

**Old Dominion University  
Caribbean Studies Program 2018  
Ocho Rios/Kingston, Jamaica**

Course Title: CHEM 511: Bioinorganic and Natural Products Chemistry in the Caribbean. Prerequisite: A grade of C or better in CHEM 211/212 Organic Chemistry I Lecture and Laboratory; A grade of B or better in CHEM 351 Inorganic Chemistry is recommended.

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**Course Overview:** The Caribbean Studies Program provides students the opportunity to live and learn in Jamaica. Such an experience encompasses more than merely studying in a different physical location; it involves interacting with different people in a different environment. One normally does not realize how and when people in other parts of the world eat, how they relate to time (some cultures live by the clock more than others), how they express themselves (everything from emotions to music to religion), and which subjects are taboo. These are things that one learns by being in another place, and interacting with the people.

The Caribbean Studies Program is a short intersession course abroad, with the principal language being English. Nonetheless, any time spent abroad is excellent experience, as each trip creates new opportunities (and challenges!) and hopefully results in greater appreciation of other cultures. Students will interact with Jamaicans not only in their free time but also in this course. We will interact with Jamaican natural products chemists; and we will learn how they extract medicinal components from Caribbean medicinal plants at the University of the West Indies, Mona Campus. Students will also interact with locals when they participate in a one day service project on Labour Day, a Jamaican national holiday.

Jamaica is an interesting place to learn Natural Products Chemistry, as the island is heavily dependent upon conservation and use of medicinal plants and marine organisms for curing ailments such as diabetes, cancer, dysentery, toothache and sore gums, to name a few. In terms of heavy metal detection through the use of ascidians, there has been plenty publications on the diversity and distribution of ascidians in the Caribbean by Professor Ivan Goodbody, a respected Jamaican zoologist. The island is large enough to support a variety of species and habitats, but it is also isolated and small

enough (smaller than Connecticut, in fact) that many medicinal plants and ascidians are unique to the island and face elevated pressures of extinction from both natural and anthropogenic causes. The course will essentially work like this: Natural products isolation and/or field trips in the morning and lectures, discussions, and readings in the late afternoon or evening. Except for day-long field trips, the mid-day hours and early afternoon can be used for relaxing, studying, reading, and visiting the local communities.

### Introduction:

**Medicinal uses of Caribbean plants:** Diabetes mellitus is a serious chronic metabolic disorder that has a significant impact on the health, quality of life, and life expectancy of patients, as well as on the health care system. In the United States, diabetes is the sixth leading cause of death. Diabetes is divided into two major categories: type 1 diabetes (formerly known as insulin-dependent diabetes mellitus or IDDM) and type 2 diabetes (formerly known as non-insulin dependent diabetes mellitus or NIDDM). Despite considerable progress in the management of diabetes mellitus by synthetic drugs, the search for indigenous anti-diabetic agents still continues. In some countries, the tendency to use natural resources to fight diabetes is on the rise, and the Caribbean is one region, where herbal medicine has been used for many years to fight certain illnesses.

Bitter melon grows in tropical areas, including parts of the Amazon, east Africa, Asia, and the Caribbean, and is cultivated throughout South America as a food and medicine. It is a slender, climbing annual vine with long-stalked leaves and yellow, solitary male and female flowers borne in the leaf axils. The fruit appears as a warty gourd, usually oblong and resembling a small cucumber. The young fruit is emerald green,



turning to orange-yellow when ripe. At maturity the fruit splits into three irregular valves that curl backwards and release numerous brown or white seeds encased in scarlet arils. The Latin name *Momordica* means "to bite" (referring to the jagged edges of the leaf, which appear as if they have been bitten). All parts of the plant, including the fruit, taste very bitter.

The bitter lemon fruit

Bitter melon contains an array of novel and biologically active phytochemicals including triterpenes, proteins and steroids. In numerous studies, at least three different groups of constituents found in all parts of bitter melon have clinically demonstrated hypoglycemic (blood sugar lowering) properties or other actions of potential benefit against diabetes mellitus. These hypoglycemic chemicals include a mixture of steroidal saponins known as charantins, insulin-like peptides, and alkaloids. The hypoglycemic effect is more pronounced in the fruit of bitter melon where these chemicals are in greater abundance. To date, close to 100 *in vivo* studies have demonstrated the blood glucose-lowering effect of this bitter fruit. The fruit has also shown the ability to enhance cells' uptake of glucose, to promote insulin release, and potentiate the effect of insulin. In other *in vivo* studies, bitter melon fruit and/or seed has been shown to reduce total cholesterol and triglycerides in both the presence and absence of dietary cholesterol. In one study, elevated cholesterol and triglyceride levels in diabetic rats were returned to normal after 10 weeks of treatment.

*Annona squamosa* L. (Annonaceae), commonly known as custard apple is a native of the West Indies and is cultivated throughout India, mainly for its edible fruit. The plant is attributed with medicinal properties which include anti-fertility and anti-tumor activities in mice and rats. The young leaves of *Annona squamosa* are used extensively for their anti-diabetic activity by tribal men in and around the villages of Aligarh district in the state of Uttar Pradesh, India and also by the people of Chotanagpur district in the state of Bihar.

The neem (*Azadirachta indica* A. Juss, Meliaceae) is an indigenous tree grown all over India and Burma and is attributed to have many medicinal properties. The neem tree is grown in the Caribbean for insecticidal purposes to keep flies and other insects at bay. The anti-hyperglycemic/hypoglycemic activity of neem leaves in dogs and neem seed oil has been reported.

**Vanadium Research:** Vanadium chemistry is a relatively new area of research for our group. Since Henze's discovery that certain ascidians (tunicates) sequester vanadium(III) in their blood cells, this has spurred the interest of chemists in vanadium(III) complexes. The coordination chemistry of vanadium is of interest for a number of reasons. Vanadium is present at 20-35 nM concentrations in seawater, making it the most abundant transition metal in the aquasphere. In Nature, vanadium occurs in a variety of oxidation states ranging from V(II) through to V(V), which includes the vanadium-dependent nitrogenases in azotobacteria (V(II)/(III)), vanadium-dependent haloperoxidases in marine algae (V(V)), amavadin in the mushroom *Amanita muscaria* (V(IV)), V(III) in the marine fanworm *Pseudopotamilla ocellata* and V(III)/V(IV) in ascidians.

The aqueous coordination chemistry of vanadium(III) is of essence, due to the fact that it is not fully developed. There is no doubt that the general unsuitability of both NMR and EPR spectroscopy for the elucidation of the structures of complexes of paramagnetic vanadium(III) has severely hindered progress on the understanding and development of the coordination chemistry of vanadium(III) in aqueous solution compared with vanadium(IV) and (V). Vanadium(III) is found in some types of ascidians. Ascidians (tunicates, sea squirts) are sessile marine animals which vary from microscopic colonial forms through to individuals 8-12 inches in size. Remarkably, ascidians not only have the capability to reduce vanadates (V(V)) from seawater ( $\text{H}_2\text{VO}_4^-$ ,  $\text{HVO}_4^{2-}$ ,  $\text{NaHVO}_4^-$ ) to the V(III) state, but also concentrate it up to 7 orders of magnitude (from nM concentrations in sea water up to ~1 M in their blood cells). The reason why ascidians assimilate and reduce vanadates from seawater is currently not known, hence the reason why there is a need to carry out a detail physical and chemical study of the habitat of *Ascidia nigra* tunicates, which are known to proliferate in the Caribbean basin. These tunicates are also known to accumulate copper, lead, cadmium, mercury and other toxic metals.



An *Ascidia nigra* tunicate.

**Mission:**

The mission of the Caribbean Studies Program offered by Old Dominion University is to provide students and faculty with the opportunity to live and learn in Jamaica, a Caribbean center of life, culture, commerce, and education and to study social, economic, political, artistic, and educational institutions throughout Jamaica.

**Course Description:****Lecture and laboratory component together (4 hours)**

This course introduces students to isolation of natural products from Caribbean medicinal plants and from the tunicate *Ascidian nigra*. Hands-on activities in the laboratory and field trips will emphasize (1) identification of Caribbean medicinal plants for anti-diabetic uses that thrive in Jamaica and the *Ascidian nigra* tunicates, (2) methods of collection and preservation of such organisms for scientific studies (for interaction of the aqueous and nonaqueous extracts with vanadium(IV) and vanadium(V) species, (3) extraction of the blood cells of the *Ascidian nigra* tunicates for atomic absorption, EPR, NMR, and UV/Visible studies at ODU), (4) extraction and characterization of active natural product components of Caribbean medicinal plants and *Ascidian nigra* tunicates at the University of the West Indies, Mona Campus, Kingston, Jamaica, (5) testing the environment where these organism proliferate (measurements including pH, salinity, temperature, with heavy metal detection being carried at the Mona Campus, (6) collection of sea water for  $^{51}\text{V}$  NMR spectroscopic analysis at ODU and (7) local economic uses of medicinal plants of Jamaica (environmental factors and features that influence their distribution, use of tunicates for environmental monitoring through analytical chemistry).

Lectures, reading, and discussion will focus on these topics, as well as basic and coordination chemistry of vanadium, vanadium detection, heavy metal pollution, medicinal uses of vanadium-containing compounds, and literature as it relates to uptake of vanadium(V) by the *Ascidian nigra* tunicates.

Students will also learn social, economic, political, and artistic features of Jamaica, while developing a greater appreciation for and tolerance of other cultures, and gain a broader world view and an increased understanding of global affairs. Students will visit some educational institutions in that country.

**Learning Objectives:**

In this course students will:

- Interact with Jamaican natural products chemists
- Learn how to identify the selected Caribbean medicinal plants and tunicates (*Ascidian nigra*)
- Learn how Jamaicans use plants as a form of medicine and appreciate the use of select Caribbean medicinal plants in the fight against diabetes
- Learn how to extract active medicinal components from selected Caribbean medicinal plants; then characterize them *via* FT IR and NMR spectroscopy
- Learn how to obtain blood cells and extract active medicinal components from *Ascidian nigra* tunicates for atomic absorption, EPR, UV/Visible, and NMR spectroscopic analysis at Mona Campus and ODU
- Learn how isolated active medicinal components from natural products are commercialized after physiological testing and clinical trials

- Learn basic bioinorganic and coordination chemistry of vanadium
- Learn about the use of vanadium-containing compounds as insulin-like agents
- Determine pH, temperature, salt content, and heavy metal concentration of the surrounding and sea water where the tunicates proliferate
- Discuss literature on how *Ascidian nigra* tunicates convert vanadium(V) to vanadium(III) in their blood cells.
- Develop a greater appreciation for and tolerance of other cultures
- Develop a broader world view and an increased understanding of global affairs

#### **Teaching/Learning Approaches:**

- Some of the course content will be presented in a traditional lecture format. Students are expected to read the assigned material, to be attentive and engaged in class, to take good notes, to ask questions and contribute to the discussions, and to study in order to learn the course content.
- Some of the course content will be conducted in the field and in the laboratory at the University of the West Indies, Mona Campus, Kingston, Jamaica, where students will extract active medicinal component from selected Caribbean medicinal plants and *Ascidian nigra* tunicates; then characterize them *via* NMR spectroscopy. These students will take back some of these extracts and blood cells of *Ascidian nigra* tunicates to ODU for atomic absorption, EPR, and  $^{51}\text{V}$  NMR studies with vanadium-containing species. The students will also determine pH, temperature, salt content, and heavy metal concentration of the surrounding and sea water where the tunicates proliferate
- Some of the course content will be presented during site visits, where students will interact with Jamaican government officials, scientists, teachers, entrepreneurs and students. Students are expected to be attentive, to ask questions, and to contribute to the discussions. They will be able to (i) research the use of tropical medicinal plants in Jamaica, (ii) get advice on entrepreneurial skills from Tanaud Research Laboratories, University of the West Indies, Mona Campus, Kingston, Jamaica, and (iii) see the connection between pure and applied natural product chemistry from a Caribbean point of view.
- Students must devote some time each day to summarize the day's activities and to reflect upon their own reactions to these new experiences. These reactions will be recorded as daily journal entries.

#### **Topics to be covered:**

##### **Natural Product Chemistry:**

1. Extraction and separation of active medicinal components from selected Caribbean medicinal plants and *Ascidian nigra* tunicates.
2. Structural elucidation of active medicinal components *via* FT IR and NMR spectroscopy.



3. Commercialization of medicinal extracts that are isolated and purified by Tanaud Research Laboratories, University of the West Indies, Mona Campus, Kingston, Jamaica.

### Medicinal Chemistry:

1. A brief bioinorganic chemistry of the use of vanadium compounds in the fight against diabetes.
2. Medicinal uses of aqueous extracts from the *Annona squamosa* tree, the bitter lemon plant, and the neem tree.
3. Environmental effects of heavy metal pollution.

### Basic Chemistry of Vanadium:

1. **Introduction to Transition Metal Ions and Coordination Chemistry.** The Periodic Table d-orbital occupation and electronic configuration of  $M^{2+}$  ions, common oxidation states and their colors. General properties of transition elements.
2. The Historical Development of coordination chemistry
3. Nomenclature of coordination compounds
4. Basic chemistry of vanadium. Its discovery; various oxidation states, aqueous chemistry, and coordination compounds
5. Chemistry as it relates to uptake of vanadium(V) by the *Ascidian nigra* tunicates.

### Analytical and Environmental Chemistry:

1. Errors in chemical analysis based on pH and salinity measurements
2. A brief introduction to spectroscopic methods of analysis. The use of FT IR and the atomic absorption spectrometer in spectroscopic analysis of vanadium detection in aqueous solution.

### Required texts and literature:

We will be using a textbook specifically designed for undergraduate use, "*An introduction to Medicinal Chemistry*" by Graham L. Patrick.

Dr. Holder will post **HANDOUTS** for the course on the internet before classes are in session. Dr. Holder will have a binder with the following literature:

- Basic Natural Products Chemistry.
- Basic coordination chemistry and chemistry of vanadium.
- G.F. Asprey and Phyllis Thornton, Technical Data Report for Bitter Melon (*Momordica charantia*). Medicinal Plants of Jamaica. parts 1 & 11., The West Indian Medical Journal. Vol. 2 (No. 4.) and Vol. 3 (No. 1.).
- India Annie Shirwaikar, K. Rajendran, C. Dinesh Kumar, Ramgopal Bodla, Antidiabetic activity of aqueous leaf extract of *Annona squamosa* in

streptozotocin–nicotinamide type 2 diabetic rats, *Journal of Ethnopharmacology* **2004**, 91, 171-175.

- S. Gupta, M. Kataria, P.K. Gupta, S. Murganandan, R.C. Yashroy, Protective role of extracts of neem seeds in diabetes caused by streptozotocin in rats, *Journal of Ethnopharmacology* **2004**, 90, 185–189.
- M. Henze, *Hoppe-Seyler's Z. Physiol.* **1911**, 72, 494
- A Neotropical Companion: An Introduction to the Animals, Plants, and Ecosystems of the New World Tropics. 2<sup>nd</sup> edition by John Kricher, Princeton University Press, **1997**.
- G.F. Asprey and Phyllis Thornton, Technical Data Report for Bitter Melon (*Momordica charantia*). Medicinal Plants of Jamaica. parts 1 & 11., The West Indian Medical Journal. Vol. 2 (No. 4.) and Vol. 3 (No. 1.)
- Rosana M. Rocha, Suzana B. Faria, and Tatiane R. Moreno, Ascidiens from Bocas del Toro, Panama. I. Biodiversity. *Caribbean Journal of Science* **2005**, Vol. 41 (No. 3), 600-612.
- Ivan Goodbody, Diversity and Distribution of Ascidiens (Tunicata) in the Pelican Cays. Belize, National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A., March **2000**.
- Kan Kanamori, Structures and properties of multinuclear vanadium(III) complexes: seeking a clue to understanding the role of vanadium(III) in ascidiens, *Coordination Chemistry Reviews* **2003**, 237, 147-161.
- Katharine Gilbert, Kenneth Kustin, Guy C. McLeod, Gel filtration analysis of vanadium in *Ascidia nigra* blood cell lysate, *Cell Physiol.* **1977**, 93(2), 309-311.
- Annie Shirwaikar, K. Rajendran, C. Dinesh Kumar, Ramgopal Bodla, Antidiabetic activity of aqueous leaf extract of *Annona squamosa* in streptozotocin–nicotinamide type 2 diabetic rats, *Journal of Ethnopharmacology* **2004**, 91, 171-175.
- S. Gupta, M. Kataria, P.K. Gupta, S. Murganandan, R.C. Yashroy, Protective role of extracts of neem seeds in diabetes caused by streptozotocin in rats, *Journal of Ethnopharmacology* **2004**, 90, 185–189.

Download and print the following articles:

(i) <http://www.bio.mq.edu.au/MarBiol/poll.htm>

(ii) <http://www.unesco.org/csi/pub/papers/kjerfve.htm>, Björn Kjerfve, John C. Ogden, Jaime Garzón-Ferreira, Eric Jordán Dahlgren, Kalli De Meyer, Pablo Penchaszadeh, William J. Wiebe, Jeremy D. Woodley, and Joseph C. Zieman. **1998**. CARICOMP: A Caribbean Network of Marine Laboratories, Parks, and Reserves for Coastal Monitoring and Scientific Collaboration. Coastal region and small island papers 3, UNESCO, Paris.

- Print out the handouts for the PowerPoint lectures, which will be available 1-2 weeks prior to the course (in Web-CT or as e-mail attachments from Dr. Holder).

- Students should also do some background reading on Jamaican geography, politics, and history before arriving. A quick introduction may be found in any encyclopedia (e.g., the online Wikipedia, <http://en.wikipedia.org/wiki/Jamaica>).

#### **Class Procedures and Requirements:**

- Students will always conduct themselves in a manner that is consistent with the behavioral expectations defined in the ODU's Study Abroad Policies. Students will present themselves in the community *at all times* as professional, in terms of *both behavior and dress*, so as to reflect positively on the chemical profession and on the ODU Department of Chemistry and Biochemistry.
- Students will be proactive learners and will assume personal responsibility for their own intellectual growth. Students must be prepared for class, field activities, and site visits. Active participation is required during all class and field activities.
- Attendance in class is required. One non-excused absence from any activity will result in a drop of one letter grade in the student's final grade. All anticipated attendance issues must be worked out, and approved by the instructor in advance.
- All assignments will be turned in on time, before leaving Jamaica. Late assignments will not be graded.

#### **Evaluation Criteria:**

Students will be evaluated in this course by five means: daily quizzes, daily journal entries, participation, quantitative analyses, and a final exam.

Quizzes will consist of field questions (including natural products chemistry of selected Caribbean medicinal plants and *Ascidian nigra* tunicates, and separation techniques) or short essay questions based on lecture and readings. The final exam will be similar to the quizzes, only covering both aspects (field and indoor) more thoroughly. The journal will be graded daily and consists of the student's summary of the day's activities and a reflection upon their reactions (and possibly others' reactions) to their new experiences. Each journal entry must be at least two pages long. Participation points come from being present at every activity, being actively involved in learning, and acting with courtesy and sensitivity toward fellow students and Jamaican colleagues.

Your collection will consist of neem and bitter melon (*Momordica charantia*) plants and seeds, leaves of *Annona squamosa* (custard apple), live and dried *Ascidian nigra* tunicates, sea water where the tunicate thrive, and extracts of the medicinal components from the said plants and blood cells of the *Ascidian nigra* tunicates. The specimens must be accompanied by a label sheet with the following information: location (including parish, directions, latitude/longitude, and altitude), habitat description, collector's name and number, and the date of collection. Collections will be graded based on quality (appropriate size and available, aesthetically prepared), identifications, and label data.

You will be evaluated on the qualitative and quantitative measurements which you would have acquired both on land and the marine environment. The FTIR and NMR spectra of the medicinal components will be assessed as well.



**A survey of the literature regarding an important research topic relevant to this course** 100 points (25%)

This will be a report involving the literature regarding an important research topic relevant to this course. Note that you will consult full peer-reviewed articles (NOT a communication or a review) that have been published in the last five (5) years. You will submit three days before you depart Jamaica, a brief report with ACS style references (ten (10) pages, exclusive of references) on the same topic.

**Journal** 50 points (5%)

Students briefly summarize the day's activities. Write enough so that when you read it later (as alumni/alumnae), you will remember what you did.

- ◆ Students record their impressions of what they saw or did. What did the experience mean to you? How did your experience relate to cultural differences?
- ◆ Students reflect upon the cross-cultural experience as related to what they know life is like in the United States. Identify the times you imposed your cultural biases upon situations you witnessed in Jamaica.

These pages are turned in daily (yes, weekends too!). Dr. Holder will mark the writing with the same rigor in terms of format and grammar as will be done for the term paper, but such errors will not be penalized. Journal writings will be returned to students as soon as practicable, so that students may see how the assignment is graded. However, Dr. Holder will collect the original writings before we leave Jamaica, copy them in the U.S.A., and return to each student.

**Participation** 50 points (10%)

Be present (and on time) at every activity

- ◆ Be actively engaged in your learning
- ◆ Participate with courtesy and sensitivity in every interaction with your fellow students and with all of our Jamaican colleagues and acquaintances

**Analysis of data collected with a term paper** 120 points (30%)

Students should carry out in-depth structural analysis of the NMR data of the purified medicinal components of the tropical plants. Students will also carry out basic statistical analysis of the physical measurements taken while in the field.

**Notebook, plant and animal collection** 80 points (10%)

Students record their scientific observations at each field site, including physical conditions, a list of the specimens collected or observed, and weights of each specimen collected for extraction of the medicinal components.

- ◆ These pages are due by the morning of the day after each field collection. The graded notebook pages will be returned to students as soon as practicable, so that students may see how the assignment is graded and to study for the final exam. However, Dr. Holder will collect the original writings before we leave Jamaica, copy them in the U.S.A., and return to each student.

**Final Exam**

100 points (20%)

Essay questions and short answer questions that focus on readings, field observations and collections, lecture content

**Grades**

Grades will be based on the following scale: **A** = > 93 %, **A<sup>-</sup>** = 92 – 90 %, **B<sup>+</sup>** = 89 – 87 %, **B** = 86 – 83 %, **B<sup>-</sup>** = 82 – 80 %, **C<sup>+</sup>** = 79 – 77 %, **C** = 76 – 73 %, **C<sup>-</sup>** = 72 – 70 %, and **F** = < 70 %). However, if the class average is significantly below 80%, the class will be graded on a curve.

**Academic Honesty (directly from the *Undergraduate Bulletin*):**

“When cheating is discovered, the faculty member may give the student an F on the work involved or in the course. If further disciplinary action is deemed appropriate, the student should be reported to the Dean of Students. In addition to being a violation of academic honesty, cheating violates the Code of Student Conduct and may be grounds for probation, suspension, and/or expulsion. Students on disciplinary suspension may not enroll in any courses offered by Old Dominion University. All students are expected to abide by the University honor pledge (<http://studentservices.odu.edu/hc/>).

**ADA Policy:**

If a student has a disability that qualifies under the Americans with Disabilities Act and requires accommodations, he/she should contact Elizabeth Dickie.

**Required Supplies:**

- One regular ring binder notebook with college-ruled paper for lecture/discussion notes, your journal, and label information to submit with plant and tunicate collection.
- Please acquire one or more several pocket-size notebooks. Please use your discretion here. Something is needed that you will feel comfortable carrying with you and taking notes in the field or at other lectures. Some prefer small clipboards; others prefer reporter-style steno notebooks. Just make sure it can fit in a pocket or pouch, or you can attach it to a carabineer and clip it onto your belt loops. If you bring a larger notebook, you will probably be frustrated as you have to put it in and take it out of your backpack incessantly.
- Pens pencils and one black or blue Sharpie marker (fine point).
- The use of a computer is *not* encouraged. You will not need one for this course.
- Professional Dress (for wearing at official functions and tours)
- Shirt or blouse with sleeves or at least wide shoulder seams (no thin straps or muscle shirts)
- Full-length pants / trousers (no blue jeans or capri pants)
- Knee-length or longer skirt / dress (no miniskirts)
- A necktie is optional for men.
- Students should bring at least one professional outfit and expect to wear it several times.

### **Field Dress**

- Bring your own snorkel, mask, fins, and snorkeling (flotation) vest
- Bring a mesh bag with a zipper or a string closure to which you sew or velcro a carrying strap to hold the filled plastic bags
- Field clothing must include lycra tights or long pants with a snug hem (no loose bell bottom pants) and a long sleeve shirt (“rash guard”), both of which you will wear in the water to minimize potential cnidarian stings, cuts/scratches, and sun exposure
- 1-2 pairs of shoes to hike in and/or wear in the water (I am bringing leather sneakers and dive booties)—no bare feet, flip-flops, sandals while snorkeling or collecting; no flip-flops on boats
- Long pants with a snug hem (no loose bell-bottoms) and long sleeve shirts, both of which will help minimize insect bites, sun exposure, and cuts / scratches. Typical khaki pants are much better than blue jeans because they are lighter, cooler, and dry more easily if (when!) you get wet. Short sleeve shirts are permissible, but appropriate protection from insects and sun should be worn.
- One or two pairs of shoes and good socks for hiking. These shoes will probably get wet. I prefer good old rubber boots, but some people get blistered feet from walking in them for a long period.  
Decent shoes will be needed for official events and for tours.
- Sunblock or sunscreen (>15 SPF), hat or bandana, and sunglasses for protection from the sun
- Light rain jacket, appropriate for showers and also for higher altitudes or on boat rides
- A water bottle
- Daypack to carry stuff (which sometimes will include lunch)

### **Don't Forget ...**

- Extra eyeglasses or contacts
- Medicine for headaches, stomach ache, and diarrhea
- Underwater camera – “disposable” or other; most students will also bring a regular camera and film (50-, 64-, and 100-speed work best)
- Air-tight plastic bags (*e.g.*, Ziplock freezer bags) for precious things that might get caught in the rain (passport, camera, etc.)

### **Some Background:**

- No snakes in Jamaica are poisonous.

Temperatures in Jamaica during May generally vary between an average high during the day of 86.5 °F and an average low at night of 78.0 °F. You may experience a few rainy days, but for the most part, it's the perfect outdoor climate for activities.

- Relative humidity is about 70%, sometimes higher.
- Earthquakes are possible but rare, and hurricanes are very rare so early as the hurricane season is from June 01 until November 30 each year.

