Bases Celulares y Moleculares de los Ritmos Circadianos.

Profesor responsable:
Raúl Aguilar Roblero
Profesores invitados:
Ivette Caldelas Sánchez (ICS) Instituto de investigaciones Biomédicas;
Maria Luisa Fanjul de Moles(MFM) Facultad de Ciencias;
Mauricio Díaz Muñoz (MDM) Instituto de Neurobiología;
Arturo Vega González (AVG) Facultad de Medicina.
Iván Villanueva (IV) Escuela de Ciencias Biológicas (IPN)

Objetivos
Revisar los conceptos básicos de la teoría de los ritmos biológicos con énfasis en los ritmos circadianos. Así como discutir y analizar la bibliografía reciente sobre la regulación celular y molecular de los osciladores circadianos.

Organización del curso
Sesiones 1 vez por semana de 3 horas cada una, que se realizarán en el Instituto de Fisiología Celular. Se discutirán un capítulo de libro y de 2 a 5 artículos por sesión. Se solicitarán que los alumnos presenten un resumen de 1 artículo que halla aparecido durante el último trimestre en relación al tema de la sesión.

Evaluación
Participación y discusión en clase 50 %. Presentación de una propuesta de investigación de un tema de su interés en relación al curso 50 %.

Programa:

Clase	17 de Agosto de 2006	Ponente
1.	INTRODUCCIÓN AL ESTUDIO DE LOS RITMOS BIOLÓGICOS. 1. Capítulos I al V en: Gruart A, Delgado JM, Escobar C y Aguilar-Roblero R. **Los relojes que gobiernan la vida**. FCE, Mx., pp.19-69. 2002 2. Aschoff, J. A survery on Biological Rhythms. En : Aschoff J. (Ed) Handbook of Behavioral Neurobiology, vol. 4: **Biological Rhythms**. Plenum press, NY., pp 3-10. 1981. 3. Reinberg, A. Smolensky, MH. Intorduction to chronobiology. En: A. Reinberg and M. Smolensky (Eds.) **Biological Rhythms and Medicine.** Springer-Verlag, NY, pp 1-21, 1993. 4. Horton, TH. Conceptual issues in the ecology and evolution of circadian rhythms. En: J. Takahashi, Turek FW. Y Moore RY (Eds.) Handbook of behavioral neurobiology, vol. 12: **Circadian clocks**. Kluwer Academic/Plenum Publishers, NY, pp 45-57, 2001. 5. Pittendrigh, CS. Temporal organization: Reflections of a Darwinian Clock-Watcher. Ann Rev Physiol 55: 17-54, 1993. 6. Pittendrigh CS. On temperature independence in the clock system controling emergence time in drosophila. Proc Nat Acad Sci (USA) 40: 1018-1029, 1954. 7. Pittendrgh CS. Biological Clocks, the Functions, Ancient and Modern, of Circadian Oscillations. En: Science in the Sixties, Proceedings of the 1965 Cloudcroft Symposium, Air Force Office of Scientific Research, pp. 96-111, 1965.	RAR

Clase	24 de Agosto de 2006	Ponente
2.	PERSPECTIVA GENERAL DE LOS RITMOS CIRCADIANOS, LIBRE CURSO. 1. Pittendrigh, CS. Circadian Rhythms and the Circadian Organization of Living Systems. XXV Cold Spring Harbor Sympos. on Quant. Biol., 159-184. 1960. 2. Menaker, M. Biological Clocks. Bioscience 19: 681-689, 1969. 3. Pittendrigh, CS. Circadian System General Perspective. En: Aschoff J. (Ed) Handbook of Behavioral Neurobiology, vol. 4: **Biological Rhythms**. Plenum press, NY., pp 57-80. 1981. 4. Aschoff, J. Free running and entrained circadian rhythms. En: Aschoff J. (Ed) Handbook of Behavioral Neurobiology, vol. 4: **Biological Rhythms**. Plenum press, NY., pp 81-93. 1981. 5. Pittendrigh, CS. y Daan, S. A fuctional analysis of circadian pacemakers in nocturnal rodents. I The stability and lability of spontaneous frequency. J Comp Physiol 106: 223-252, 1976. 6. Pittendrigh, CS. y Daan, S.A fuctional analysis of circadian pacemakers in nocturnal rodents. III. Heavy water and constant light: Homeostasys of frequency? J Comp Physiol 106: 267-290, 1976. 7. Pittendrigh, CS. y Daan, S.A fuctional analysis of circadian pacemakers in nocturnal rodents. V Pacemaker structure: a clock for all seasons. J Comp Physiol 106: 333-355, 1976.	RAR

Clase	31 de Agosto de 2006	Ponente
3.	SINCRONIZACIÓN A CICLOS LD y lA CURVA DE RESPUESTAS DE FASE. 1. Aschoff, J. Free running and entrained circadian rhythms. clase anterior 2. Pittendrigh, CS. Circadian Systems: Entrainment. En: Aschoff J. (Ed) Handbook of Behavioral Neurobiology, vol. 4: **Biological Rhythms**. Plenum press, NY., pp 95-124. 1981. 3. Saunders DS. An introduction to biologiological clocks. Cap. 3: Circadian rhtyhms: Entrainment by light and temperature. Blackie and Sons, Glasgow. pp 40-64, 1977. 4. Pittendrigh, CS. Temperature compensation of the ciradian oscillation in drosophila pseudoobscura and its entrainment by temperature cycles. J Insect Physiol 14: 669-684, 1968. 5. Daan S y Aschoff J. The entrainment of circadian rhythm. En: J. Takahashi, Turek FW. Y Moore RY (Eds.) Handbook of behavioral neurobiology, vol. 12: **Circadian clocks**. Kluwer Academic/Plenum Publishers, NY, pp 45-57, 2001. 6. Pittendrigh, CS. y Daan, S. A fuctional analysis of circadian pacemakers in nocturnal rodents. II The variability of phase response curves. J Comp Physiol 106: 253 -266, 1976. 7. Pittendrigh, CS. y Daan, S. A fuctional analysis of circadian pacemakers in nocturnal rodents. IV Entrainment: Pacemaker as a clock. J Comp Physiol 106: 291-331, 1976.	RAR

Clase	7 de Septiembre de 2006	Ponente
4.	Análisis de datos con énfasis en la series de tiempo.	AVG

5. Levine JD, Funes P, Dowse HB, Hall JC. Signal analysis of behavioral and molecular cycles. BMC Neurosci. 2002;3:1.
6. D. M. Halliday, J. R. Rosenberg, A. M. Amjad, P. Breeze, B. A. Conway and S. F. Farmer, A framework for the analysis of mixed time series/point process data--Theory and application to the study of physiological tremor, single motor unit discharges and electromyograms, Progress in Biophysics and Molecular Biology, Vo. 64 (2-3) 1995;237-278.
7. Chan FHY, Wu BM, Lam FK, Poon Paul WF, Poon AMS. Multiscale Characterization of Chronobiological Signals Based on the Discrete Wavelet Transform IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, VOL. 47(1), 2000;88:95
8. Glynn EF, Chen J, Mushegian AR. Detecting periodic patterns in unevenly spaced gene expression time series using Lomb-Scargle periodograms. Bioinformatics. 2006;22(3):310-6.
9. Van Dongen HP, Olofsen E, VanHartevelt JH, Kruyt EW. Searching for biological rhythms: peak detection in the periodogram of unequally spaced data. J Biol Rhythms. 1999 (6):617-20.
10. Sokolove PG, Bushell WN. The chi square periodogram: its utility for analysis of circadian rhythms. J Theor Biol. 1978 72(1):131-60.
11. Minors DS, Waterhouse JM. Mathematical and statistical analysis of circadian rhythms. Psychoneuroendocrinology. 1988;13(6):443-64.
12. Nelson W, Tong YL, Lee JK, Halberg F. Methods for cosinor-rhythmometry. Chronobiologia. 1979 Oct-Dec;6(4):305-23.
13. Redmond DP and Sing HC, Biological time series analysis using complex demodulation, in Rhythmic Aspect of Behavior, F. M. Brown and R. C. Graeber, Eds. Hillsdale, NJ: Lawrence Erlbaum Assoc., 1982, ch. 12, pp. 429-457.
14. Enright JT. The search for rhythmicity in biological time-series. J Theor Biol. 1965 May;8(3):426-68.
15. Vega-González, A Análisis Estadístico en Cronobiología, Psiquis México, 1993 2(6) 139-149

Libros:

16. Alan V. Oppenheim, Ronald W. Shafer, Discrete-Time Signal Processing, Prentice Hall, 1989. Rolf Weitkunat, Digital Biosignal Processing, Elsevier Science Publishers.

Clase	14 de Septiembre de 2006	Ponente
5.	Regulación circadiana en organismos unicelulares. 1. Dunlap JC, Loros JJ. The neurospora circadian system. J Biol Rhythms. 2004 Oct;19(5):414-24.	MFM

Clase	21 de Septiembre de 2006	Ponente
6.	Regulacion circadiana en Invertebrados. 1. Chag DC. McWatters HG. Williams JA. Gotter AL. Levine JD. And Reppert SR. Constructing a Feedback loop with circadian clock molecules from the silkmoth, Antheraea pernyi. J Biol Chem 278: 38149-38158, 2003.	MFM

Clase	28 de Septiembre de 2006	Ponente
7.	El oscilador molecular en drosofila. 1. Chang DC. Neural circuits underlying circadian behavior in Drosophila melanogaster. Behav Processes. 71: 211-25, 2006. 2. Emery P. Venus So W. Kaneko M. Hall JC. Rosbash M. CRY, a drosophila clock and light-regulates chryptochrome, Is a major contributor to circadian rhythm resetting and photosensitivity. Cell 95: 669-679, 1998.	MFM

Clase	Tema	Ponente
17.	Regulación circadiana en vertebrados no mamíferos.	ICS

Clase	Tema	Ponente
18.	Perspectiva del sistema circadiano en mamíferos.	RAR

Clase	Tema	Ponente
19.	Mecanismos celulares en el supraquiasmático.	RAR
Clase	Tema	Ponente
20.	Genes reloj en el núcleo supraquiasmático.	RAR
Clase	Tema	Ponente
21.	Aspectos celulares y moleculares de la sincronización	ICS
Clase	Tema	Ponente
22.	Desarrollo de los ritmos circadianos.	ICS
Clase	Tema	Ponente
23.	Osciladores periféricos y sincronización al alimento.	MDM
Clase	Tema	Ponente
24.	Ritmos circadianos en Humanos.	RAR
Clase	Tema	Ponente
25.	Presentación de proyectos finales	

Bibliografía:

Libros:

1.
2. Takahashi J, Turek F, Moore R. (Eds) Handbook of Behavioral Neurobiology, vol. 12: **Circadian Clocks.** Kluwer Academic/Plenum press, NY. 2001, pp 710.
3. GruartA, Delgado JM, Escobar C y Aguilar-Roblero R. **Los relojes que gobiernan la vida**. FCE, México, 2002, pp 197.
4. Wetterberg L. (Ed) Werner-Green international seres vol. 63: **Light and Biological Rhtyhms in Man.** Pergamon Press. Oxford, 1993, pp 448.
5. Klein, D., Moore, R. & Reppert, S. (Eds) **Suprachiasmatic nucleus. The mind's clock.** Oxford University Press, Oxford, 1991, pp 467.

Artículos:

2. Aguilar-Roblero, R. & Vega-González, A. (1993) Splitting of locomotor rhythmicity in Hamsters is facilitated by Pinealectomy. Brain Res 605: 229-236.
3. Albrecht U. The mammalian circadian clock: a network of gene expression. Front Biosci. 2004 Jan 1;9:48-55.
4. Allada R, Meissner RA. Casein kinase 2, circadian clocks, and the flight from mutagenic light.Mol Cell Biochem. 2005 Jun;274(1-2):141-9.
5. Antle MC, Silver R. Orchestrating time: arrangements of the brain circadian clock. Trends Neurosci. 2005 Mar;28(3):145-51.
6. Aton SJ, Herzog ED. Come together, right...now: synchronization of rhythms in a mammalian circadian clock. Neuron. 2005 Nov 23;48(4):531-4.
7. Bell-Pedersen D, Cassone VM, Earnest DJ, Golden SS, Hardin PE, Thomas TL, Zoran MJ. Circadian rhythms from multiple oscillators: lessons from diverse organisms. Nat Rev Genet. 2005 Jul;6(7):544-56.
8. Brunner M, Schafmeier T. Transcriptional and post-transcriptional regulation of the circadian clock of cyanobacteria and Neurospora.Genes Dev. 2006 May 1;20(9):1061-74.

9. Chang DC. Neural circuits underlying circadian behavior in Drosophila melanogaster. Behav Processes. 2006 Feb 28;71(2-3):211-25. Epub 2006 Jan 18.
10. Cloues, R.K. & Sather, W.A. (2003) Afterhyperpolarization regulates firing rate in neurons of the suprachiasmatic nucleus. J Neurosci 23: 1593-1604.
11. Colwell CS, Michel S. Sleep and circadian rhythms: do sleep centers talk back to the clock? Nat Neurosci. 2003 Oct;6(10):1005-6.
12. Coogan AN, Piggins HD. MAP kinases in the mammalian circadian system--key regulators of clock function. J Neurochem. 2004 Aug;90(4):769-75
13. Davidson AJ, Menaker M. Birds of a feather clock together--sometimes: social synchronization of circadian rhythms. Curr Opin Neurobiol. 2003 Dec;13(6):765-9.
14. Díaz-Muñoz, M., Dent, A., Granados-Fuentes, D., Hall, A., Hernández-Cruz, A., Harrington, M. & Aguilar-Roblero, R. (1999) Circadian modulation of the ryanodine receptor type 2 in the SCN of rodents. Neuroreport 10: 481-486.
15. Duffy JF, Wright KP Jr. Entrainment of the human circadian system by light. J Biol Rhythms. 2005 Aug;20(4):326-38.
16. Dunlap JC, Loros JJ. The neurospora circadian system. J Biol Rhythms. 2004 Oct;19(5):414-24.
17. Hannibal, J. (2002) Neurotransmitters of the retino-hypothalamic tract. Cell Tissue Res 309: 73-88.
18. Hardin PE, Yu W. Circadian transcription: passing the HAT to CLOCK. Cell. 2006 May 5;125(3):424-6.
19. Hardin PE. Transcription regulation within the circadian clock: the E-box and beyond. J Biol Rhythms. 2004 Oct;19(5):348-60.
20. Hardin PE. The circadian timekeeping system of Drosophila. Curr Biol. 2005 Sep 6;15(17):R714-22.
21. Harms E, Kivimae S, Young MW, Saez L. Posttranscriptional and posttranslational regulation of clock genes. J Biol Rhythms. 2004 Oct;19(5):361-73.
22. Hastings MH, Herzog ED. Clock genes, oscillators, and cellular networks in the suprachiasmatic nuclei. J Biol Rhythms. 2004 Oct;19(5):400-13.
23. Hastings MH. Circadian clocks: self-assembling oscillators? Curr Biol. 2003 Sep 2;13(17):R681-2.
24. Helfrich-Forster C. Neurobiology of the fruit fly's circadian clock. Genes Brain Behav. 2005 Mar;4(2):65-76.
25. Helfrich-Forster C. Organization of endogenous clocks in insects. Biochem Soc Trans. 2005 Nov;33(Pt 5):957-61.
26. Hirayama J, Sassone-Corsi P. Structural and functional features of transcription factors controlling the circadian clock. Curr Opin Genet Dev. 2005 Oct;15(5):548-56.
27. Hirota T, Fukada Y. Resetting mechanism of central and peripheral circadian clocks in mammals. Zoolog Sci. 2004 Apr;21(4):359-68.
28. Homberg U, Reischig T, Stengl M. Neural organization of the circadian system of the cockroach Leucophaea maderae. Chronobiol Int. 2003 Jul;20(4):577-91.
29. Honma S, Honma K. The biological clock: Ca2+ links the pendulum to the hands. Trends Neurosci. 2003 Dec;26(12):650-3.
30. Ikeda, M., Sugiyama, T., Wallace, C.S., Gompf, H.S., Yoshioka, T., Miyawaki, A. & Allen, C.N. (2003) Circadian dynamics of cytosolic and nuclear Ca^{2+} in single suprachiasmatic nucleus neurons. Neuron 38: 253-263.
31. Iwasaki H, Kondo T. Circadian timing mechanism in the prokaryotic clock system of cyanobacteria. J Biol Rhythms. 2004 Oct;19(5):436-44.
32. Jackson, A., Yao, G.L. & Bean, B. (2004) Mechanism of spontaneous firing in dorsomedial suprachiasmatic nucleus neurons. J Neurosci 24: 7985-7998.
33. Johnson CH. Precise circadian clocks in prokaryotic cyanobacteria. Curr Issues Mol Biol. 2004 Jul;6(2):103-10.
34. Kim, D.Y., Choi, H.J., Kim, J.S., Kim, Y.S., Jeong, D.U., Shin, H.C., Kim, M.J., Han H-C. Homg, K.S. & Kim, Y.I. (2005) Voltage gated calcium channels play crucial roles in the glutamate-induced phase shifts on the rat suprachiasmatic circadian clock. Eur. J. Neurosci. 21: 1215-1222.
35. Korf HW, Von Gall C, Stehle J. The circadian system and melatonin: lessons from rats and mice. Chronobiol Int. 2003 Jul;20(4):697-710.
36. Lakin-Thomas PL. Transcriptional feedback oscillators: maybe, maybe not...J Biol Rhythms. 2006 Apr;21(2):83-92.
37. Liu Y, He Q, Cheng P. Photoreception in Neurospora: a tale of two White Collar proteins. Cell Mol Life Sci. 2003 Oct;60(10):2131-8.

38. Lundkvist, G.B., Kwak, Y., Davis, E.K., Tei, H. & Block, G.D. (2005) A calcium flux is required for circadian rhythm generation in mammalian pacemaker neurons. J Neurosc 25: 7682-7686.
39. Meijer, J.H. & Schwartz, W. (2003) In search of the pathways for Light-Induced pacemarker resetting in the suprachiasmatic nucleus. J Biol Rhythms 18: 235-249.
40. Merrow M, Dragovic Z, Tan Y, Meyer G, Sveric K, Mason M, Ricken J, Roenneberg T. Combining theoretical and experimental approaches to understand the circadian clock. Chronobiol Int. 2003 Jul;20(4):559-75.
41. Merrow M, Roenneberg T. Cellular clocks: coupled circadian and cell division cycles. Curr Biol. 2004 Jan 6;14(1):R25-6
42. Merrow M, Spoelstra K, Roenneberg T. The circadian cycle: daily rhythms from behaviour to genes. EMBO Rep. 2005 Oct;6(10):930-5.
43. Mistlberger RE, Skene DJ. Nonphotic entrainment in humans? J Biol Rhythms. 2005 Aug;20(4):339-52.
44. Mistlberger RE. Circadian regulation of sleep in mammals: role of the suprachiasmatic nucleus. Brain Res Brain Res Rev. 2005 Nov;49(3):429-54.
45. Morin, L.P. & Allen, C.N. (2005) The circadian visual system, 2005. Brain Res. Rev. in press (BRESR-100370; DOI 10.1016/j.brainresrev.2005.08.003)
46. Mrosovsky N, Hattar S. Diurnal mice (Mus musculus) and other examples of temporal niche switching. J Comp Physiol A Neuroethol Sens Neural Behav Physiol. 2005 Nov;191(11):1011-24. Epub 2005 Nov 4. Review.
47. Olcese J. Circadian signaling in the chick pineal organ. Chronobiol Int. 2003 Jul;20(4):617-36.
48. Panda S, Hogenesch JB. It's all in the timing: many clocks, many outputs. J Biol Rhythms. 2004 Oct;19(5):374-87.
49. Pennartz, C., de Jeu, M., Boss, N., Scaap, J. & Geurtsen, A. (2002) Diurnal modulation of pacemaker potentials and calcium current in the mammalian circadian clock. Nature 416: 286-290.
50. Piggins HD, Loudon A. Circadian biology: clocks within clocks.Curr Biol. 2005 Jun 21;15(12):R455-7.
51. Pourquie O, Goldbeter A. Segmentation clock: insights from computational models. Curr Biol. 2003 Aug 19;13(16):R632-4.
52. Reppert SM. A colorful model of the circadian clock. Cell. 2006 Jan 27;124(2):233-6.
53. Reppert, S. & Weaver, D. (2002) Coordination of timing in mammals. Nature 418: 935-941.
54. Richardson GS. The human circadian system in normal and disordered sleep. J Clin Psychiatry. 2005;66 Suppl 9:3-9.
55. Rollag, M.D., Berson, D.M. & Provencio, I. (2003) Melanopsin, ganglion-cell photoreceptors, and mammalian photoentrainment. J Biol Rhythms 18: 227-234.
56. Sancar A. Regulation of the mammalian circadian clock by cryptochrome. J Biol Chem. 2004 Aug 13;279(33):34079-82. Epub 2004 Apr 27.
57. Sang-Soep, N., Farnell, Y.Z., Griffith, W. & Earnest, D.J. (2005) Circadian regulation and fuction of voltage-dependent calcium channels in the suprachiasmatic nucleus. J Neurosc 25: 9304-9308.
58. Saper CB, Lu J, Chou TC, Gooley J. The hypothalamic integrator for circadian rhythms. Trends Neurosci. 2005 Mar;28(3):152-7.
59. Schibler U, Naef F. Cellular oscillators: rhythmic gene expression and metabolism. Curr Opin Cell Biol. 2005 Apr;17(2):223-9.
60. Schwartz WJ, Meijer JH. Real-time imaging reveals spatiotemporal dynamics of cellular circadian clocks. Trends Neurosci. 2004 Sep;27(9):513-6.
61. Shirasu N, Shimohigashi Y, Tominaga Y, Shimohigashi M. Molecular cogs of the insect circadian clock. Zoolog Sci. 2003 Aug;20(8):947-55.
62. Smale L, Lee T, Nunez AA. Mammalian diurnality: some facts and gaps. J Biol Rhythms. 2003 Oct;18(5):356-66.
63. Stephan FK. Broken circadian clocks: a clock gene mutation and entrainment by feeding. Am J Physiol Regul Integr Comp Physiol. 2003 Jul;285(1):R32-3.
64. Takahashi JS. Finding new clock components: past and future. J Biol Rhythms. 2004 Oct;19(5):339-47.
65. Tamai TK, Carr AJ, Whitmore D. Zebrafish circadian clocks: cells that see light. Biochem Soc Trans. 2005 Nov;33(Pt 5):962-6.
66. Teshima, K., Kim, H. & Allen, C.N. (2003) Characterization of an apamin-sensitive potassium current in suprachiasmatic nucleus neurons. Neuroscience 120: 65-73.
67. Van Gelder RN. Resetting the clock: Dexras1 defines a path. Neuron. 2004 Sep 2;43(5):603-4.
68. Zhou QY, Cheng MY. Prokineticin 2 and circadian clock output. FEBS J. 2005 Nov;272(22):5703-9.