

**Biology of Chemosensory Systems (3 credits)**  
**708Q/339D, Fall, 2013**

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Office Hours: Mon 5:00-6:00\*

\*If this time is a conflict, I can arrange a meeting at another time. Please send me an email ([raraneda@umd.edu](mailto:raraneda@umd.edu)) to schedule an appointment. Students with disabilities should contact Dr. Araneda during the first week of class to discuss special accommodations. Communication among course participants is essential. I want to hear your comments, criticisms, questions, etc. I am always available via the Canvas site and during the office hours.

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**OBJECTIVES**

The chemical senses play an important role in mammalian physiological processes, including feeding, sexual behaviors and homeostasis. The significant role of these sensory systems to human life is often underscored by our lack of understanding of the biology underlying chemoreception. Although we usually associate chemosensation to olfaction and taste, several other chemosensory systems play an important role in basic physiological functions.

In this course will cover a wide range of chemosensory systems including olfactory, gustatory, pheromonal, gastrointestinal and central chemosensation. Lectures and paper discussions of these topics will emphasize recent advances in transduction mechanisms, neural processing and the organization of central pathways. We will also correlate these biological aspects of chemosensation to their function in physiological and pathological states.

This is a graduate course, seminar style, and therefore participation from students is **very important**. You are invited to actively engage in the course by asking questions and bringing useful knowledge that complements our learning goals.

**PREREQUISITES**

BSCI353 (undergraduates), or an equivalent neuroscience course (graduate students). There are no books associated with the book, but students are encouraged to read the selected reviews provided for the course.

**LECTURES**

Monday, Wednesday @ 2:00 – 3:15 PM in BPS 1230

A PDF of the slide presentation used for the lecture will be made available the day before the lecture (Files: Lectures folder). Please note that sometimes this PDF file may

not contain all the material covered in the lecture. The lecture schedule is posted online and also includes links to supplemental materials that complement these lectures (e.g. reviews).

Each Wednesday one or two student(s) will lead the discussion of two papers relevant to the field (see below). Student presentations will begin on September, Wednesday 11.

### **CANVAS WEB SITE**

Students are expected to routinely access the course canvas site. In this site you will find relevant links and course materials. Please feel free to share any relevant audiovisual material with the rest of the class (video, magazine article, etc). You can ask content questions by posting them on the Ask Dr. Araneda. Confidential questions may be sent using a direct email.

If you have difficulty accessing or using the site, please contact the OIT or elms Helpdesk via the web or by calling 301-405-1400.

### **EXAMINATIONS**

Midterm: Monday, October 28

Final: Wednesday, December 11

The midterm is an in class exam spanning materials from the olfaction and taste lectures, in particular the papers discussed in class.

For the final, students will present a science project that can have any of the following formats.

- A scientific review summarizing recent findings in one of the areas discussed in class.
- A grant proposal, with two specific aims, that test hypotheses developed from a research topic in the discussion papers.
- A preview or "news and views" of a recently published paper
- Art work, for example a digital design for a webpage or a short video (i.e. commercial), highlighting one of the topics discussed in class.

A part of the grade for the final exam, students will give a short presentation of their proposal to the whole class (December 11). The final is due on December 14. For projects involving writing, these should be limited to two pages, single space (not including figures and references).

### **GRADES**

An important component of the final grade is class participation:

Examinations = 100 points

Discussion = 20 points

Participation and Attendance = 80 points

### **STUDENT PRESENTATIONS**

Class meetings on Wednesday consist of student presentations. A previously committed student(s) will lead the discussion of two papers. Although, one student is in charge of leading the paper presentation, everyone is expected to read the papers and contribute to the discussion. The presentation should be complemented with background information.

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### **A Final Note**

I am dedicated to making this course an enjoyable and worthwhile learning experience for everyone. To do well in this course you must attend the lectures and actively participate in the discussion meetings. Please, arrive on time! **If you arrive more than 15 min late you will lose partial attendance points for that day.**

***BIOLOGY OF CHEMOSENSORY SYSTEMS, FALL 2013***

<b>DATE</b>	<b>LECTURE/DISCUSSION</b>	<b>PAPER ASSIGNMENTS</b>
4-Sep	Welcome & Organization	
9-Sep	Chemical Senses Overview	
11-Sep	Discussion	1&2 (Araneda)
16-Sep	Main Olfactory System I	
18-Sep	Discussion	3&4
23-Sep	Main Olfactory System II	
25-Sep	Discussion	5&6
30-Sep	The Vomeronasal system and Pheromones I	
2-Oct	Discussion	7&8
7-Oct	The Vomeronasal system and Pheromones II	
9-Oct	Discussion	9&10
14-Oct	Gustation I (invited)	
16-Oct	Discussion	11&12
21-Oct	Gustation II	
23-Oct	Discussion	13&14
28-Oct	Flavor	
30-Oct	<b>MIDTERM</b> (in-class exam)	
4-Nov	Invertebrate Chemosensation	
6-Nov	Discussion	15&16
11-Nov	SFN	
13-Nov	SFN	
18-Nov	Gastrointestinal Chemoreception	
20-Nov	Discussion	17&18
25-Nov	Central Chemoreception	
27-Nov	Discussion	19&20
2-Dec	Social Behaviors and Chemoreception (invited)	
4-Dec	Discussion	21&22
9-Dec	Evolution of Chemosensation	
11-Dec	<b>FINAL</b> (Presentation of projects)	

## PAPERS FOR DISCUSSIONS

### *General*

1- Gelstein S, Yeshurun Y, Rozenkrantz L, Shushan S, Frumin I, Roth Y, Sobel N. (2012) "Human tears contain a chemosignal". *Science*. 331(6014):226-30

2- Pinc L, Bartoš L, Reslová A, Kotrba R. (2011) "Dogs discriminate identical twins". *PLoS One*. 6(6):e20704

### *Main Olfactory System I*

3- Buck L, Axel R. (1991) "A novel multigene family may encode odorant receptors: a molecular basis for odor recognition". *Cell*. 1991 Apr 5;65(1):175-87.

4- Fantana AL, Soucy ER, Meister M. 2008. Rat olfactory bulb mitral cells receive sparse glomerular inputs. *Neuron* 59:802–14

### *Main Olfactory System II*

5- Choi, G.B., Stettler, D.D., Kallman, B.R., Bhaskar, S.T., Fleischmann, A., and Axel, R. (2011). "Driving opposing behaviors with ensembles of piriform neurons". *Cell* 146, 1004–1015.

6- Alonso, M., Lepousez, G., Sebastien, W., Bardy, C., Gabellec, M.M., Torquet, N., and Lledo, P.M. (2012) "Activation of adult-born neurons facilitates learning and memory". *Nat. Neurosci.* 15, 897–904.

### *The Vomeronasal System and Pheromones I*

7- Chamero P, Katsoulidou V, Hendrix P, Bufe B, Roberts R, Matsunami H, Abramowitz J, Birnbaumer L, Zufall F, Leinders-Zufall T. (2011) "G protein  $G\alpha_o$  is essential for vomeronasal function and aggressive behavior in mice". *Proc Natl Acad Sci U S A*. 108(31):12898-903.

8- He J, Ma L, Kim S, Nakai J, Yu CR. (2008) "Encoding gender and individual information in the mouse vomeronasal organ". *Science*. 320(5875): 535-8

### *The Vomeronasal System and Pheromones II*

9- Luo M, Fee MS, Katz LC. (2003) "Encoding pheromonal signals in the accessory olfactory bulb of behaving mice". *Science* 299:1196–201

10- Kimchi T, Xu J, Dulac C. (2007) "A functional circuit underlying male sexual behaviour in the female mouse brain". *Nature*. 448:1009-14

### *Gustation I*

11- Nelson G, Hoon MA, Chandrashekar J, Zhang Y, Ryba NJ, Zuker CS. (2001) "Mammalian sweet taste receptors". *Cell*. 106(3):381-90.

12- Finger, T.E., Danilova, V., Barrows, J., Bartel, D.L., Vigers, A.J., Stone, L., Hellekant, G. & Kinnamon, S.C. (2005) "ATP signaling is crucial for communication from taste buds to gustatory nerves". *Science* 310: 1495–1499.

### ***Gustation II***

13- Stapleton JR, Lavine ML, Wolpert RL, Nicolelis MA, Simon SA. (2006) "Rapid taste responses in the gustatory cortex during licking". *J. Neurosci.* 26(15):4126-38.

14- Accolla R, Carleton A. (2008) Internal body state influences topographical plasticity of sensory representations in the rat gustatory cortex". *Proc Natl Acad Sci U S A.* 105(10):4010-5.

### ***Invertebrate Chemosensation***

15- Sato, K., M. Pellegrino, T. Nakagawa, et al. (2008) "Insect olfactory receptors are heteromeric ligand-gated ion channels". *Nature* 452:1002–1006

16- Jeong YT, Shim J, Oh SR, Yoon HI, Kim CH, Moon SJ, Montell C. (2013) "An odorant-binding protein required for suppression of sweet taste by bitter chemicals". *Neuron.* 79(4):725-37

### ***Gastrointestinal Chemoreception***

17- Margolskee, R.F., Dyer, J., Kokrashvili, Z., Salmon, K.S., Ilegems, E., Daly, K., Maillet, E.L., Ninomiya, Y., Mosinger, B., and Shirazi-Beechey, S.P. (2007) "T1R3 and gustducin in gut sense sugars to regulate expression of Na<sup>+</sup>-glucose cotransporter1". *Proc. Natl. Acad. Sci. USA* 104, 15075–15080.

18- Janssen, S., Laermans, J., Verhulst, P.J., Thijs, T., Tack, J., and Depoortere, I. (2011). "Bitter taste receptors and a-gustducin regulate the secretion of ghrelin with functional effects on food intake and gastric emptying". *Proc. Natl. Acad. Sci. USA* 108, 2094–2099

### ***Central Chemoreception***

19- Ziemann, A.E., Allen, J.E., Dahdaleh, N.S., Drebot, I.I., Coryell, M.W., Wunsch, A.M., Lynch, C.M., Faraci, F.M., Howard, M.A., III, Welsh, M.J., and Wemmie, J.A. (2009). "The amygdala is a chemosensor that detects carbon dioxide and acidosis to elicit fear behavior" *Cell* 139:1012-1021

20- Dubreuil V, Ramanantsoa N, Trochet D, Vaubourg V, Amiel J, Gallego J, Brunet JF, Goridis C. (2008) "A human mutation in Phox2b causes lack of CO<sub>2</sub> chemosensitivity, fatal central apnea, and specific loss of parafacial neurons". *Proc Natl Acad Sci USA* 105: 1067–1072

### ***Social Behaviors and Chemoreception***

21- Stern K, McClintock MK (1998). "Regulation of ovulation by human pheromones". *Nature* 392 (6672): 177–9

22- Kendrick KM, Lévy F, Keverne EB. (1992) "Changes in the sensory processing of olfactory signals induced by birth in sheep". *Science* 256:833–6.