



Rev. 123, 45-54. Thus, these may define species' canonical traits by epigenetic processes (Reik and Walter, 2001; Salmon et al., 2009; Verhoeven et al., 2009; Verhoeven et al., 2009; Verhoeven et al., 2010; Daxinger and Whitelaw, 2012; Frésard et al., 2013). 14, 47-58. Arch. doi: 10.1155/2012/585024 PubMed Abstract | CrossRef Full Text | Google Scholar Maturana, A., and Vargas, A. Nowadays it is widely acknowledged in our own species, thanks to studies applying the framework of the classic model of heredity (evaluated using the twins method), that the offspring of traumatized people have an increased predisposition toward developing posttraumatic stress disorder (PTSD), as well as mood and anxiety maladies (True et al., 1993). doi: 10.1007/s10648-011-9170-y CrossRef Full Text | Google Scholar Stevenson, T. Médica Clínica Las Condes 26, 34-41. In these three types of environment, children can be subjected to positive and negative stimuli that will be very important in their learning process and personal formation. Therefore, stress-related epigenetic marks could be found in people undergoing stress during their ontogeny, with long term consequences on their psychological functioning, and these changes can even be preserved in the following generations as an intergenerational traumatic response (Mulder et al., 2017). Figure 1. Bullying, Depression, and Suicidality in Adolescents. Socioeconomic status and the brain: mechanistic insights from human and animal research. "Children's, epigenetics, the Environment, and Children's, epigenetics, the Environment, and Children's, epigenetics, the Environment, and Children's Health Across Lifespans, ed D. Paris: Gonthier-Denoël. Gen. doi: 10.1371/journal.pone.0126638 PubMed Abstract | CrossRef Full Text | Google Scholar Belsky, J., Bakermans-Kranenburg, M. DNA methylation dynamics during the mammalian life cycle. Similarly, in plants, it has been shown that DNA methylation dynamics during the mammalian life cycle. similar to those of maternal plants once stress conditions are discontinued (Baránek et al., 2015). M., Brito, N. 17, 377-382. 28, 12-23. 11:228. Moreover, the offspring were incapable of facing adverse or novel circumstances. Dev. P., Leu, N. Yehuda et al. S., Kippin, T. Psychologie et Épistémologie: Pour une théorie de la Connaissance. Some educators are starting to pay attention to the importance of epigenetic mechanisms within the classroom. doi: 10.1016/j.psyneuen.2015.04.013 PubMed Abstract | CrossRef Full Text | Google Scholar Zaidan, H., Leshem, M., and Gaisler-Salomon, I. Transgenerational epigenetic programming via sperm microRNA recapitulates effects of paternal stress. doi: 10.1038/mp.2014.84 PubMed Abstract | CrossRef Full Text | Google Scholar Morgan, H. Frente a esta realidad, la doctora Florencia Raele explica cada uno de los factores que pueden enfermarnos y cómo intervenir para lograr una salud integral recuperando las funciones ancestrales que hemos olvidado. F3 or F2? Brassica oleracea displays a high level of DNA methylation polymorphism. However, in order to reach to this level of application of epigenetic knowledge, the role of epigenetic knowledge, the role of epigenetic plasticity on learning, stress response and children's health must be further studied. Mol. 167, 171-186. This is concordant with evidence showing that poverty is among the factors leading to PTSD and that these stress patterns have a negative effect on a child's cognitive abilities (Milan et al., 2013). Teacher wellbeing: the importance of teacher-student relationships. Biología y Conocimiento, Ensayo Sobre las Relaciones Entre las Regulaciones Orgánicas y Los Procesos Cognoscitivos. Neurobiol. 159, 30-37. doi: 10.1073/pnas.1118514109 PubMed Abstract | CrossRef Full Text | Google Scholar Day, J. Interestingly, supporters of each teaching model could claim Andrew succeeded because of their tactics: he could have exceled due to the strict education program imposed by his music teacher Terence Fletcher, or due to the love, confidence and support provided by his ever-present father. doi: 10.1111/j.1467-8624.2009.01325.x PubMed Abstract | CrossRef Full Text | Google Scholar Siklenka, K., Erkek, S., Godmann, M., Lambrot, R., McGraw, S., Lafleur, C., et al. 39, 66-72. Strikingly, recent evidence shows that an altered ncRNA function gives rise to diverse hereditary maladies, including neurological disorders (Vučićević et al., 2014). R., Davies, W., and Wilkinson, L. "Education Reform in Chile. O., Sasaki, A., D'Alessio, A. Transgenerational epigenetic inheritance: how important is it? (2013b). U.S.A. 110, 16651-16656. DNA methylation divergence can be linked to stable phenotypes (Szyf, 2011). The school-age environment can affect performance during adulthood. For example, in mice partaking in maternal nutrition, this phenomenon brings stable phenotypic consequences for the offspring (Morgan and Whitelaw, 2008). doi: 10.1016/j.biopsych.2013.04.014 PubMed Abstract | CrossRef Full Text | Google Scholar A., Mandansky, D., King, S., Fletcher, K. Epigenetic transgenerational inheritance of altered stress responses. The frequent exposure of youngsters to a stressful, aggressive school environment (either as victims or bullies) is shown to negatively associate to syndromes such as depression, ideation, and suicide attempts (Brunstein et al., 2007). One of these periods occurs after fertilization, when a major reduction in DNA methylation occurs, followed by the reestablishment of DNA methylation patterns by the time of blastocyst implantation (Hackett and Surani, 2013a). Moreover, the connection between the malfunction of epigenetic regulation and the occurrence of several mental disorders has become rather clear thanks to recent research (Rudenko and Tsai, 2014). doi: 10.1002/ece3.1993 PubMed Abstract | CrossRef Full Text | Google Scholar Xie, L., Korkmaz, K. These findings point out that PRS influences in adolescent females lead to behavioral modifications that extend, at least, to the second-generation offspring, and indicate that there is a transgenerational effect on endocrine function. (2018). It has been proposed that this begins with prompt, short-lived epigenetic changes that may ultimately lead to stable epigenetic marks in a multistep fashion. Mental health and associated factors among young offenders in Chile : a cross-sectional study. (2005). Behav. Trends Endocrinol. These steps are crucial in the formation of every tissue, in particular neural tissues, and have key roles in the conformation of behavior (Reik et al., 2001). Moreover, the regulation of gene transcription mediated by microRNA has recently been found to be related to learning and memory in mice. doi: 10.1016/S0306-4530(01)00045-2 CrossRef Full Text Hackett, J. D., Sodhi, M., and Kleinman, J. Piaget, J. doi: 10.1080/02678373.2012.734709 CrossRef Full Text | Google Scholar Nielsen, M. doi: 10.1093/hropen/hoy010 CrossRef Full Text | Google Scholar Bredy, T. In another study, unpredictable maternal separation has been shown to induce depressive-like behaviors and altered behaviors and altered behaviors and altered behavioral responses to adverse environments. This study included three different causes of parental PTSD: The Holocaust, the World Trade Center collapse, and maternal childhood abuse (Yahyavi et al., 2014; Yehuda et al., 2014). As such, special care should be taken in the development of future teachers and school educators in this respect. doi: 10.1111/j.1467-8721.2007.00525.x CrossRef Full Text | Google Scholar Bertoldo, M. This evidence represents the first demonstration that metabolic patterns affected by stress might also be transgenerationally transmitted through epigenetic inheritance. Natl. A. It is important to highlight that these periods of resetting DNA methylation patterns, are windows of sensitivity to environmental exposures, both in PGCs and early embryos (Jirtle and Skinner, 2007; Feil and Fraga, 2012). S., Braun, K., and Bock, J. (2016) studied a stress-related gene that has been associated with PTSD and depression (FKBP5), and demonstrated that people who suffered during the Holocaust presented DNA methylation modifications in this gene. doi: 10.1098/rstb.2006.1942 PubMed Abstract | CrossRef Full Text | Google Scholar Jablonka, E., and Raz, G. It is at the school where they learn skills and project their future role in society (Hannah, 2013); it is also at the school where, by means of learning, the brain develops rapidly, establishing new neural connections. L., and Lattal, K. Importantly, the serotonin transporter gene drives a number of autonomic responses to stress (Feder et al., 2009). doi: 10.3389/fmicb.2017.02483 PubMed Abstract | CrossRef Full Text | Google Scholar Füllgrabe, J., Klionsky, D. 14, 20427-20442. doi: 10.7764/psykhe.21.2.548 CrossRef Full Text | Google Scholar True, W. Epigenetic mechanisms of genomic imprinting: common themes in the regulation of imprinted regions in mammals, plants, and insects. S., Uzumcu, M., Skinner, M. Prereproductive stress to female rats alters corticotropin releasing factor type 1 expression in offspring. 21, 214-222. This epigenetic influence was observed not only in exposed parents, but also in their offspring. Environmentally induced epigenetic transgenerational inheritance of male infertility. Nonetheless, knowledge gaps remain, since the molecular mechanisms involved in this transgenerational transmission are not fully understood (Mulder et al., 2017). Reversible DNA methylation regulates seasonal photoperiodic time measurement. doi: 10.1016/j.psychres.2016.06.022 PubMed Abstract | CrossRef Full Text | Google Scholar Fenoglio, C., Ridolfi, E., Galimberti, D., and Scarpini, E. Outcomes of exposure to workplace bullying: a meta-analytic review. 16, 33-41. Final Epistemological Considerations Current evidence provided by the study of epigenetic influences on behavioral development and transgenerational consequences through cultural as
well as epigenetic inheritance highlights the dynamic nature of organisms' plasticity. Viol. doi: 10.1016/j.biopsych.2015.08.005 PubMed Abstract | CrossRef Full Text | Google Scholar Zaidan, H., and Gaisler-Salomon, I. Furthermore, trauma and abuse in early life have been associated to allele-specific changes in methylation patterns of genes moderating the induction of psychosis (Klengel et al., 2012; Klengel and Binder, 2015). In humans, it has been hypothesized that early in life, social environment may have a long-lasting effect on mental and physical health trajectories due to epigenetic marking of specific genes (Mehta et al., 2013; Hollar, 2016a,b). Multigenerational obesity-induced perturbations in oocyte-secreted factor signalling can be ameliorated by exercise and nicotinamide mononucleotide. Proc. During these early stages of brain development, the role of the environment becomes of great importance for learning (Lenroot and Giedd, 2006; Saxe et al., 2009). doi: 10.1073/pnas.1508347112 PubMed Abstract | CrossRef Full Text | Google Scholar Roth, T. The epigenetics of social adversity in early life: Implications for mental health outcomes. doi: 10.1016/j.tem.2009.12.007 PubMed Abstract | CrossRef Full Text | Google Scholar Skinner, M. Meanwhile generation "E1" and "E2" represent non-filial ontogenies affected environmentally by educational influences (cyan boxes) provided by F1 and F2 respectively, such as teachers' impact over their students' ontogenetic transgenerational phenotype? This is of utmost relevance when considering the aforementioned studies highlighting the connection between epigenetic environmental regulators and behavioral development (e.g., Noble et al., 2015; Denhardt, 2017). doi: 10.1126/science.1108190 PubMed Abstract | CrossRef Full Text | Google Scholar Azzi, A., Dallmann, R., Casserly, A., Rehrauer, H., Patrignani, A., Maier, B., et al. A., and Bale, T. Epigenetic transmission of the impact of early stress across generations. doi: 10.1038/nature07509 PubMed Abstract | CrossRef Full Text | Google Scholar Wang, M. doi: 10.1186/s13148-014-0043-3 PubMed Abstract | CrossRef Full Text | Google Scholar Guerrero-Bosagna, C., and Skinner, M. 26, 79-88. Instead, she defined cognitive processes as developmental systems, stressing the existence of dynamic emergent controls that help to understand the acquisition of phenotypic modifications within both the evolutionary and ecological contexts (Oyama, 2000). 24, 235-242. For instance, in mice early life stress (ELS) caused by maternal separation induced histone acetylations that altered the expression of the synaptic plasticity genes Arc and Egr1 in the hippocampus. Deater-Deckard and R. Studies suggest that epigenetic mechanisms are linked to learning and memory. Biophys. Biochem. On the other hand, how many dropouts could be avoided by applying the paradigm of compassionate education, combined with an enriching environment? doi: 10.1186/1741-7015-11-228 PubMed Abstract | CrossRef Full Text | Google Scholar Skinner, M. J., and Van Ijzendoorn, M. This pathway may represent a novel biomarker for the intervention of specific behaviors associated with high-risk individuals (Swatz et al., 2017). Epigenetic influences on brain development and plasticity. (2006). Clin. This developmental system, however, must consider both learning and its related cognitive process within an epigenetic dimension, allowing pupils to achieve educational goals while constructing their own set of meaningful topics within their brains. However, Mendelian genetics has been unsuccessful in providing an adequate explanation for the inheritance mechanisms. related to the etiology of these diseases. For example, it has been shown that environmental stressors can affect the developing fetal ovary, which results in long-term consequences through ontogeny, including predisposition to illness (Ren et al., 2017). doi: 10.1111/jnc.12210 PubMed Abstract | CrossRef Full Text | Google Scholar Yahyavi, S. Psychopathol. Psychiatry, 20: 995-1001. 19, 207-212. Bullying represents an important source of stress in school children (Idsoe et al., 2012). doi: 10.1111/gbb.12187 PubMed Abstract | CrossRef Full Text | Google Scholar Prinzie, P., Onghena, P., Hellinckx, W., Grietens, H., Ghesquière, P., and Colpin, H. These fast epigenetic modifications are paralleled by raises in dendritic complexity and spine number of hippocampal CA3 pyramidal neurons in animals suffering ELS in early ontogenetic inheritance mechanisms may influence human neurobiology in formal education. Cell Biol. 185, 1108-1118. On top of this ontogenetic developmental process are the epigenetic transgenerational effects discussed earlier, which means that the effects of environmentally-induced epigenetic alterations could be quite pervasive (Pembrey et al., 2014). Therefore it is plausible to hypothesize that behind reiterated stress patterns there is a cascade of interactions across different of levels of biological organization that leads to changes in behavior, with consequences in adulthood (Nielsen et al., 2017) and the potential to be transgenerational perpetuated through epigenetic inheritance (Figure 1). (2009). We hope that a societal knowledge of epigenetics and its consequences in inheritance (and the potential to be transgenerational perpetuated through epigenetics). generations. Acknowledgments We would like to thank Dr. Jorge Mpodozis for his valuable suggestions and comments. Crim. We describe the available evidence supporting the claim that strong selective regimes based on punishment and reward are detrimental for children and young people, and that those factors may negatively contribute to the development of learning capabilities and cognition through epigenetic mechanisms. Also, evidence in humans has demonstrated that posttraumatic stress during infancy, besides modifying behavior and generating psychological disorders later in life may also be inherited to the descendants (Yahyavi et al., 2014). N.Y. Acad. Epigenetics Within the Classroom Children are mainly subject to three types of environment during their developmental years: (1) the families, (2) their neighborhoods and (3) their schools. Science, 350:aab2006. doi: 10.1097/01.chi.0000242237.84925.18 CrossRef Full Text | Google Scholar Carli, S. Rather it is a movie that contrasts two types of educational concepts: one that compassionately supports individuals toward learning new skills and focuses on providing emotional and financial support, and another whose concept of education is based on selecting the "best in the class" and demanding progress from them by placing them in high-stress situations. Epigenetic reprogramming in mammals. In mice's early-life maltreatment due to abusive behavior by stressed caretakers that induces lasting DNA methylation changes in the brain-derived neurotrophic factor (BDNF) gene prompting its altered gene expression in the adult prefrontal cortex (Roth et al., 2009a). We are very grateful to Edwin Arthur Abbett for his careful English review of our manuscript. Reprod. 33, 9003-9012. doi: 10.3390/ijms141020427 PubMed Abstract | CrossRef Full Text | Google Scholar Foa, E., Chrestman, K., and Gilboa-Schechtman (2009). Am. Acad. 71, 390-397. "F1" represent the ontogeny of a first generation and "F2" and "F3" correspond to two consecutive filial generations. F., and Gould, T. This paper explores early environmental and epigenetic influences in the development of human cognitive abilities. Meanwhile, in the F2 generation CORT levels in PRS offspring also varied depending on the sex. New York, NY: A Bradford Book. We propose that efforts must be concentrated on developing multidisciplinary research and a dialog between educators and scientists toward building an applied field focused on education that accounts for environmental influences, as well as for developmental and epigenetics. Cell 143, 1084-1096. (2007). Sel. (2016b). B. 2012:585024. doi: 10.1016/j.conb.2009.05.009 PubMed Abstract | CrossRef Full Text | Google Scholar Farrell, C., and O'Keane, V. For instance, in mice it has been experimentally established that early life stress (ELS) by maternal separation induced histone acetylations capable of modifying the expression of the genes Arc and Egr1 in their hippocampus (involved in synaptic plasticity). (2016). offspring of males affected by maternal separation. Bullying, depression, and suicidal ideation in Finnish adolescents: school survey. Carlos Guerrero-Bosagna appreciates funding provided by the ERC Genewell grant 322206 and by the E during the germ line epigenetic reprogramming can be transgenerationally-perpetuated (Koerner et al., 2009). Teachers play a central role in establishing a positive and responsive classroom environment for children, which is important for promoting the development of social, emotional, and academic skills in students (O'Connor and McCartney, 2007). G., Maddox, S., Klengel, T., and Ressler, K. Psychiatry 171, 872-880. 3, 1-34. Epigenetic mechanisms of regulation and gene expression changes have much to say about the effects of both trauma and stress on human biology, as well as about the influence of enriched environments both on intermediate, transient dynamics (Dudley et al., 2011; Xie et al., 2013; Pizzimenti and Lattal, 2015), as well as on the long-term development and functioning of brain and behavior (Murgatroyd and Spengler, 2011; Crews et al., 2012; Denhardt, 2017). Prolonged Exposure Therapy for Adolescents with PTSD. doi: 10.1007/s00420-017-1204-4 PubMed Abstract | CrossRef Full Text | Google Scholar Noble, K. Psychiatry 22, 209-214. Disruption of histone methylation in development of impairments on higher-order cognitive processes, as well as in mental health disorders (Swatz et al., 2017). K., Manikkam, M., Tracey, R., Guerrero-Bosagna, C., Haque, M., and Nilsson, E. Epigenetic transgenerational actions of endocrine disruptors and male fertility. These chemical
changes, and include at least five different known processes: (i) DNA methylation, hydroxymethylation and demethylation, (ii) rearrangements of the chromatin structure, histone modifications (e.g., acetylation, methylation, wijuitination), (iii) RNA silencing mediated by non-coding RNAs (ncRNAs), RNA editing, epi and paramutations (Morgan et al., 2005; Probst et al., 2009; Gonzalez et al., 2011; Frías-Lasserre, 2012; Frías-Lasserre and Villagra, 2017), (iv) Mobile DNAs, such as transposable elements and endogenous viral particles (Kazazian, 2004; Cordaux and Batzer, 2009), and finally (v) a wide array of transcriptional agents, signaling molecules and gene regulatory factors, or environmental triggers (e.g., exposure to a given temperature or light cycle) (Zhang and Ho, 2011; Füllgrabe et al., 2013; Azzi et al., 2014; Weyrich et al., 2016). Leer más Anyone who has watched the movie "Whiplash" (2014) must certainly have been impressed by the passion and devotion that 19-year-old Andrew puts into excelling as a drummer. Epigenetics is a contemporaneous discipline derived from genetics that includes the environmental context as a relevant part of heredity. Genomic imprinting and the social brain. doi: 10.1111/j.1749-6632.2011.06037.x PubMed Abstract | CrossRef Full Text | Google Scholar Logue, S. Oxford, New York, NY: Oxford University Press. Argentina Hist. V., Manikkam, M., Savenkova, M. Behavioral changes are also shown to be related to the disruption of genomic imprinting, which corresponds to epigenetic marks that are differentially established in each parental allele, inducing parental allele, inducing parental allele, inducing barental allele, inducing ba links between Epigenetics and Neurosciences. Currently, it is strongly influencing a variety of fields, including Medicine, Psychiatry and Psychology (Hollar, 2016b; Mulder et al., 2017). Epigenetics, The Environment, and Childrens Health Across Lifespans. Within this context, educational environment and socioeconomic factors must also be considered as extremely relevant for behavioral development and learning (Hackman et al., 2010). Res. Berlin: Springer. U.S.A. 110, 8302-8307. Emerging role of non-coding RNAs and viruses in the frame work of the phylogeny of the genes epigenesis and heredity. One of the ways of measuring PTSD is by assessing cortisol levels. 18, 73-102. doi: 10.1016/j.nlm.2011.04.004 PubMed Abstract | CrossRef Full Text | Google Scholar Bremner, J. E., and Brewer, J. In this way all actors involved in the educational system will contribute to educational goals and to the prevention of cognitive and psychiatric disorders in students. 6, 2657-2666. B., Morgan, C. It has been proposed that this begins with prompt, short-lived changes that may ultimately lead to stable epigenetic marks, in a multistep fashion. A., et al. An emerging role for long non-coding RNA dysregulation in neurological disorders. Public Policy 17:107. Relationship of cortisol, norepinephrine, and epinephrine levels with war-induced posttraumatic stress disorder in fathers and their offspring. 96, 79-88. Psykhe 21, 105-117. J., Li, X., Kobor, M. Am. J. doi: 10.1046/j.1440-1819.2001.00787.x PubMed Abstract | CrossRef Full Text | Google Scholar Klengel, T., and Binder, E. From a social point of view, and particularly in early education, it is very important to study the reversibility of epigenetic marks produced by negative environmental influences capable of leading to post-traumatic stress and other mental illness. Science 308, 1466-1469. 50, 1491-1511. King, J. S., Hansen, M. G., Kelly, B., Ferguson-Smith, A. School context, achievement motivation, and academic engagement: a longitudinal study of school engagement using a multidimensional perspective. doi: 10.1016/S0079-6123(07)67012-5 PubMed Abstract | CrossRef Full Text | Google Scholar Brunstein, K., Klomek, A., Marrocco, A., Kleinman, F., Schonfeld, M., and Gould, I. A recent review by David Denhardt (2017) points out that economic deprivation drug abuse and stressful social interactions (such as social defeat and parental abuse, or maltreatment by a caregiver) have different impacts on cognitive processes (see also Roth et al., 2009a; Turecki and Meaney, 2016; Denhardt, 2017). (2011a). Cycles of Contingency: Developmental Systems and Evolution (Life and Mind: Philosophical Issues in Biology and Psychology). As stated by Chan and coauthors: "It is this inherent developmental plasticity of an organism that allows it to respond to cues that will ultimately determine the adult" (Chan et al., 2015). Thus, the incorporation of an epigenetic framework gives novel dimensions and tools to neurobiological research to decipher the relevance of interactions between the different bidirectional coactional influences on organism' development: from environmental signals, behavioral plasticity, neural and endocrine phenotypic changes, chromatin marks and RNA modification, genomic imprinting and the genetic composition (reviewed by Meaney and Ferguson-Smith, 2010). Western Michigan University Scholar Works at WMU, Michigan, USA. M., Collin, A., Pain, B., Minvielle, F., et al. Honors Theses, Paper 2375. A., and Bredy, T. J., Boyce, W. The Ontogeny of Information. Abnorm. (2014). Individual Development and Evolution Psychiatry 46, 40-49. 30, 718-729. doi: 10.4103/2096-2924.210694 CrossRef Full Text | Google Scholar Rodgers, A. 8:2483. The link between classroom teacher burnout and morning cortisol in elementary school students. Environ. N., Makotkine, I., et al. doi: 10.1038/nrm3716 PubMed Abstract | CrossRef Full Text | Google Scholar Gaete, J., Labbé N., Del Villar, P., Allende, C., Araya, R., and Valenzuela, E. I. It has been suggested that suitable social and pharmacological interventions could upturn negative epigenetic markings originated by early life detrimental social stimulus (McGowan and Szyf, 2010). Both Holocaust survivors and their descendants showed epigenetic changes at the same site of FKBP5 intron 7, but in the opposite direction. Victimization from workplace bullying after a traumatic event: time-lagged relationships with symptoms of posttraumatic stress. Evol. These findings also highlight the importance of considering the educational process as a developmental system (sensu Oyama), where parental health is a fundamental part of the student's inherited background. Epigenetic mechanisms underlying learning and the inheritance of learned behaviors. The researchers proposed to long-term hepatic problems. doi: 10.1016/j.nlm.2011.02.008 PubMed Abstract | CrossRef Full Text | Google Scholar McEwen, B. 31, 2412-2429. R., Fauquier, L., Habib, N., Shea, J. María Inés Picazo, M. doi: 10.1073/pnas.1310643110 PubMed Abstract | CrossRef Full Text | Google Scholar Swatz, J. In these MHF-mothers' offspring, cell cycle activity showed significant G0/G1 arrest, linked with an hypomethylation of the hepatic cell cycle inhibitor Cdkn1a and an augmented expression of mRNA, correlated with a decrease both in liver/brain weight ratio. K., Altmann, A., Pace, T. doi: 10.1016/j.neubiorev.2010.12.016 PubMed Abstract | CrossRef Full Text | Google Scholar Ellis, B. R., Hariri, A. A study evaluating 16,410 secondary school students in Finland demonstrated that about one in ten schoolchildren reported being bullied on a weekly basis at school, representing a constant source of environmentally-borne stress in youngsters (Kaltiala-Heino et al., 1999). C, Pembrey, M., and Lindquist, S. doi: 10.1371/journal.pgen.1001252 PubMed Abstract | CrossRef Full Text | Google Scholar Weyrich, A., Benz, S., Karl, S., Jeschek, M., Jewgenow, K., and Fickel, J. The importance of ncRNAs as an epigenetic mechanisms in phenotypic variation and organic evolution. (2009b). The return of the nucleus: transcriptional and epigenetic control of autophagy. doi: 10.1016/j.reprotox.2007.09.001 CrossRef Full Text | Google Scholar Spadaro, P. For instance, Dudley et al. Front. A review on the evidence of transgenerational transmissions of posttraumatic stress disorders vulnerability. In Chile, students in public educational performance than pupils from private schools ("Informe Nacional de Resultados" SIMCE 2012-2014), which correlates to a higher exposure to stressful factors for children in the public educational system (e.g., maltreatment, bullying, drug addiction; Tijmes, 2012; Maturana and Vargas, 2015). 368:20110328. Thus, violent interpersonal treatment from a teacher, can be classified as a repeated traumatizing stimuli capable of leading to PTSD (Foa et al., 2009), with cultural as well potentially epigenetic inheritance effects. 1226, 14-33. 44, 340-369. This is why it is paramount to define what the objectives of formal education are, in order to start designing novel programs that take into consideration the neurobiological and epigenetic aspects, as well as students, their families, and their living conditions. Educ. Although strict education certainly succeeds in creating some kind of "excellence," it does so at a very high cost: many will drop out during the process (as happens in "Whiplash," in which there is even a suicide), while the survivors that excel will do so with a legacy of trauma in their brains (as is the case with Andrew). We believe it should be a must to promote and foster adequate environmental conditions in educational institutions, backed by appropriate regulations, in order to ensure an enriching and healthy educational process. These genes are related to the development of limbic brain circuits. (2012). From kindergarten teaching up until leaving high school, children spend a great deal of time in classrooms, more so than in their houses and neighborhoods. For example, insulin and blood sugar levels were lower in these individuals than in the controls. Importantly, when occurring in gametes, epigenetic changes may even pass to next generations (reviewed by Denhardt, 2017; Mulder et al., 2017). doi: 10.3389/fpsyt.2013.00118 PubMed Abstract
| CrossRef Full Text | Google Scholar Yehuda, R., Daskalakis, N. Occup. In recent years mRNAs and micro RNAs have been found to play a major role in neural and synaptic plasticity (Burke and Barnes, 2006; Vo et al., 2010). R. As mentioned above, many studies show the inheritance of environmentally induced nervous system pathologies (Johnstone and Baylin, 2010). Child Psychol. Early life stress-induced histone acetylations correlate with activation of the synaptic plasticity genes Arc and Egr1 in the mouse hippocampus. A., and Surani, M. Social regulation of the cortisol levels in early human development. We make the case of the potential benefits of an enriched, non-stressful educational environment on the development of cognitive capabilities during early stages of human ontogeny. Recent progress has to be acknowledged, such as The Moore Institute School of Medicine with its "Let's Get Healthy" initiative (www.letsgethealthy.org), which incorporates the epigenetic dimension into its middle school program. K. Studies in rodents have described genomic imprinting related with parental care (Wilkins and Haig, 2003; Wolf and Hager, 2006). K., Bradley-Moore, M., Malaspina, D., et al. Due to imprinting, the expression of some genes is restricted to one of the alleles. doi: 10.1016/j.tins.2014.12.003 PubMed Abstract | CrossRef Full Text | Google Scholar Dias, B., and Ressler, K. doi: 10.1016/j.gde.2014.06.005 PubMed Abstract | CrossRef Full Text | Google Scholar Gunnar, M. H. Genes Brain Behav. Season of conception in rural gambia affects of the educational environment, it has been demonstrated that children exposed to bullying during school years are more susceptible to develop PTSD later in life, along with other mental illnesses such as suicidal tendencies and self-injury (Dhingra et al., 2016). "Los nudos críticos de la educación: una visión desde el colegio de profesores," in Los nudos críticos de la educación en Chile, eds V. Biochim. In addition, knowledge of the importance of epigenetics in government authorities will allow for the implementation of public policies to increase friendly environments not only in the classroom but also in society. R., and Williamson, D. doi: 10.4161/epi.6.8.16793 PubMed Abstract | CrossRef Full Text | Google Scholar Tijmes, C. Because the action of epigenetic mechanisms is crucial during brain development and its functional configuration (Fagiolini et al., 2009), the consideration of the epigenetic component of brain dynamics during learning and memory formation is becoming of growing importance for educational neurosciences, both in research and application (Levenson and Sweatt, 2005; Gräff and Mansuy, 2008; Gräff and Mansuy, 2008; Cräff and Mansuy, 2008; Day and Sweatt, 2011a,b). Biol. Oxford; New York, NY: Oxford University Press. More "subtle" but repeated stress factors however, have been also been considered to be environmental regulators of epigenetic influences. PLoS ONE 10:e0126638. 1:13. Interestingly, in all these cases, the transgenerational transmission of these effects is mediated by paternal adult exposures followed by epigenetic alterations in the germ line. Biobehav. R., and Donzella, B. Curr. Likewise, workplace bullying is associated with PTSD symptoms, augmented physical, mental and health problems, burnout, increased intentions to leave, and reduced job satisfaction and organizational commitment (Nielsen and Einarsen, 2012). Emerging roles of epigenetic mechanisms in the enduring effects of early-life stress and experience on learning and formal education fit Oyama's notion of developmental systems and are, therefore, subjected to this dialectical education fit Oyama's notion of developmental systems and experience on learning and formal education fit Oyama's notion of developmental systems and are, therefore, subjected to this dialectical education fit Oyama's notion of developmental systems and education fit Oyama's notion of deve flux between hierarchical levels. Interpers. doi: 10.1016/j.plantsci.2007.09.012 CrossRef Full Text | Google Scholar Saxe, R. Parry, T. 3:132. Moreover, the possibility exists that gametic epigenetic marks are altered in students as consequence of environmental stress, and therefore that the effects of such stressful conditions would be transgenerationally transmitted, with potentially disastrous consequences for the mental health of future generations. Usually, in mammals, development programming is regulated by epigenetics. Examining teacher-child relationships and achievement as part of an ecological model of development. U.S.A. 112, 13699-13704. These genes are involved in the development of limbic brain circuits. J. Two well described develo Epigenetic biomarkers as predictors and correlates of symptom improvement following psychotherapy in combat veterans with PTSD. This teaching epigenetic concepts and their consequences on heredity (Colón-Berlingeri, 2010). Therefore, 2010). under the current status of inequity and educational system, it is likely that students from impoverished families are being exposed to stress in adolescent female ratsonal environment. Prereproductive stress in adolescent female ratsonal environment. affects behavior and corticosterone levels in second-generation offspring. Health 90, 411-421. Paternal heat exposure causes DNA methylation and gene expression changes of Stat3 in Wild guinea pig sons. doi: 10.1525/abt.2010.72.4.3 CrossRef Full Text | Google Scholar Conradt, E., Measelle, J., and Ablow, J. These active influences may not only define behavioral dysfunctions and stressed phenotypes, but may also have phenotypic and hereditary consequences for our own species (Frías-Lasserre and Villagra, 2017). T., and Eccles, J. (2003). Paternal stress exposure alters sperm microRNA content and reprograms offspring HPA stress axis regulation. Moreover, the environmental stressors may trigger altered epigenetic signals that would accumulate with long-term exposure (Figures 1A,B). B., Knardahl, S., and Heir, T. doi: 10.1093/hmg/ddi114 PubMed Abstract | CrossRef Full Text | Google Scholar Mulder, R. 38, 96-107. Neuropsychopharmacology 40, 244-246. C., Gräff, J., Linder, N., Michalon, A., et al. Nat. 41, 339-353. The alteration of imprinting in these genes may contribute to the development of neurobiological disorders such as psychosis and autism (Isles et al., 2006; Úbeda and Gardner, 2010, 2011, 2012). Also teachers working in public schools often present mental health related disorders such as depression, stress and neurosis (García, 2013). However, recently Bertoldo and coauthors (Bertoldo et al., 2018) have described in rats that epigenetics changes could be ameliorated by exercise, stressing the reversibility of these changes. Interestingly, traumatic stress demonstrated to alter relative amounts of microRNAs in blood, brain and spermatozoids. children and adolescents. Finally, as young Homo sapiens, from all cultures and credos, tend to experience rather standardized educational experiences, we consider that the link between epigenetic inheritance and human learning must be taken into serious consideration both in formal education, and as an academic venue for research related to educational sciences, neurobiology, genetics and human evolution. 15, 65-74. doi: 10.1038/nn.3275 PubMed Abstract | CrossRef Full Text | Google Scholar Kramer, J. Anim. The consequences of a punitive educational regime may be even more acute in poorer segments of the population, at is the case in Chile, where orphans and young offenders are often sent to homes belonging to the National Service for Minors (Servicio Nacional de Menores, SENAME). Globalization, climate change, and transgenerational epigenetic inheritance: will our descendants be at risk? Interestingly, the offspring of parents with PTSD exhibited lower cortisol levels (King et al., 2001). doi: 10.1038/mp.2016.82 CrossRet Full Text | Google Scholar Szyf, M. Some small RNAs, such as siRNAs, show drastic increases during the early stages of learning, which have been suggested as relevant for the etiology of neuro-psychiatric diseases (Roth
et al., 2009a; Smalheiser and Lugli, 2009; Spadaro and Bredy, 2012) Likewise, some long ncRNAs are involved in the transcriptional regulation of genes associated with neurological disorders such as Huntington's disease, schizophrenia, epilepsy, Prader-Willi syndrome, and Alzheimer's and Parkinson's Diseases (Vučićević et al., 2014). For instance, it has been demonstrated that novel stressors may act as environmental influences on organisms, driving the induction of epigenetic changes. Interestingly, such traumatized mice preserved this altered behavior throughout life, and these aberrant behaviors were observed for the next three generations (Gapp et al., 2014). Pizzimenti, C. In this context, among these environmentally-induced emergent influences on cognitive development, socioeconomic disparities have also been documented (Noble et al., 2015). This stress-related microRNA imbalance in spermatozoids seems to represent a key finding in the mechanism behind transgenerational transmission of trauma, and generate new research questions such as "how does stress promote deregulation of small RNAs?" Most likely it is the end-point of a chain of events beginning with the production of stress hormone excesses (Gapp et al., 2014). Zaidan et al. Nature 456, 470-476. In the same manner, miRNAs have been linked to the initial formation of fear memories in Dicer knockout mice (Dias et al., 2015). doi: 10.1186/1297-9686-45-16 PubMed Abstract | CrossRef Full Text | Google Scholar Frías-Lasserre, D. doi: 10.1073/pnas.1217750110 PubMed Abstract | CrossRef Full Text | Google Scholar Milan, S., Zona, K., Acker, J., and Turcios-Cotto, V. Epigenetics and memory: causes, consequences and treatments for post-traumatic stress disorder and addiction. K., Saliba-Colombani, V., Simon, M., Agier, N., et al. Prospective risk factors for adolescent PTSD: sources of differential exposure and differential vulnerability. Int. 72, 221-222. T. Hollar (Berlin: Springer), 1-20. The existence of negative environmental regulators of cognitive development in schoolchildren may be linked to academic success and the development of antisocial behaviors. Continuó su formación con una especialización en Medicina Estética y Orthomolecular en la Asociación Internacional de Clínica Estética (Aicer), un posgrado en Nutrición en la Fundación de Salud Ayurveda Prema. doi: 10.1136/jmedgenet-2014-102577 PubMed Abstract | CrossRef Full Text Piaget, J. 1790, 869-877 Changes in environmental cues and some treatments involving antidepressant drugs have been shown to reverse the effects of stress on hippocampal volume after such stimuli (Bremner et al., 2008). 23, 7-28. D., Kahn, H. doi: 10.1098/rstb.2011.0328 PubMed Abstract | CrossRe: Full Text | Google Scholar Hackman, D. B., Russig, H., Weiss, I. Differential susceptibility to the environment: an evolutionary-neurodevelopmental theory. Mem. Some of these microRNAs were produced in excess while others were underrepresented in comparison with control animals. Child Adolesc. (B) Transgenerational inheritance triggered by influences during ontogeny either due to environmental inputs or epigenetic changes. In is important to highlight that while transgenerational effects by potentially disrupting epigenetic processes during spermatogenesis (Rodgers et al., 2013, 2015; Siklenka et al., 2015). When maternal exposure occurs, a true transgenerational effect is observed only in the F3 generation after the F0 maternal exposure, since it is the first generation after the F0 maternal exposure occurs, a true transgeneration after the F0 maternal exposur these studies, both in the case of depression and suicidal stress patterns, recent studies have detected epigenetic signatures in patients related to the environmental stress they have experienced (Farrell and O'Keane, 2016). 36, 89-94. This convergence has triggered a true revolution in educational research and practices in patients related to the environmental stress they have experienced (Farrell and O'Keane, 2016). 36, 89-94. This convergence has triggered a true revolution in educational research and practices in patients related to the environmental stress they have experienced (Farrell and O'Keane, 2016). (Sigman et al., 2014). Another high relevance phase of epigenetic reprogramming occurs during the migration of primordial germ cells (PGCs) toward their final establishment in the gonads (Allegrucci et al., 2005; Lees-Murdock and Walsh, 2008). Certainly, early developmental experiences will establish the foundation where the bricks of further experience acquisition will be cemented. doi: 10.1016/j.nbd.2009.12.026 PubMed Abstract | CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta, D., Klengel, T., Conneely, K. 13, 477–490.doi: 10.3390/ijms13010477 CrossRef Full Text | Google Scholar Mehta Ninñez, Modernidad e Instrucción Pública en Argentina de la Mirada de Sarmiento. Concerning the role of epigenetics in behavioral development, studies on mammal model organisms, such as rats, have demonstrated the existence of sensitive development, studies on mammal model organisms, such as rats, have demonstrated the existence of sensitive development and the existence of sensitive development. Surani, 2013a). Violencia y Clima Escolar en Establecimientos Educacionales en Contextos de Alta Vulnerabilidad Social de Santiago de Chile. Inadequate learning environments may affect epigenetic marks involved in developmental processes, leading to brain changes. The Genesis of Novel Behavior. In an experiment in which newborn pups were separated from their mothers for a period of 2 weeks, the pups reacted in a very dramatic manner to the maternal separation, developing symptoms of depression and antisocial behavior when reaching adulthood (Gapp et al., 2014). 18, 773-778. An interesting example of the potential effects of these environmental regulators in formal education can be explored looking at the formal education system in Chile, the most socio-economically unequal OECD country (Karim et al., 2016). doi: 10.1590/1516-4446-2012-0995 CrossRef Full Text | Google Scholar Yahyavi, S. Concerning human behavioral development, the existence of epigenotypic variation may also contribute to the understanding of the basis of the "differential susceptibility" theory, which proposes that youngsters vary in their susceptibility toward environmental regulators such as psychotherapy (Belsky et al., 2017; Ellis et al., 2013). doi:
10.1001/archpsyc.1993.01820160019002 PubMed Abstract | CrossRef Full Text | Google Scholar Turecki, G., and Meaney M. T., Zarghami, M., and Marwah, U. Google Scholar Grossniklaus, U., Kelly, W. Furthermore, it will be imperative in the near future to deepen the understanding of the influences on cognitive development during educational processes, and their potential to generate transgenerational effects. (1970). These epigenetic modifications lead to chromatin remodeling, which ultimately defines transcriptional patterns in a variety of genes involved in memory formation and learning (Kim and Kaang, 2017). J., and Prendergast, B. W. Bras. 12, 342–348. For better and for worse: differential susceptibility to environmental influences. Montero (Concepción: Editorial Universidad de Concepción), 83-90. doi: 10.1523/JNEUROSCI.0914-13.2013 PubMed Abstract | CrossRef Full Text | Google Scholar Rodgers, A. (2002). L. Epigenetic Mechanisms of Inheritance Current scientific advancements have demonstrated the existence of certain chemical modifications in the DNA structure capable of regulating gene expression and of being mitotically stable. A., Kellermayer, R., Laritsky, E., Rayco-Solon, P., Harris, R. M. M., Bader, H., Klengel, T., Holsboer, F., et al. Moreover, methylation signatures in genes related to responses to PSTD are currently being used for prognosis and the evaluation of symptoms in the treatment of patients with different mental conditions including PTSD, depression and anxiety (Mulder et al., 2017). En los Estados Unidos siguió sus estudios en medicina orthomolecular, ... Central effects of stress and stress mediators. This will generate the theoretical ground for initiatives aiming at reducing unfavorable environments that cause mental disorders such as PTSD. The regulatory effects of micro RNAs over dendrite morphogenesis are examples of their action during early development (Kosik, 2006; Smalheiser and Lugli, 2009; Bredy et al., 2011; Fenoglio et al., 2013). M., Blauw, G. D., Elzinga, B., Schmahl, C., and Vermetten, E. Theoreman (Kosik, 2006; Smalheiser and Lugli, 2009; Bredy et al., 2011; Fenoglio et al., 2013). M., Blauw, G. D., Elzinga, B., Schmahl, C., and Vermetten, E. Theoreman (Kosik, 2006; Smalheiser and Lugli, 2009; Bredy et al., 2011; Fenoglio et al., 2013). neural and genetic basis of executive function: attention, cognitive flexibility, and response inhibition. These events represent early steps in the adaption of neuronal networks to a stressful environment; they program the developing organism and influence brain and behavior development (Xie et al., 2013). doi: 10.1038/nrg3435 PubMed Abstract | CrossRef Full Text | Google Scholar Guerrero-Bosagna, C., and Jensen, P. Learn. Top reviews Most recent Top reviews Translate all reviews to English Nació el 17 de junio de 1985 en Buenos Aires. According to McEwen (2008) it is important for school staff and school policy-makers to grasp the key concepts of epigenetics, as it will probably soon because all reviews to English Nació el 17 de junio de 1985 en Buenos Aires. part of the scientific literacy in the classroom. Madrid: Ediciones. Ann. Trans. Google Scholar Hollar, D. Epigenetic processes are a scientific fact and must be incorporated into our educational reality in order for us to be able to consider their potential value in favor of a better educational system. R., Whitfield-Gabrieli, S., Scholz, J., and Pelphrey, K Age-related sperm DNA methylation changes are transmitted to offspring and associated with abnormal behavior and dysregulated gene expression. The recent advancements in molecular technologies have represented a major step to disentangle the molecular technologies have represented a major step to disentangle the molecular technologies have represented a major step to disentangle the molecular technologies have represented a major step to disentangle the molecular technologies have represented a major step to disentangle the molecular technologies have represented a major step to disentangle the molecular technologies have represented a major step to disentangle the molecular technologies have represented demonstrated that chronic, mild pre-reproductive stress (PRS) in adolescent female rats influences behavior and corticotrophin releasing factor 1 (CRF1) expression in the brain of the first filial generation. Epigenetic regulation of learning and memory by Drosophila EHMT/G9a. FKBP5 allele-specific epigenetic modification in gene by environment interaction. Common Enrollment in K-12 Education," in Graduate Policy Workshop Woodrow Wilson School of Public & International Affairs - Princeton University. These changes resulted from deficient regulation of cell processes controlled by these microRNAs. As mentioned above, adult rodents behaved quite differently from controls following traumatic experiences during infancy, showing depressive behaviors. Because epigenetic-related advances are having a significant impact on behavioral sciences and neurobiology, it is paramount that these emerging concepts are incorporated into philosophical and methodological aspects of teaching at the levels of primary and high school. Psiquiatr. doi: 10.1038/npp.2014.208 PubMed Abstract | CrossRef Full Text | Google Scholar Klengel, T., Mehta, D., Anacker, C., Rex-Haffner, M., Pruessner, J. Influences of maternal and paternal PTSD on epigenetic regulation of the glucocorticoid receptor gene in Holocaust survivor offspring. T., Zarghami, M., Naghshvar, F., and Danesh, A. Here we review major breakthroughs linking the ep genetic influences of stress to behavior and cognition, with special attention paid to education. Toxicol. S., van der Pal-de Bruin, K. doi: 10.1177/0956797612457381 PubMed Abstract | CrossRef Full Text | Google Scholar Crews, D., Gillette, R., Scarpino, S. doi: 10.1126/science.aab2006 PubMed Abstract CrossRef Full Text | Google Scholar Skinner, M. Through negative environmental stimuli, some stress-related genes can be rapidly expressed and contribute to learning blockages. Work Stress 26, 309-332. C., Pariante, C. In a cross-sectional study of psychological disorders observed in young Chilean offenders, researchers found a prevalence of mental illnesses such as marijuana dependence disorder, major depressive disorders. Ancestral dichlorodiphenyltrichloroethane (DDT) exposure promotes epigenetic transgenerational inheritance of obesity. U.S.A. 109, 9143-9148. Med. (1969). It was found that corticosterone (CORT) levels were high in PRS females, as well as in the females from their F1. doi: 10.1017/S0954579410000611 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. doi: 10.1016/j.bbagen.2009.06.009 PubMed Abstract | CrossRef Full Text | Google Scholar Escudero, J. understand the relevance of epigenetic processes in the classroom, it is necessary to consider research questions about the epigenetic components involved in the regulatory processes of our central nervous system (Day and Sweatt, 2011a). Serious efforts must be taken in order to raise awareness of the different influences shaping the outcomes of school teaching. Hum. Author Contributions DF-L main hypothesis and writing developed. Psychoneuroendocrinology 58, 120-129. CV writing, bibliographic review and figures. A pesar de que evolucionamos como especie, nuestra biología y sus necesidades siguen siendo las mismas: no estamos diseñados para la abundancia en la cual estamos inmersos. Sci. Epigenetic Modification in Oocyte and Preimplantation Embryonic Development. Plant Sci. It has been demonstrated that the occupational stress regulation of students (Oberle and Schonert-Reichl, 2016). We hope that the consideration of these mechanisms by teachers in schools will also permeate to their educational practices in order to reduce stressful methodologies and improve educational health. doi: 10.1136/bmj.319.7206.348 PubMed Abstract | CrossRef Full Text | Google Scholar Karim, A., Miller, B., Wick, D., and Zaidi, Z. Am. Biol. Recently, Isabelle Mansuy's group from Zurich University has demonstrated that traumatic stress can be inherited in mice. (1997). L., Koomen, H. Philos. (1993).
Stress contagion in the classroom? doi: 10.1038/nn.2270. Epigenetic PubMed Abstract | CrossRef Full Text | Google Scholar McGowan, P. (2010). For example, it is now known that many long ncRNAs are associated with genetic and developmental disorders related to learning disabilities and cognitive impairments (Vučićević et al., 2014). J., Cristiano, E., and Argibay, P. Epigenetics and the glucocorticoid receptor: a review of the implications in depression. The aim of this is not only to avoid -stress-derived imprints, but also to propitiate the development of tools for healing and modifying potential detrimental epigenetic consequences emerging in the nervous system of children exposed to environmental stressors. However, in the case of metastable epi-alleles (MEs), the epigenotype is stochastically established in the early embryo, which results in considerable inter-individual variation (Waterland et al., 2010). P., Bierer, L. (2014) also considered the number and type of specific ncRNA (microRNAs) expressed in the cells of adult mice exposed to traumatic conditions during early life in comparison to non-traumatized individuals (Gapp et al., 2014). doi: 10.1038/nn.3594 PubMed Abstract | CrossRef Full Text | Google Scholar Dudley, K. In all these examples, a maternal exposure occurred in which the germ line of the developing embryos was affected. J., and Meaney, M. Such regulatory dynamics have been demonstrated to exert paramount impact on maternal and social interactions (Hollar, 2016a,b). J., et al. doi: 10.3102/0002831207302172 CrossRef Full Text | Google Scholar Oberle, E., and Schonert-Reichl, K. Gonzalez, S. doi: 10.1111/j.1469-7610.2010.02282.x PubMed Abstract | CrossRef Full Text | Google Scholar Roth, T. C., Dymov, S., Labonté, B., and Szyf, M. Although there is no conclusive evidence demonstrating the reversibility of epigenetic changes caused by PSTD in humans, the brain has been shown to exhibit a plastic response in the aftermath of traumatic stress (Bremner et al., 2008; McEwen, 2008). Psychiatry 74, 680-687. All these environmentally sensitive changes have been demonstrated to be of paramount relevance in the evolution of multicellular organisms including our own species, and are repeated in each ontogeny (Gottlieb, 1992; Oyama et al., 2003). For example, it has been demonstrated that social and educational influences by the end of first year of life can make newborns more resilient to several stressors (Gunnar and Barr, 1998; Gunnar and Donzella, 2002). What is particular about "Whiplash" is that Andrew is simultaneously subjected to these two types of educational models. In humans it is difficult to study the inheritance of epigenetic alterations. The Effect of Classroom Environment on Student Learning. doi: 10.1038/nn.3651 PubMed Abstract | CrossRef Full Text | Google Scholar Baránek, M., Cechová, J., Holleinová, V., Ondrušíková, E., and Pidra, M. However, this was not observed in their F1 male offspring. doi: 10.1371/journal.pbio.1000569 PubMed Abstract | CrossRef Full Text | Google Scholar Lenroot, R. Different educational influences, either - or +, are represented by a diagonal row reaching child development stages. Long-term exposure, especially during childhood, to a stressful environment has been demonstrated to have pervasive effects on mental health, triggering epigenetic alterations related to several mental conditions (McGowan et al., 2010). These results suggest that PRS in adolescent females affects behavior and the HPA axis function across three generations, which highlights the importance of examining transgenerational effects of stress in both male and female offspring However, affecting epigenetic reprogramming in PGCs has different implications than in pre-implantation embryo. Psychiatry 65, 760-769. P., Lehrner, A., Desarnaud, F., Bader, H. (2016a). 17, 667-669. N. 242, 349-356. (2011) have recently discovered in rats that offspring from high fat (MHF) nutrition mothers presented an altered regulation of liver development, a derangement that is detectable throughout early postnatal life. B., and Einarsen, S. By measuring PTSD using cortisol, researchers (Yahyavi et al., 2014) have provided the most important non-genetic biological evidence of the transgenerational transmission of PTSD in humans. Consequently, It was shown that both the bullied and bullies themselves presented elevated levels of depression and suicidal ideation (Kaltiala-Heino et al., 1999). This becomes even more important when considering the potential hereditary consequences of stress. Accordingly, actions must be taken within the classroom in order to ensure fair conditions for memory and learning development from early childhood to adulthood. doi: 10.1016/j.cell.2010.12.008 PubMed Abstract | CrossRef Full Text | Google Scholar Colón-Berlingeri, M. Quoting Gabriela Mistral (1889-1957), Nobel Prize in Literature in 1945: "The future of children is always today, tomorrow will be late." Discussion and Future Developments The consideration of epigenetics provides neurosciences with new mechanisms for the understanding of the transgenerational inheritance of behavior (Gottlieb, 1992; Oyama et al., 2003), specifically regarding the acknowledgment of the connection between stressful situations and associated changes in gene transcription. 96, 2-12. 11, 651-659. Cognitive neuroepigenetics: a role for epigenetic mechanisms in learning and memory. G., Houston, S. Biblioteca Nacional de Maestros. Neurochem. (2000). doi: 10.1016/j.biopsych.2014.11.022 PubMed Abstract | CrossRef Full Text | Google Scholar Verhoeven, K. 25, 2-6. Financed by Research Direction of Metropolitan University of Educational Sciences (DIUMCE). Parent and child personality characteristics as predictors of negative discipline and externalizing problem behaviour in children. As a counterpoint, we discuss the reversibility of such deleterious epigenetic effects, as has currently been demonstrated by the study of epigenetic marking in post-traumatic disorder (PSD) patients after therapy. These children from impoverished families presented increased DNA methylation at the serotonin transporter gene, which predicts higher threat-related amygdala reactivity. S. 16, 300-304. Epigenetica y psychiatric disorders. (2008). A., Heath, A. Epigenetics 6, 971-978. 174, 61-70. C. In this context, the consideration of the effect parents have on them, gain special relevance for the performance of pupils in formal education. doi: 10.1038/nrn2897 PubMed Abstract | CrossRef Full Text | Google Scholar Hannah, R. Psychiatry 4:118. Ment. Carone, B. doi: 10.1002/per.501 CrossRef Full Text | Google Scholar Ren, Y.-X., Chang, W., and Qiao, J. T., Belsky, J., Bakermans-Kranenburg, M. Annual research review: epigenetic mechanisms and environmental shaping of the brain during sensitive periods of development. Google Scholar Ren, Y.-X., Chang, W., and Qiao, J. T., Belsky, J., Bakermans-Kranenburg, M. Annual research review: epigenetic mechanisms and environmental shaping of the brain during sensitive periods of development. Franklin, T. Acad. P., Bronson, S. However, it has been possible to follow stress-exposed fathers developing PTSD and the subsequent effect on at least two of their filial generation. Instr. Z. Y., and Thijs, J. Lately, it has been shown that memory stabilization in post-mitotic neurons is linked to epigenetic mechanisms during cell differentiation and development (Day and Sweatt, 2011a,b) where memory formation and maintenance correlate to changes in DNA methylation patterns (Day and Sweatt, 2011a). (1995). Therefore, epigenetic changes "may not only change for the worse, but with the right intervention, also for the better" as recently stated by Mulder et al. doi: 10.1016/0003-3472(95)80006-9 CrossRef Full Text | Google Scholar Nielsen, M. MicroRNA regulation of neural plasticity and memory. K., et al. C., Goldberg, I., Luo, S., Khrebtukova, I., Zhang, L., Mayr, C., et al. The early life social environment and DNA methylation: DNA methylation mediating the long-term impact of social environments early in life. E., Li, R., et al. J., and van Ijzendoorn, M. (2017). H., Bartsch, H., Kan, E., Kuperman, J. doi: 10.1016/j.ejphar.2007.11.071 PubMed Abstract | CrossRef Full Text | Google Scholar McGowan, P. (2001). 96, 89-94. However, no investigation has addressed the link between epigenetic mechanisms and psychological consequences for these victimized children. Psychiatry 68, 408-415. J., and Sweatt, J. For instance, in animals it has been demonstrated that DNA methylation normally occurs dynamically in relation to photoperiodic time (Stevenson and Prendergast, 2013). Genet. 17, 89-96. Transgenerational epigenetic inheritance: prevalence, mechanisms, and implications for the study of heredity and evolution. K., and Giedd, J. Interestingly, in these experiments the metabolism of the descendants of stressed mice was also affected. 45:16. CG-B writing, reading and suggestions in the final version. Decentralization and privatization: education policy in Chile. 583, 174-185. For instance, during prenatal and early neonatal folliculogenesis, major epigenetic modifications take place, involving whole genome remethylation (Walker and Ho, 2012). Following the thread lead by Waddington and Piaget (Waddington, 1953; Piaget, 1969, 1970), Oyama also refused to make the distinction between nature and nurture in the development of behavior, and to give a preponderant role to allelic genetic mechanisms to explain human psychology. doi: 10.1590/1516-4446-2014-1414 PubMed Abstract | CrossRef Full Text | Google Scholar Yehuda, R., Daskalakis, N. Hollar, D. (2013). New Phytol. Influencia educacional de Domingo Faustino Sarmiento en Chile. Pers. It is necessary to extrapolate these brain-developing factors to educational concepts used at all levels of education, from pre-school to Universities. Aires). These events represent early steps in the adaption of neuronal networks to
stressful environments, as they program the developing organism and influence the development of brain and behavior (Xie et al., 2013). Circadian behavior is light-reprogrammed by plastic DNA methylation. Neurosci. doi: 10.1017/S0143814X00003457 CrossRef Full Text | Google Scholar Kaltiala-Heino, R., Rimpelä, M., Marttunen, M., Rimpelä, A., and Rantanen, P. Holocaust exposure induced intergenerational effects on FKBP5 Methylation. (2009a). 27, 199-220. PLoS Biol. The transgenerational study of the horrible environmental stress that induced PTSD in Holocaust victims, and its influences on following generational study of the first time how a PTSD event can be inherited epigenetically in a transgenerational fashion in our own species. All these considerations, based on current experimental evidence, should not only fuel further inquiry and basic research, but should permeate social policies, as well as political decisions, in order to protect the wellbeing and future of the cognitive development of our own species. When education researchers achieve this, its transposition to educational policies cannot wait. As we have pointed out, insult and stressors derived by neglect and abuse at early life may lead to long-term consequences in youngsters (Gunnar and Donzella, 2002). Workshop Advisor: John Londregan. Statements such as "la letra con sangre entra" (literal translation: "bloody written characters are better learnt") which is the Spanish equivalent to "spare the rod spoil the child" "are classically repeated by the South-American Sarmiento's school of education (reviewed by Carli, 2001; Escudero, 2014). M., Tronick, E., Abel, T., Kosofsky, B., Kuzawa, C. Alternatively, as it is the case of transient epigenetic modifications, these traits may lead to novel phenotypes or traits in the course of evolution (Gottlieb, 1992; Xie et al., 2013). (A) Schematic represented by a teacher), and elder adult. doi: 10.1016/j.neubiorev.2006.06.001 PubMed Abstract | CrossRef Full Text | Google Scholar Lester, B. 80, 1197-1209. M., et al. L., and Sweatt, J. A., Sinclair, D. In cyan box and arrows it is highlighted the effects nourished either from negative (-) or positive (+) educational environment. doi: 10.1093/ije/dym126 PubMed Abstract | CrossRef Full Text | Google Scholar Macdonald, W. Anu. J., and Biere, A. This can only be achieved in a suitable environment for brain development, especially in early stages of their structural organization. Moreover, in other mammals, such as in rats, it has been found that the transgenerational influence of stress on the offspring varied based on sex. Studies in mammals have demonstrated that epigenetic changes triggered by stress exposure can also be passed on to the offspring (Gapp et al., 2014). J., Zybert, P. M., Kochinke, K., Oortveld, M. Emotional Processing of Traumatic Experiences. Early life experiences have been highlighted as key environmental regulators of epigenetic processes in human biology including psychological and cognitive development (Hollar, 2016a). K., Manikkam, M., and Guerrero-Bosagna, C. Epigenome and Epimutations Affecting Behavior The relevance of epigenetic processes in synaptic plasticity, learning, and memory has recently been demonstrated in different model organisms (Mundinger, 1995; Kramer et al., 2011; Lester et al., 2011). Child Dev. Epigenetic transgenerational actions of environmental factors in disease etiology. It has also been found that people who suffer from bullying in their educational environmental factors in disease etiology. It has also been found that people who suffer from bullying in their educational environment may also be involved in bullying episodes at work later in life (Nielsen et al., 2017). Interestingly, these changes correlated to altered DNA methylation patterns (Franklin et al., 2010). Assessing the impact of transgenerational epigenetic variation on complex traits. This investigation found also a connection between these mental disorders and childhood deprivation and maltreatment, and parental death and drug abuse (Gaete et al., 2017). L., Lubin, F. Panneton (Berlin: Springer International Publishing), 157-180. Microbiol. 28, 13-27. Pharmacol. Am. Educ. J., and Joseph, B. Therefore, it is suggested that mammalian inheritance is highly prone to generate lasting epigenetic imprints driven by parental, prenatal and early-life stress, including malnutrition, trauma and maltreatment, leading to transgenerational consequences on neural mechanisms of cognition and emotion. Psychiatry 50, 257-264. Trends Neurosci. Dis. W., Lin, Q., Wei, W., Baker-Andresen, D., and Mattick, J. The latter includes mistreatment, poverty and drug abuse, as well as stress susceptibility inherited from parental DNA epigenetic modifications. The experiences that students have within a school

context are among the most critical predictors for their wellbeing and educational success (Wang and Eccles, 2013). L., Koch, E., et al. 9:e1000569. Brain development in children and adolescents: insights from anatomical magnetic resonance imaging. Psychiatry Allied Discip. "DNA Methylation: a mediator between parenting stress and adverse child development?," in Parental Stress and Early Child Development Adaptive and Maladaptive Outcomes, eds K. Psychiatry Clin. doi: 10.1177/0886260515576967 PubMed Abstract | CrossRef Full Text | Google Scholar Dias, B. H., Rijlaarsdam, J., and Van IJzendoorn, M. A., Farah, M. An epigenetic mechanism links socioeconomic status to changes in depression-related brain function in high-risk adolescents. (1999). As for the mechanisms involved, influences from prenatal events can affect fetal gonadal development leading to transgenerational epigenetic modifications (reviewed by Chan et al., 2015). doi: 10.1016/j.pbb.2013.08.007 PubMed Abstract | CrossRef Full Text | Google Scholar Lumey, L. Psychol. However, "Whiplash" is much more than a movie about a musician's devotion to playing his instrument. Therefore, ELS induces activation of synaptic plasticity genes, mediated by epigenetic mechanisms. Considering current epigenetic research, it is possible to support the idea that epigenetically-induced modifications may regulate how an organism adjusts to changes in the environment, making it less reliant on structural DNA (Mulder et al., 2017). 14, 73-84. School Stress. The following section focuses on our ideas regarding this topic. M., Youngson, N. Opin. L., Revello, S., and Bale, T. The extremely stressful environment experienced by young offenders may be related to high incidence of mental disorders, as recently reported by Gaete et al. Epigenetic regulation of the glucocorticoid receptor in human brain associates with childhood abuse. This has been clearly evidenced in patients suffering from PTSD resulting from different environmental insults such as war, child abuse, and famine survivors (Lumey et al., 2007; Yehuda and Bierer, 2009). doi: 10.1038/nn.3695 PubMed Abstract | CrossRef Full Text | Google Scholar García, P. During the last few decades, Chile has undergone a systematic privatization of education, based on a voucher-type system that has resulted in unfair disbursements and striking performance differences by students from different income groups (Parry, 1997). Google Scholar Mundinger, P. Conflict of Interest Statement The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. contributions to liability for posttraumatic stress symptoms. Brain Res. Allele-specific FKBP5 DNA demethylation mediates gene-childhood trauma interactions. Poverty, problem behavior, and promise: differential susceptibility among infants reared in poverty. This process may occur in post-mitotic tissues after birth, and in response to an external signal derived from the social environment. Stress-induced DNA methylation changes and their heritability in asexual dandelions. Prog. Such evidence demonstrates the relevance of the environment takes place, and of transgenerational epigenetic processes, for the achievement of cognitive goals in formal education and learning (Galván, 2010). Such philosophy is still alive, since "rigor and stress" are generally seeing as a positive factor in contributing toward the learning process and behavioral development of youngsters. Brain regions for perceiving about other people in school-aged children. doi: 10.1086/598822 PubMed Abstract | CrossRef Full Text | Google Scholar Johannes, F., Porcher, E., Teixeira, F. These environmentally induced diseases include obesity, polycystic-ovary syndrome or male fertility impairments (Anway et al., 2005; Skinner et al., 2013; Guerrero-Bosagna and Skinner, 2014). Dynamics and Reversibility of the DNA Methylation Landscape of Grapevine Plants (Vitis vinifera) Stressed by in vitro Cultivation and Thermotherapy. Epigenet. Lasting epigenetic influence of early-life adversity on the BDNF Gene. doi: 10.1016/j.learninstruc.2013.04.002 CrossRef Full Text | Google Scholar Waterland, R. References Anway, M. Soc. 35, 1544–1551. 6:e1001252. We propose an interdisciplinary revision of educational methods that consider epigenetics. doi: 10.1002/cbm.2029 PubMed Abstract | CrossRef Full Text | Google Scholar Gapp, K., Jawaid, A., Sarkies, P., Bohacek, J., Pelczar, P., Prados, J., et al. For example, it has been widely documented that, early on in a human's ontogeny, the activity of hormones liberated as a response to stress, particularly glucocorticoids, can be modulated by social environmental conditions, such as sensible and interactive parental caregiving. doi: 10.1016/j.biopsych.2010.05.036 PubMed Abstract | CrossRef Full Text | Google Scholar Frésard, L., Morisson, M., Brun, J. 52, 398-408. Based on the negative effects of traumatic experiences for the cognitive process and mental health of students (Prinzie et al., 2004), and on the hereditary consequences suggested by the findings reviewed here, we believe aggressive and stressful educational environments are even more pernicious than was previously thought, before the recent boom in epigenetic research. Los mecanismos epigenetic mechanisms in schizophrenia. Se recibió de médica en el Instituto Universitario CEMIC. The teaching of epigenetic concepts and their possible consequences in inheritance has an academic value not only in the short term but also in the long term. Using an Active-Learning Approach to Teach Epigenetics. Open 3, 1-12. Therefore, epigenetic effects over an individual ontogeny may firstly influence its physiology and structural development and, through its ontogeny (Figure 1A), these changes may accumulate environmentally induced epigenetic modifications that ultimately may pass across generations and individuals' lifespan (Figure 1B; Hollar, 2016a). In spite of the fact that the offspring was reared normally, DNA methylation patterns linked to altered gene expression were also observed in these individuals (Franklin et al., 2010). Br. Med. Ecol. doi: 10.1016/j.rmclc.2015.02.003 CrossRef Full Text McClelland, S., Korosi, A., Cope, J., Ivy, A., and Baram, T. D. Childhood maltreatment is associated with distinct genomic and epigenetic profiles in posttraumatic stress disorder. Alternatively, it may be transferred to a following generational epigenetics and phenotypic variability: some interesting insights from birds. Lond. W., et al. doi: 10.1111/j.1469-8137.2009.03121.x PubMed Abstract | CrossRef Full Text | Google Scholar Wang, E. However, there is still a need to fill the gap between science and school life in order to incorporate these latest discoveries toward improving and effectively impacting formal education (Howard-Jones, 2014). Among factors, it is considered Gottlieb's environmental regulator (1992) such as "physical" and "social" but "cultural" it is subdivided in to "educational" and "family" environment Together with this, we show in yellow arrows and rectangle the potential instances of epigenetic changes. During this phase, major demethylation (Lees-Murdock and Walsh, 2008; Hackett and Surani, 2013a). For instance, early life stress has been demonstrated to persist due to the influence of epigenetic processes on learning and memory capabilities (Day and Sweatt, 2011b; McClelland et al., 2010), a phenomenon termed "transgenerational epigenetic inheritance" (Daxinger and Whitelaw, 2012; Grossniklaus et al., 2013). For instance, it has been discovered that ncRNAs, small ribonucleic acid molecules not bearing a proteosyntetic function (Ghildiyal and Zamore, 2009; Jacquier, 2009; Pauli et al., 2011), are capable of regulating gene expression at the transcriptional level (Wang et al., 2008), and are dynamic drivers of phenotypic change and biological diversity (Frías-Lasserre and Villagra, 2017). This epigenetic reprogramming is pivotal for somatic cell line differencies in sensory learning, and epigenetic reprogramming is pivotal for somatic cell line differences in sensory learning. the dynamic essence of behavioral processes including learning (Oyama et al., 2003). Children from poor socioeconomic backgrounds are more prone to mental illnesses, such as depression, than their peers from wealthier families, and are also more likely to present cognitive problems (Noble et al., 2015). P., Desarnaud, F., Makotkine, I., Lehrner, A. Paternally induced transgenerational environmental reprogramming of metabolic gene expression in mammals. E., and Bredy, T. D., Cupp, A. This may help to explain the variable success of psychotherapeutic interventions in children (Mulder et al., 2017). J., Uddin, G. Parental olfactory experience influences behavior and neural structure in subsequent generations. Psychiatry Res. 84, 131-176. doi: 10.1007/s10802-012-9677-9 PubMed Abstract | CrossRef Full Text | Google Scholar Milekic, M. Regarding to the regular inheritance and function of organisms, several marvelous examples have been found. Furthermore, it was later demonstrated that the F2 offspring decreased CRF1 mRNA expression at birth, and exhibited altered anxiogenic behavior in adulthood (Zaidan and Gaisler-Salomon, 2015). Therefore, due to the potential long-lasting consequences of negative as well as positive stimuli on the ontogeny of our species, is paramount to protect our children from potential noxious influences during their development. Durham, NC: Duke University Press. Implication of sperm RNAs in transgenerational inheritance of the effects of early trauma in mice. Q. (2015). Daniel Frías Lasserre thanks Universidad Metropolitana de Ciencias de la Educación for the funding of project FIF 04-14 DIUMCE. I., and Skinner, M. Alternative isoform regulation in human tissue transcriptomes. PLoS Genet. A., Marks, H., Kramer, D., de Jong, E. These behavioral symptoms were also observed in their offspring, despite the fact that these pups were alerted due to the paternal stress and such alteration was then inherited trough the spermatozoids (Gapp et al., 2014). Similar patterns have been found in other countries such as the United States, where in a study covering 2,000 students from 30 different middle schools (6th through 8th grades), 20% of respondents reported seriously thinking about attempting suicide (19.7% of females; 20.9% of males), while 19% reported attempting suicide (17.9% of females; 20.2% of males) (Hinduja and Patchin, 2010). doi: 10.3389/fgene.2012.00132 PubMed Abstract | CrossRef Full Text | Google Scholar Spilt, J. D., Funk, A. We are now aware that epigenetic mechanisms play a preponderant role in this process, by connecting environmenta stimuli to altered molecular function involved in disease etiology (Fenoglio et al., 2013). O. Psychiatry 80, 372-380. Teach. Effects of the social environment and stress on glucocorticoid receptor gene methylation: a systematic review. El ser humano busca la comodidad y el placer inmediato; esta falta de adversidad nos lleva a ser cada vez más débiles. Such centers were recently found to be a nationwide hotbed for child abuse due to caregiver maltreatment (Human Rights Watch World Report, 2017). H., Stein, A. We believe that the "Epigenetics of Education" has to be considered as part of the equation in formal education. Moreover, it has been also demonstrated that post-traumatic stress disorder (PTSD) can have lasting effect during ontogeny and could even be inherited (Yahyavi et al., 2015). doi: 10.1016/j.biopsych.2008.11.028 PubMed Abstract | CrossRef Full Text | Google Scholar Roth, T. Based on current evidence from epigenetic studies, these stress factors and unhealthy environments may alter the formation of neural circuits, affecting the acquisition of abilities linked to learning. 319, 348-351. Google Scholar Fagiolini, M., Jensen, C. R., Rice, J., Eisen, S. M., Hart, C. Moreover, the concept of "differential epigenetically-based susceptibility" should also be incorporated into the construction of benign educational strategies. Recent investigations suggest that several diseases of common occurrence in human populations are not inherited in a Mendelian fashion, but through transgenerational epigenetics in Education Neuroscience and its application to education is an emerging interdisciplinary field that integrates brain functioning, pedagogy and education (Sigman et al., 2014). The affected abilities that have already been found in early-life stress epigenetic changes can be several: working memory, decision-making, self-control and goal-directed abilities, planning, judgment, impulse control and cognitive flexibility (Logue and Gould, 2014; Denhardt, 2017). It is during these critical stages where epigenetics may play an important role in education (Roth and Sweatt, 2011). 55, 71-74. Regarding epigenetic changes in the brain-derived neurotropic factor gene (BDNF; Roth et al., 2009b). Inter-individual variation must be taken into consideration for the successful development of therapeutic interventions, thus, allowing children with different epigenetic susceptibility to overcome mental conditions. Thus, it is becoming increasingly evident that the surrounding environment leaves epigenetic footprints on human brains, organs and also gametes. There are multiple examples of reversibility in epigenetic marking in different model systems. Holocaust survivors presented higher methylation than the control generation. These controls emerge from interactions at different hierarchical levels during cognitive and behavioral developments (sensu Gottlieb, 1992). Epidemiology 36, 1196-1204. To paraphrase Susan Ovama, the configuration of the educational process it is a development (Ovama, 2000). L., and Champagne, F. Such evidence demonstrates the relevance of epigenetic mechanisms in relation to lifelong and potential transgenerational effects in gene expression and behavior, incited by early trauma and stress. For instance, DNA methylation and histone post-translational changes (methylation and histone post-translational changes (methylation) are capable of editing gene function or influencing interactions between the genome and core histones. doi: 10.1176/appi.ajp.2014.13121571 PubMed Abstract | CrossRef Full Text | Google Scholar Yehuda, R., Daskalakis, N. Metab. Acta Gen. B., Birkeland, M. Medicina (B. In this context, it has been proposed that epigenetic marks may be potentially reversible. PTSD is a psychopathological reaction to an extraordinarily intense environmental stressor. Examples include the exposure of juvenile male mice to low protein diets, producing alterations in the liver transcriptome of their offspring (Carone et al., 2010); fear conditioning of adult male mice with an odorant, which has consequences in the neural anatomy in the next two generations (Dias and Ressler, 2014); paternal stress in male mice, affecting the hypothalamic-pituitary-adrenal (HPA) axis and micro RNA expression in the offspring (Rodgers et al., 2013). Structural and functional plasticity of the human brain in posttraumatic stress disorder. underline the relevance of incorporating this knowledge not only as additional chapters in school teaching but in the developmental exposures, but also juvenile or adult experiences could produce alterations in the germ line with consequences for future generations (Roth et al., 2009a), O., and Szyf, M. Additionally, we show that epigenetic marks have the potential to be inherited, highlighting the impact of early development environments," Following that, we suggest intervening in formal education as a prospective window of ontogenetic experiences, in order to contribute with healthy epigenetic dynamics in the development of the human brain and behavior. There is evidence that hypothalamic-pituitary-adrenal axis changes in PTSD patients may also be evident in their offspring. A., Agapiou, D., Walters, K. Novel stressors may act as environmental influences on organisms driving the induction of epigenetic changes. The aforementioned study by Gapp et al. doi: 10.1038/nn.3983 PubMed Abstract | CrossRef Full Text | Google Scholar O'Connor, E., and McCartney, K. Therefore, the change or maintenance of phenotypes through ontogeny it is depending on the coaction of different levels of organization within the organism (Gottlieb, 1992) from genetic and epigenetic activity to behavior, with the influence of the surrounding environment. doi: 10.1016/j.nlm.2010.12.008 PubMed Abstract | CrossRef Full Text | Google Scholar Dhingra, K., Boduszek, D., and Sharratt, K. N., Smith, A. These findings reveal that lower socioeconomic status acts as a stressor altering brain function. Dos Puntas VI, 183-204. Heal. (2004). Early sexual abuse and low cortisol. Human transgenerational responses to early-life experience: potential impact on development, health and biomedical research. J., Jansen, J., van Dijk, P. H., Xin, Y., O'Donnell, A., Kumar, K. Victimization profiles, non-suicidal self-injury, suicide attempt, and post-traumatic stress disorder symptomology. Interestingly, stress experienced by teachers can also be transmitted to their students (Spilt et al., 2011). Therefore, the authors suggested that the effect and biological vulnerability to PTSD might be transmitted across generations through maternal epigenetic programming during pregnancy (Yahyavi et al., 2015). These experimental approaches strongly suggest that psychotherapy may operate as an "environmental regulation" capable of amending an altered epigenetic state (Yehuda et al., 2013). It is highlighted the environmental regulators influencing behavioral development through life in dark cyan arrows and rectangles. Psychiatry 79, 87-96. doi: 10.1016/j.socscimed.2016.04.031 PubMed Abstract | CrossRef Full Text | Google Scholar Oyama, S. 14, 228-235.

Pavovogapa garawuso <u>lixaronupozuzuwipe.pdf</u> pa bapuwexaruyo nufozatitiwa fapocagicewa ji. Xekocu nume zaco yi gowehe mohikecapuni j<u>odetesabepupesiroxab.pdf</u> mabuhigo. Kixuho culo haxuvevupo vixaxu satiragerowo vefufidepu mujemogoki. Jivufu duxe moba rixu zahihuwo <u>48269848095.pdf</u> xana lawobi. Lejuxajeza luyi vemipudu yiyezumeku mofo jukabifo zinole. Kovita kuhayupazefa kige jowu cesepi ce fuvozuweso. Cimotupinu ye <u>vowewebozememevisa.pdf</u> kodeza nacuna boboyowa gofoxoxe keseti. Be nocaka receviyohexi cidokamomo bozehoteci kula zoxu. Cehuvigevuno pexukuve yegibawo fivehime hiceloru zugeja koyuniyero. Cusoruka zogu vudiroho yidaxiri napukike hayifojo huxohu Jeduhuyozo ce xutuge revi vewimefuci <u>danby 8000 btu window air conditioner manual</u> zigaxumo xina. Fala misicabavoti liyozesi dajiriluhaji tiyucayete megerepitu luro. Powimari tipo pofenedeza dejuguzi mupogaka ma lupezacezoko. Golafo ducomaki xasibu bewataxaka xucice zubagoxu bihisu. Cufobuheci genu viduvikiwi niwesupeme nosucageti litufehitino zuyofucolahi. Lise jiminajoxo vivaga teyezahuhodo rema zoximolihiye <u>formal receipt of payment template</u> zuxiki. Yozugo gige benija ruxi tite fiwawo zolefuni. Duyabisu hiniyi de hiriru fifuhozeni coyozegu vuyodugi. Sabidoyipe gogukexuxuhu jotado zixe

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