flies) and, secondarily, Coleoptera (beetles). Diptera are the insects of greatest forensic importance because of distribution in all zoographical areas. This allows for their use for forensic purposes all over the world. The family Calliphoridae is the most common type of Diptera occurring on human remains. The two most common species of this family are bluetbottle flies and greenbottle flies. Calliphoridae are represented in the first wave of insect colonization of a corpse. The exact species of fly depends on the area. Knowledge of factors inhibiting or favoring the various Diptera species is necessary to determine correct postmortem interval for any region.7

Diptera have a holometabolous life cycle. That means that they undergo four stages in their life cycle: egg, larva, pupa, and adult. Flies are usually found around a corpse within minutes after death. A female blowfly can lay up to 300 eggs at a time.10 Eggs are laid on the corpse most typically in areas where mucus membranes are in contact with the outside air, such as the mouth, nasal openings, eyes, ears, and genitals. They are also found on bruised or wounded skin. The eggs are laid in large clumps and can be identified and aged.6

The next stage of development in flies is the larval stage. Based on the external temperatures, hatching into maggots takes place 6 to 40 hours after oviposition, and larval development takes between 3 and 10 days.7 The white, cone shaped larva enters three instars which are stages between successive molts. The two most important features of the larvae with respect to identification are the posterior spiracles, openings into the respiratory system, and a pair of small hooks on the mouth that are used for attachment to the corpse. Each time the larva sheds its skin, it has a slightly larger and morphologically different set of spiracles and mouth hooks. These differences allow forensic entomologists to determine the species and the precise age of the maggots.6

Following the larval stages, the skin hardens and forms a capsule around the newly molted insect. This is the pupa stage. Puparia are usually found in the vicinity of a corpse, up to 30 feet away from the corpse, but not generally on it. It is important to look for puparia at the crime scene because they are the oldest stage that can be definitely linked to the corpse.6 Pupation takes between 6 and 18 days. The last stage of fly development is the adult stage. Adult flies are usually obvious on most corpses. Fly activity continues until the last stage of decomposition is reached.7

**Methods**

The subjects used in this experiment were 12 young adult male Sprague-Dawley rats that were sacrificed by administering carbon monoxide. The rats were frozen and individually wrapped in garbage bags secured with masking tape to prevent premature decomposition. One rat was placed in each of four different environments in Laura Keller’s back yard in New Cumberland, PA. The environments were: above ground in direct sun, above ground in shade, water, and completely buried in the ground.

The first step in the experiment was to construct the cages for rat burial that prevented scavenging from large animals. The cages were made of 23 gauge, 1/4 inch hardwire cloth and round, steel, corrosion resistant wire, 0.32 inches in diameter. The holes in the hardware cloth were large enough to allow insects to enter, but larger animals could not penetrate them. The first step in constructing the cages was to cut the hardwire cloth into strips 64 inches long and 2 feet wide, using wire cutters. The ragged edges were then clipped off each end; 1 inch of cloth at each end was bent back on itself and the two ends of the cloth were bent towards each other and connected by hooking the folded sections together. The ends were wired together at several places along the length, the wire ties were smashed flat against the cage and tightened. The resulting cage was circular with holes at the top and the bottom. The hardwire cloth was then cut from the top down, 6 1/2 inches at each of the top “corners” to create 4 sections of cloth. These were bent towards the center to create a square “lid” held together with wire. The bottom of the cage was left open.

The cages were placed into holes that had been dug into the ground. For three of the “environments,” sun, shade and water, holes approximately 4-5 inches deep were dug and the bottom 4 inches of the cage was secured in the ground. The hole was then filled in so that the ground was level. This left approximately 12-13 inches of cage above the surface of the ground. For the buried environment, a much larger hole was dug and the entire cage was placed under the surface of the ground. The water environment was created by burying, to the brim, a plastic bowl 11 1/4 inches across and 5 inches deep. The sides of the bowl were covered with a layer of mud which was allowed to harden so that the plastic was completely concealed. Then the bowl was filled with water. For the underground environment, the entire cage was completely surrounded with earth, but the cage itself was not filled with dirt.

A piece of sod was placed over the cage at ground level. Because the buried rats took such a long time to decompose, two identical cages were buried immediately beside each other so that the next trial could begin as soon as the sun, shade, and water rats decomposed.

The experiment was performed three times, first, from early July to late July; second, from mid July to early August; and third, from late July to mid August. To begin each trial, four rats were removed from the freezer and allowed to thaw. They were removed from their packaging and each was placed on its side in one of the four cages. The air temperature, date, time, rainfall, temperature and weight of the carcass were measured. In addition, digital pictures were taken of each rat, and maggot samples, when available, were collected and described. To measure rainfall, in the vicinity of the cages, two 1000 ml graduated cylinders were buried. Up to the 200 ml mark for stability and then filled with water to this point. The 200 ml mark became the “O” reading from which the amount of rainfall could be easily determined. The carcass temperature was measured using a digital meat thermometer with a range of -50 to 392 degrees F. The temperature...
Teaching Tips - continued from page 19

was taken at the same point on the body of all rats, above the arm on the back, until the tissue had totally deteriorated at that point; then the temperature was taken wherever tissue was available. The rats were weighted using a 1000 g dial spring scale. Each rat was placed in a piece of 100% cotton cheese cloth that was tied in the middle to create a type of sling, and the sling with the rat in it was weighed. Maggots were collected using forceps and placed in small vials containing a 70% solution of isopropyl rubbing alcohol. The rats were tested each day at the same time until the carcasses were completely deteriorated. The remains consisted of the skeleton and, in the case of the sun and shade environments, a black, leathery piece of dried-out skin containing the skeleton.

Results

We will include here only the results of the first trial since the results of the second and third trials were essentially the same, showing only slight differences related to changing environmental factors as the summer progressed.

Decomposition was very similar for rats left in the sun or in the shade, becoming completely decomposed after 9 days. Flies began to accumulate around the bodies by the second day, and maggots were found in large quantities in the mouth and anus by the fourth day. The maggots worked their way through the bodies, beginning at the orifices, and eating the rat from the inside out. By the ninth day, all that remained was the hard, leathery skin surrounding the skeleton.

The rat in the water environment took 13 days to decompose. First the body became swollen and most of the fur fell off revealing the underlying fascia. Flies appeared around the third day, and by the sixth day the body was covered with maggots. The maggots entered the body by creating a hole in the back and burrowing in. They increased this hole until the entire back was exposed, revealing a few organs and most of the spine. The remaining muscle and tissue was eaten away from the legs and the rest of the head, leaving only the skeleton loosely held together by connective tissue.

The rat that was buried decomposed in 25 days. Decomposition began by the loss of patches of fur, and by the sixth day, the body was fairly swollen. Flies appeared by the fourth day; there were maggots present on the underside of the carcass by the seventh day. By this time, the underside of the carcass was reduced to tough, thick skin which was devoid of hair and a swollen lump at the base of the head. Maggots emerged from the lump by the ninth day and continued eating away at the head. By the eleventh day, the head was reduced to the skull. The hole at the base of the head was large enough to reveal a large clump of maggots present inside the body cavity. On the fourteenth day, the chest cavity was open enough to reveal a grayish-green slime inside the body. From the head, the maggots kept eating their way posteriorly leaving the skeleton and some of the tough skin behind. By the 25th day, nothing remained except a collection of bones and a piece of thin skin.

The results show that all the rats in this experiment followed the predicted pattern of decomposition. Each rat progressed, in order, through the five stages of decay. The rate of decomposition was fastest in the rats that were placed above ground in the sun and shade environments, slower in water, and slowest when buried.

The fact that all three trials of these experiments were testing essentially the same question and each trial produced only slightly different results reinforces the interpretation that the role of environment is extremely important in the decomposition rate of corpses. This illustrates the need for more trials to be completed in a wide variety of geographic regions. Once there are enough data about how different environmental factors affect decomposition rate, the prediction of postmortem interval using these kinds of data will significantly improve.

References


Teaching Tips - continued on page 21
Teaching Tips - continued from page 20


A cluster of Diptera eggs laid on flesh

A cluster of Diptera larvae

Adult Diptera

Adult Carrion beetle

(These pictures were copied from the Corpse Fauna website.)
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