“Code Biology Database – A List of Biological Codes”

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https://www.codebiology.org

Number	Code Name	Descriptive Name(s)	Full Citation(s), Hyperlinked to Source
1	Acoustic code	The Acoustic Codes	Farina, A. and N. Pieretti (2014). "Acoustic Codes in Action in a Soundscape Context." Biosemiotics 7(2): 321-328. Malavasi, R., K. Kull and A. Farina (2014). "The Acoustic Codes: How Animal Sign Processes Create Sound-Topes and Consortia via Conflict Avoidance." Biosemiotics 7(1): 89-95. Curé, C., N. Mathevon and T. Aubin (2016). "Mate vocal recognition in the Scopoli's shearwater Calonectris diomedea: do females and males share the same acoustic code?" Behav Processes 128: 96-102. Farina, A. (2018). "Ecoacoustic codes and ecological complexity." Biosystems 164: 147-154. Farina, A. (2019). "Acoustic codes from a rural sanctuary: How ecoacoustic events operate across a landscape scale." Biosystems 183: 103986.
2	Auditory Code	The Auditory Codes	Middlebrooks, J. C. and E. I. Knudsen (1984). "A neural code for auditory space in the cat's superior colliculus." J Neurosci 4(10): 2621-2634. Schwarz, D. W. and R. W. Tomlinson (1987). "A complex tone code in the auditory cortex." J Otolaryngol 16(5): 316-321.

			Sterbing, S. J., U. Schmidt and R. Rübsamen (1994). "The postnatal development of frequency-place code and tuning characteristics in the auditory midbrain of the phyllostomid bat, Carollia perspicillata." Hear Res 76(1-2): 133-146. Schwarz, D. W., F. Tennigkeit, T. Adam, P. Finlayson and E. Puil (1998). "Membrane properties that shape the auditory code in three nuclei of the central nervous system." J Otolaryngol 27(6): 311-317. Lalwani, A. K. and C. M. Castelein (1999). "Cracking the auditory genetic code: nonsyndromic hereditary hearing impairment." Am J Otol 20(1): 115-132. March, L., A. Cienfuegos, L. Goldbloom, W. Ritter, N. Cowan and D. C. Javitt (1999). "Normal time course of auditory recognition in schizophrenia, despite impaired precision of the auditory sensory ("echoic") memory code." J Abnorm Psychol 108(1): 69-75. Kozloski, J. and J. D. Crawford (2000). "Transformations of an auditory temporal code in the medulla of a sound-producing fish." J Neurosci 20(6): 2400-2408. Tseng, C. J. and A. K. Lalwani (2000). "Cracking the auditory genetic code: part II. Syndromic hereditary hearing impairment." Am J Otol 21(3): 437-451. Bodnar, D. A., A. D. Holub, B. R. Land, J. Skovira and A. H. Bass (2001). "Temporal population code of concurrent vocal signals in the auditory midbrain." J Comp Physiol A Neuroethol Sens Neural Behav Physiol 187(11): 865-873. Juslin, P. N. and P. Laukka (2003). "Communication of emotions in vocal expression and music performance: different channels, same code?" Psychol Bull 129(5): 770-814. Polley, D. B., M. A. Heiser, D. T. Blake, C. E. Schreiner and M. M. Merzenich (2004). "Associative learning shapes the neural code for stimulus magnitude in primary auditory cortex." Proc Natl Acad Sci U S A 101(46): 16351-16356. Weisz, N., S. Müller, W. Schlee, K. Dohrmann, T. Hartmann and T. Elbert (2007). "The neural code of auditory phantom perception." J Neurosci 27(6): 1479-1484. Eyherabide, H. G., A. Rokem, A. V. Herz and I. Samengo (2008). "Burst firing is a neural code in an insect auditory system." Front Comput Neurosci 2: 3.

			Werner-Reiss, U. and J. M. Groh (2008). "A rate code for sound azimuth in monkey auditory cortex: implications for human neuroimaging studies." J Neurosci 28(14): 3747-3758. Salminen, N. H., P. J. May, P. Alku and H. Tiitinen (2009). "A population rate code of auditory space in the human cortex." PLoS One 4(10): e7600. Salminen, N. H., H. Tiitinen, S. Yrttiaho and P. J. May (2010). "The neural code for interaural time difference in human auditory cortex." J Acoust Soc Am 127(2): El60-65. Clemens, J., O. Kutzki, B. Ronacher, S. Schreiber and S. Wohlgemuth (2011). "Efficient transformation of an auditory population code in a small sensory system." Proc Natl Acad Sci U S A 108(33): 13812-13817. Chen, C., H. L. Read and M. A. Escabí (2012). "Precise feature based time scales and frequency decorrelation lead to a sparse auditory code." J Neurosci 32(25): 8454-8468. Escoffier, N., J. Zhong, A. Schirmer and A. Qiu (2013). "Emotional expressions in voice and music: same code, same effect?" Hum Brain Mapp 34(8): 1796-1810. Filippopoulos, P. C., P. Hallworth, S. Lee and J. H. Wearden (2013). "Interference between auditory and visual duration judgements suggests a common code for time." Psychol Res 77(6): 708-715. Henry, K. S. and M. G. Heinz (2013). "Effects of sensorineural hearing loss on temporal coding of narrowband and broadband signals in the auditory periphery." Hear Res 303: 39-47. Micheyl, C., P. R. Schrater and A. J. Oxenham (2013). "Auditory frequency and intensity discrimination explained using a cortical population rate code." PLoS Comput Biol 9(11): e1003336. Plakke, B., M. D. Diltz and L. M. Romanski (2013). "Coding of vocalizations by single neurons in ventrolateral prefrontal cortex." Hear Res 305: 135-143. Yovel, G. and P. Belin (2013). "A unified coding strategy for processing faces and voices." Trends Cogn Sci 17(6): 263-271. Dimitrov, A. G., G. I. Cummins, Z. M. Mayko and C. V. Portfors (2014). "Inhibition does not affect the timing code for vocalizations in the mouse auditory midbrain." Front Physiol 5: 140.

			Harper, N. S., B. H. Scott, M. N. Semple and D. McAlpine (2014). "The neural code for auditory space depends on sound frequency and head size in an optimal manner." PLoS One 9(11): e108154. Lee, J. and J. M. Groh (2014). "Different stimuli, different spatial codes: a visual map and an auditory rate code for oculomotor space in the primate superior colliculus." PLoS One 9(1): e85017. Mizrahi, A., A. Shalev and I. Nelken (2014). "Single neuron and population coding of natural sounds in auditory cortex." Curr Opin Neurobiol 24(1): 103-110. Plack, C. J., D. Barker and D. A. Hall (2014). "Pitch coding and pitch processing in the human brain." Hear Res 307: 53-64. Wang, Y., Y. Gutfreund and J. L. Peña (2014). "Coding space-time stimulus dynamics in auditory brain maps." Front Physiol 5: 135. Arnal, L. H., D. Poeppel and A. L. Giraud (2015). "Temporal coding in the auditory cortex." Handb Clin Neurol 129: 85-98. Hochmair, I., E. Hochmair, P. Nopp, M. Waller and C. Jolly (2015). "Deep electrode insertion and sound coding in cochlear implants." Hear Res 322: 14-23. Laback, B., K. Egger and P. Majdak (2015). "Perception and coding of interaural time differences with bilateral cochlear implants." Hear Res 322: 138-150. Malmierca, M. S., L. A. Anderson and F. M. Antunes (2015). "The cortical modulation of stimulus-specific adaptation in the auditory midbrain and thalamus: a potential neuronal correlate for predictive coding." Front Syst Neurosci 9: 19. Rudnicki, M., O. Schoppe, M. Isik, F. Völk and W. Hemmert (2015). "Modeling auditory coding: from sound to spikes." Cell Tissue Res 361(1): 159-175. Behroozmand, R., S. Sangtian, O. Korzyukov and C. R. Larson (2016). "A temporal predictive code for voice motor control: Evidence from ERP and behavioral responses to pitch-shifted auditory feedback." Brain Res 1636: 1-12. Vyssotski, A. L., A. E. Stepien, G. B. Keller and R. H. Hahnloser (2016). "A Neural Code That Is Isometric to Vocal Output and Correlates with Its Sensory Consequences." PLoS Biol 14(10): e2000317.

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3	Actin code	The Actin Code **SEE also Cytoskeleton Code**	Vedula, P. and A. Kashina (2018). "The makings of the 'actin code': regulation of actin's biological function at the amino acid and nucleotide level." J Cell Sci 131(9).
4	Adenylation code	The Adenylation Code	Stachelhaus, T., H. D. Mootz and M. A. Marahiel (1999). "The specificity-conferring code of adenylation domains in nonribosomal peptide synthetases." Chem Biol 6(8): 493-505. Davis, R. and Y. Shi (2014). "The polyadenylation code: a unified model for the regulation of mRNA alternative polyadenylation." J Zhejiang UnivSci B 15(5): 429-437. Zhang, F., Y. Wang, Q. Jiang, Q. Chen, L. Karthik, Y.-L. Zhao and Z. Li (2018). "Substrate selection of adenylation domains for nonribosomal peptide synthetase (NRPS) in bacillamide C biosynthesis by marine Bacillus atrophaeus C89." Journal of Industrial Microbiology & Biotechnology 45(5): 335-344.

5	Adhesion code	The Adhesion Code **SEE also Synaptic code(s)** **SEE also Cadherin code(s)**	Faria, M. (2018). “Aggregating, polarizing, networking – The evolution of cell adhesion codes.” Biosystems 164: 60-67. Tsai, T. Y., M. Sikora, P. Xia, T. Colak-Champollion, H. Knaut, C. P. Heisenberg and S. G. Megason (2020). "An adhesion code ensures robust pattern formation during tissue morphogenesis." Science 370(6512): 113-116.
6	Allosteric code	The Allosteric Code	Edelstein, S. J. (1996). "An allosteric theory for hemoglobin incorporating asymmetric states to test the putative molecular code for cooperativity." J Mol Biol 257(4): 737-744. Daugherty, M. A., M. A. Shea, J. A. Johnson, V. J. LiCata, G. J. Turner and G. K. Ackers (1991). "Identification of the intermediate allosteric species in human hemoglobin reveals a molecular code for cooperative switching." Proc Natl Acad Sci U S A 88(4): 1110-1114. Goldbeck, R. A., R. M. Esquerra, D. S. Kliger, J. M. Holt and G. K. Ackers (2004). "The molecular code for hemoglobin allostery revealed by linking the thermodynamics and kinetics of quaternary structural change. 2. Cooperative free energies of (alphaFeCObetaFe)2 and (alphaFebetaFeCO)2 T-state tetramers." Biochemistry 43(38): 12065-12080. Armour-Garb, I., I. S. M. Han, B. S. Cowan and K. M. Thayer (2022). “Variable Regions of p53 Isoforms Allosterically Hard Code DNA Interaction.” J Phys Chem B.
7	Angiotensin code	The Angiotensin Receptor Code	Sadybekov, A. and V. Katritch (2020). "Breaking the Enigma Code of Angiotensin II Type 2 Receptor Signaling." Structure 28(4): 390-392.
8	Antibiotic resistance code	The Antibiotic Resistance Codes	Lo, S. W., N. Kumar and N. E. Wheeler (2018). "Breaking the code of antibiotic resistance." Nat Rev Microbiol 16(5): 262.
9	Apoptosis code	The Apoptosis Code	Basañez, G. and J. M. Hardwick (2008). “Unravelling the bcl-2 apoptosis code with a simple model system.” PLoSBiol 6(6): e154. Füllgrabe, J., N. Hajji and B. Joseph (2010). "Cracking the death code: apoptosis-related histone modifications." Cell Death Differ 17(8): 1238-1243. Biermann, M., C. Maueröder, J. M. Brauner, R. Chaurio, C. Janko, M. Herrmann and L. E. Muñoz (2013). "Surface code--biophysical signals for apoptotic cell clearance." Phys Biol 10(6): 065007.

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10	Archetype codes	The Archetype Codes	Major, J. C. (2021). "Archetypes and code biology." Biosystems 208: 104501.
11	Area code	The Area / Cell Recognition Code	Hood, L., H. V. Huang and W. J. Dreyer (1977). "The area-code hypothesis: The immune system provides clues to understanding the genetic and molecular basis of cell recognition during development." Journal of Supramolecular Structure 7(3-4): 531-559. Springer, T. A. (1993). "Signals on endothelium for lymphocyte recirculation and leukocyte emigration: the area code paradigm." Harvey Lect 89: 53-103. Dreyer, W. J. (1998). "The area code hypothesis revisited: olfactory receptors and other related transmembrane receptors may function as the last digits in a cell surface code for assembling embryos." Proc Natl Acad Sci U S A 95(16): 9072-9077. Liu, C. Y. (2020). "β7 Gives Tregs a Gut Area Code." Cell Mol Gastroenterol Hepatol 9(3): 543-544.
12	Arrestin code	The Arrestin Receptor Code	Draper-Joyce, C. J. and A. Christopoulos (2018). "Strength in numbers-an arrestin interaction code." Nat Struct Mol Biol 25(6): 437-439.
13	Assembly code	The Assembly Code	Shelton, C. L., D. G. Conrady and A. B. Herr (2017). "Functional consequences of B-repeat sequence variation in the staphylococcal biofilm protein Aap: deciphering the assembly code." Biochem J 474(3): 427-443.
14	Auxin code	The Auxin Metabolism Code	Campos, M. L. (2021). "Breaking the code of auxin metabolism: an additional role for DIOXYGENASE FOR AUXIN OXIDATION 1." Plant Physiol 187(1): 7-8.

15	Axon guidance code	The Axon Guidance Codes	Goodhill, G. J. (2003). "A theoretical model of axon guidance by the Robo code." Neural Comput 15(3): 549-564. Kinrade, E. F. and A. Hidalgo (2004). "Lateral neuron--glia interactions steer the response of axons to the Robo code." Neuron Glia Biol 1(2): 101-112. Shirasaki, R., J. W. Lewcock, K. Lettieri and S. L. Pfaff (2006). "FGF as a target-derived chemoattractant for developing motor axons genetically programmed by the LIM code." Neuron 50(6): 841-853. Zarin, A. A., A. C. Daly, J. Hülsmeier, J. Asadzadeh and J. P. Labrador (2012). "A GATA/homeodomain transcriptional code regulates axon guidance through the Unc-5 receptor." Development 139(10): 1798-1805. Kohl, A., T. Marquardt, A. Klar and D. Sela-Donenfeld (2015). "Control of axon guidance and neurotransmitter phenotype of dB1 hindbrain interneurons by Lim-HD code." J Neurosci 35(6): 2596-2611.
16	BAFF code	The BAFF Immune Code	Mackay, F. and P. Schneider (2009). "Cracking the BAFF code." Nat Rev Immunol 9(7): 491-502.
17	Bile code	The Bile Acid Code	Gadaleta, R. M., M. Cariello, L. Crudele and A. Moschetta (2022). "Bile Salt Hydrolase-Competent Probiotics in the Management of IBD: Unlocking the "Bile Acid Code"." Nutrients 14(15).
18	Binaural code	The Binaural Code	Encke, J. and M. Dietz (2022). "A hemispheric two-channel code accounts for binaural unmasking in humans." CommunBiol 5(1): 1122.
19	Bioelectric code	The Bioelectric Code	Tseng, A. and M. Levin (2013). "Cracking the bioelectric code: Probing endogenous ionic controls of pattern formation." Commun Integr Biol 6(1): e22595. Levin, M. and C. J. Martyniuk (2018). "The bioelectric code: An ancient computational medium for dynamic control of growth and form." Biosystems 164: 76-93. Silver, B. B. and C. M. Nelson (2018). "The Bioelectric Code: Reprogramming Cancer and Aging From the Interface of Mechanical and Chemical Microenvironments." Front Cell Dev Biol 6: 21.

20	Biosysnthetic code	The Biosynthetic Code	Xu, Z., M. Baunach, L. Ding, H. Peng, J. Franke and C. Hertweck (2014). "Biosynthetic code for divergolide assembly in a bacterial mangrove endophyte." Chembiochem 15(9): 1274-1279.
21	Body plan code	The (Epigenetic) Body Plan Code	Elder D (1979) An epigenetic code. Differentiation, 14, 119-122.
22	Brain code	The Universal Brain Code	Rosenberg, R. N. (2021). "The universal brain code a genetic mechanism for memory." J Neurol Sci 429: 118073.
23	Cadherin code	The Cadherin Neuronal Code	Pearson, Caroline A., Samantha J. Butler and Bennett G. Novitch (2014). "Neuronal Organization: Unsticking the Cadherin Code." Current Biology 24(23): R1127-R1129. Canzio, D. and T. Maniatis (2019). "The generation of a protocadherin cell-surface recognition code for neural circuit assembly." Curr Opin Neurobiol 59: 213-220. Bao, M., J. Cornwall-Scoones, E. Sanchez-Vasquez, D. Y. Chen, J. De Jonghe, S. Shadkhoo, F. Hollfelder, M. Thomson, D. M. Glover and M. Zernicka-Goetz (2022). "Stem cell-derived synthetic embryos self-assemble by exploiting cadherin codes and cortical tension." Nat Cell Biol 24(9): 1341-1349.
24	Calcium code	The Calcium Code	Johnston, D. (1996). The calcium code. Biophys J, 70(3), 1095. Thomine, S. (2001). "Cracking the calcium code." Trends Plant Sci 6(11): 501. Allen, G. J. and J. I. Schroeder (2001). "Combining genetics and cell biology to crack the code of plant cell calcium signaling." Sci STKE 2001(102): re13. Mauro, T. (2003). "'The discovery channel': CRAC'king the code of calcium influx." J Invest Dermatol 121(1): Ix-x. Parekh, A. B. (2006). "Cell biology: cracking the calcium entry code." Nature 441(7090): 163-165. DeFalco, T. A., K. W. Bender and W. A. Snedden (2009). "Breaking the code: Ca2+ sensors in plant signalling." Biochem J 425(1): 27-40. Haiech, J. and M. Moreau (2011). "The calcium signal: a universal carrier to code, decode and transduce information." Biochimie 93(12): v.

			Covelo, A., A. Badoual and A. Denizot (2022). "Reinforcing Interdisciplinary Collaborations to Unravel the Astrocyte "Calcium Code"." J Mol Neurosci 72(7): 1443-1455. Moccia, F., Brunetti, V., Soda, T., Berra-Romani, R., & Scarpellino, G. (2023). Cracking the Endothelial Calcium (Ca2+) Code: A Matter of Timing and Spacing. Int J Mol Sci, 24(23), 16765. Paudel, S., Yue, M., Nalamalapu, R., & Saha, M. S. (2024). Deciphering the Calcium Code: A Review of Calcium Activity Analysis Methods Employed to Identify Meaningful Activity in Early Neural Development. Biomolecules, 14(1), 138.
25	Cancer code	The Epigenetic Cancer Code	Altarac, S. (1993). "Numerical quadruplet code of human cervical carcinoma tissue proteins." Acta Med Croatica 47(2): 85-87. Smith, L. T., G. A. Otterson and C. Plass (2007). "Unraveling the epigenetic code of cancer for therapy." Trends Genet 23(9): 449-456. Ozawa, M. G., M. Cardó-Vila, P. J. Mintz, W. Arap and R. Pasqualini (2010). "Cracking the code for compartment-specific dual functionality proteins in cancer: the case for CRKL." Cell Cycle 9(1): 8-9 Brower, V. (2011). "Epigenetics: Unravelling the cancer code." Nature 471(7339): S12-13. New, M., H. Olzscha and N. B. La Thangue (2012). "HDAC inhibitor-based therapies: can we interpret the code?" Mol Oncol 6(6): 637-656. Blancafort, P., J. Jin and S. Frye (2013). "Writing and rewriting the epigenetic code of cancer cells: from engineered proteins to small molecules." Mol Pharmacol 83(3): 563-576. Karpathakis, A., H. Dibra and C. Thirlwell (2013). "Neuroendocrine tumours: cracking the epigenetic code." Endocr Relat Cancer 20(3): R65-82. Sato, K., T. Hara and M. Ohya (2013). "The code structure of the p53 DNA-binding domain and the prognosis of breast cancer patients." Bioinformatics 29(22): 2822-2825. Kulkarni, R. A. and J. L. Meier (2014). "Chemical cryptology of cancer's histone code." Chem Biol 21(11): 1419-1421.

			Lomberk, G. A. and R. Urrutia (2015). "The Triple-Code Model for Pancreatic Cancer: Cross Talk Among Genetics, Epigenetics, and Nuclear Structure." Surg Clin North Am 95(5): 935-952. Roschewski, M. and W. H. Wilson (2015). "Cracking the diverse biologic code of diffuse large B-cell lymphoma." Semin Hematol 52(2): 55-56 Bonci, D., V. Coppola, M. Patrizii, A. Addario, A. Cannistraci, F. Francescangeli, R. Pecci, G. Muto, D. Collura, R. Bedini, A. Zeuner, M. Valtieri, S. Sentinelli, M. S. Benassi, M. Gallucci, P. Carlini, S. Piccolo and R. De Maria (2016). "A microRNA code for prostate cancer metastasis." Oncogene 35(9): 1180-1192. Qiao, H. and C. M. Lovly (2016). "Cracking the Code of Resistance across Multiple Lines of ALK Inhibitor Therapy in Lung Cancer." Cancer Discov 6(10): 1084-1086. Søreide, K., M. M. Watson and H. R. Hagland (2016). "Deciphering the Molecular Code to Colorectal Liver Metastasis Biology Through Microsatellite Alterations and Allelic Loss: The Good, the Bad, and the Ugly." Gastroenterology 150(4): 811-814. Lucas, C. (2017). “Cracking the cancer code: a personalised genomic approach.” Lancet Oncol 18(6): 717. Yotsukura, S., M. Karasuyama, I. Takigawa and H. Mamitsuka (2017). "Exploring phenotype patterns of breast cancer within somatic mutations: a modicum in the intrinsic code." Brief Bioinform 18(4): 619-633. Rodríguez, E., S. T. T. Schetters and Y. van Kooyk (2018). "The tumour glyco-code as a novel immune checkpoint for immunotherapy." Nat Rev Immunol 18(3): 204-211. Lopes, N., V. G. Correia, A. S. Palma and C. Brito (2021). "Cracking the Breast Cancer Glyco-Code through Glycan-Lectin Interactions: Targeting Immunosuppressive Macrophages." Int J Mol Sci 22(4). Xia, Z., N. Kon, A. P. Gu, O. Tavana and W. Gu (2022). “Deciphering the acetylation code of p53 in transcription regulation and tumor suppression.” Oncogene 41(22): 3039-3050. Zuo, J., Zhang, Z., Li, M., Yang, Y., Zheng, B., Wang, P., . . . Zhou, S. (2022). The crosstalk between reactive oxygen species and noncoding RNAs: from cancer code to drug role. Molecular Cancer, 21(1), 30.

26	Cell access code	The Cell Access Code	Zengel, J. and J. E. Carette (2020). “Cracking the cell access code for the deadly virus VEEV.” Nature 588(7837): 223-224.
27	Cell surface code	The Cell Surface Recognition Code	Mountoufaris, G., D. Canzio, C. L. Nwakeze, W. V. Chen and T. Maniatis (2018). “Writing, Reading, and Translating the Clustered Protocadherin Cell Surface Recognition Code for Neural Circuit Assembly.” Annu Rev Cell Dev Biol 34: 471-493.
28	Cell wall code	The Plant Cell Wall Code	Tavares, E. Q. and M. S. Buckeridge (2015). “Do plant cell walls have a code?” Plant Sci 241: 286-294.
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