UNIVERSITAS
GADJAH MADA
Ekspresi Gen Cyp19a Ikan Gupi (Poecilia reticulata, Peters 1859) pada Proses Sex Reversal Menggunakan Induksi Suhu 36°C
Fathiyya Riyana Murti, Dr. Dini Wahyu Kartika Sari, S.Pi, M.Si; Prof. Dr. Ir. Murwantoko, M.Si
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

DAFTAR PUSTAKA

Allen, G.R. 1991. Field Guide to the Freshwater Fishes of New Guinea. Christensen Research Institute, California.

Backiel, T. and R. L. Welcomme (eds). 1980. Guidelines for Sampling Fish in Inland Waters. Food and Agriculture Organization of the United Nation, Rome.

Baroiller, J. and H. D'Cotta. 2016. The reversible sex of gonochoristic fish: insights and consequences. Sexual Development. 1-25.

Baroiller, J.F. and H. D'Cotta. 2001. Environment and sex determination in farmed fish. Comparative Biochemistry and Physiology Part C. 130: 399-409.

Baroiller, J.F., D. Chourrout, A. Fostier and B. Jalabert. 1995. Temperature and sex chromosomes govern sex ratios of the mouthbrooding cichlid fish *Oreochromis niloticus*. The Journal of Experimental Zoology. 273: 216-223.

Baroiller, J.F., H. D'Cotta, E. Bezault, S. Wessels and G. Hoerstgen-Schwark. 2009. Tilapia sex determination: where temperature and genetics meet. Comparative Biochemistry and Physiology, Part A. 153: 30-38.

Berger, S.L. 2007. The complex language of chromatin regulation during transcription. Nature. 447: 407-412.

Cao, J., J. Chen, Z. Jiang, Y. Luo and X. Gan. 2012. Molecular cloning and expression analysis of FTZ-F1 in the GIFT tilapia, *Oreochromis niloticus*. Zoological Research. 33(E3-4): E40-E46.

Chang, C., W. Lin and S. Tu. 2014. Genome-wide analysis of heat-sensitive alternative splicing in physcomitrella patens. Plant Physiol. 165(2): 826-840.

Chen, X., Z. Wang, S. Tang, Y. Zhao, J. Zhao. 2017. Genome-wide mapping of DNA methylation in Nile tilapia. Hydrobiologia. 791(1): 247-257.

Cheung, P., C.D. Allis and P. Sassone-Corsi. 2000. Signaling to chromatin through histone modification. Cell. 103: 263-271.

De Almeida, D.B.S. 2016. Gonad Differentiation in Guppy Fish and Testing Strategies for the Production of Sterile and All-Female Offspring. Disertasi. Universidade do Porto. Portugal.

Deacon, A. 2023. *Poecilia reticulata* (guppy). CABI COMPENDIUM. 1-20.

Devlin. R.H. and Y. Nagahama. 2002. Sex determination and sex differentiation in fish: an overview of genetic, physiological and environmental influences. Aquaculture. 208: 191-364.

Díaz, N. and F. Piferrer. 2015. Lasting effects of early exposure to temperature on the gonadal transcriptome at the time differentiation in the European sea bass, a fish with mixed genetic and environmental sex determination. BMC Genom. 16: 679.

Diotel, N., Y.L. Page, K. Mouriec, S. Tong, E. Pellegrini, C. Vaillant, I. Anglade, F. Brion, F. Pakdel, B. Chung and O. Kah. 2010. Aromatase in the brain of

UNIVERSITAS
GADJAH MADA
Ekspresi Gen Cyp19a Ikan Gupi (Poecilia reticulata, Peters 1859) pada Proses Sex Reversal Menggunakan Induksi Suhu 36°C
Fathiyya Riyana Murti, Dr. Dini Wahyu Kartika Sari, S.Pi, M.Si; Prof. Dr. Ir. Murwantoko, M.Si
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

teleost fish: expression, regulation and putative functions. Frontiers in Neuroendocrinology. 31: 172-192.

Discus. 2025. Red Lace Guppy. <discus.ae/products/red-lace-guppy?srsltid=AfmBOorlvHlgZDpjNB_qgB0HXy2ivnBkWNTRMdIxBlY2g1zL2G_UWdQO>. Diakses pada 30 Desember 2025.

Domingos, J.A., A.M. Budd, Q.Q. Banh, J.A. Goldbury, K.R. Zenger, D.R. Jerry. 2018. Sex-specific *dmrt1* and *cyp19a1* methylation and alternative splicing in gonads of the protandrous hermaphrodite barramundi. PLOS ONE. 13(9): 1-19.

Dor, L., A. Shirak, Y. Y. Kohn, T. Gur, J. I. Weller, D. Zilberg, E. Seroussi and M. Ron. 2019. Mapping of the sex determining region on linkage group 12 of guppy(*Poecilia reticulata*). Genetics of Sex. 9: 3867-3875.

Dussenne, M., J. Delcourt, P. Poncin, C.A. Cornil and E. Parmentier. 2022. Impact of temperature-induced sex reversal on behaviour and sound production in Nile tilapia (*Oreochromis niloticus*). Hormones and Behaviour. 142: 1-13.

Dussenne, M., V. Gennotte, C. Rougeot, C. Mélard and C.A. Cornil. 2020. Consequences of temperature-induced sex reversal on hormones and brain in Nile tilapia (*Oreochromis niloticus*). Hormones and Behaviour. 121: 1-13.

Ellison, A., C.M. Rodríuez-López, P. Moran, J. Breen, M. Swain, M. Megias, M. Hegarty, M. Wilkinson, R. Pawluk and S. Consuegra. 2015. Epigenetic regulation of sex ratios may explain natural variation in self-fertilization rates. Proc. Biol Sci. 282(1819): 1-9.

Fang, J., G. Li., W. Luo and Q. Hu. 2025. Undestanding Genetic Regulation of Sex Differentiation in Hermaphroditic Fish. MDPI. 15 (119): 1-20.

Farrel, A.P. 2011. Encyclopedia of Fish Physiology: From Genome to Environment. Elsevier, Italy.

Feng, S., S.J. Cokus, X. Zhang, P. Chen, M. Bostick, M.G. Goll, J. Hetzel, J. Jain, S.H. Strauss, M.E. Halpern, C. Ukomadu, K.C. Sadler, S. Pradhan, M. Pellegrini and S.E. Jacobsen. 2010. Conservation and divergence of methylation pattering in plants and animals. PNAS. 109(19): 8689-8694.

FishBase. 2025. Adult.< FishBase Glossary>. Diakses tanggal 8 Mei 2025.

Fricke, R., Eschemeyer W.N. and Van der Laan, R. 2025. Eschemeyer's Catalog of Fishes: Genera, Species. <CAS - Eschmeyer's Catalog of Fishes:> Diakses pada 12 Maret 2025.

Gavery, M.R. and S.B. Roberts. 2017. Epigenetic considerations in aquaculture. PeerJ. 1-21.

Gennotte, V., E. François, C. Rougeot, J. Ponthier, S. Deleuze and C. Mélard. 2012. Sperm quality analysis in XX, XY and YY males of the Nile tilapia (*Oreochromis niloticus*). Theriogenology. 78: 210-217.

Genten, F., E. Terwinghe and A. Danguy. 2009. Atlas of Fish Histology. Science Publishers, USA.

UNIVERSITAS
GADJAH MADA
Ekspresi Gen Cyp19a Ikan Gupi (Poecilia reticulata, Peters 1859) pada Proses Sex Reversal Menggunakan Induksi Suhu 36°C
Fathiyya Riyana Murti, Dr. Dini Wahyu Kartika Sari, S.Pi, M.Si; Prof. Dr. Ir. Murwantoko, M.Si
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Guiguen, Y., A. Fostier, F. Piferrer and C. Chang. 2010. Ovarian aromatase and estrogens: a pivotal role for gonadal sex differentiation and sex change in fish. General and Comparative Endocrinology. 165: 352-366.

Hoivik, E.A., A.E. Lewis, L. Aumo and M. Bakke. 2010. Molecular aspects of steroidogenic factor 1 (SF-1). Molecular and Cellular Endocrinology. 315: 27-39.

Ji, X., S. Bu, Y. Zhu, Y. Wang, X. Wen, F. Song and J. Luo. 2022. Identification of SF-1 and *FOXL2* and their effect on activating P450 aromatase transcription via specific binding to the promoter motifs in sex reversing *Cheilinus undulatus.* Frontiers in Endocrinology. 13: 1-14.

Kirshbaum, F. and K. Formicki. 2020. The Histology of Fishes. CRC Press, New York.

Kitano, J., S. Ansai, Y. Takehana and Y. Yamamoto. 2023. Diversity and convergence of sex-detemination mechanisms in teleost fish. Annual Reviews of Animal Biosciences. 12: 233-59.

Kitano, T., K. Takamune, T. Kobayashi, Y. Nagahama and S-I. Abe. 1999. Suppression of P450 aromatase gene expression in sex-reversed males produced by rearing genetically female larvae at high water temperature during period of sex differentiation in the Japanese flounder (*Paralichthys olivaceus*). Journal of Molecular Endocrinology. 23: 167-176.

KKP RI. 2019. Keputusan Menteri Kelautan dan Perikanan Republik Indonesia Nomor 1/KEPMEN-KP/2019 tentang Obat Ikan.

KKP. 2025. KKP Ajak para Breeder Hasilkan Ikan Koi Kualitas Ekspor. < KKP | Kementerian Kelautan dan Perikanan>. Diakses pada tanggal 18 Maret 2025.

Kwan, T. N. and J. G. Patil. 2019. Sex biased expression of anti-Mullerian hormone (*amh*) gene in a live bearing fish, *Gambusia holbrooki*: evolutionary implications and potential role in sex differentiation. Comparative Biochemistry and Physiology Part B. 231: 59-66.

Lal, J., A. Vaishnav, S.K. Singh, P. Biswas, N.K. Mehta, D.K. Meena and G. Waikhom. 2024. The potential of aromatase inhibitors in fish masculinization: a comprehensive review of applications, mechanisms and future perspectives. International Aquatic Research. 16: 113-142.

Law, J.A. and S.E. Jacobsen. 2010. Establishing, maintaining and modifying DNA methylation patterns in plants and animals. Nat. Rev. Genet. 11(3): 204-220.

Lyko, F. 2018. The DNA methyltransferase family: a versatile toolkit for epigenetic regulation. Nature Reviews Genetics. 10: 81-92.

Matsumoto, Y. and D. Crews. 2012. Molecular mechanisms of temperature-dependent sex determination in the context of ecological developmental biology. Molecular and Cellular Endocrinology. 354: 103-110.

Mokhtar, D.M. 2022. Fish Histology From Cells to Organs 2nd Edition. Apple Academic Press, USA.

UNIVERSITAS
GADJAH MADA
Ekspresi Gen Cyp19a Ikan Gupi (Poecilia reticulata, Peters 1859) pada Proses Sex Reversal Menggunakan Induksi Suhu 36°C
Fathiyya Riyana Murti, Dr. Dini Wahyu Kartika Sari, S.Pi, M.Si; Prof. Dr. Ir. Murwantoko, M.Si
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Morris, J., L. Darolti, W. van der Bijl and J.E. Mank. 2020. High-resolution characterization of male ornamentation and re-evaluation of sex linkage in guppies. Proceedings of the Royal Society B. 287: 1-8.

Navarro-Martin, L., J. Viñas, L. Ribas, N. Diaz, A. Gutiérrez, L.D. Croce and F. Piferrer. 2011. DNA methylation of the gonadal aromatase (*Cyp19a*) promoter is involved in temperature-dependent sex ratio shifts in the European sea bass. PLOS Genetics. 7(12): 1-15.

Nishimura, T. and M. Tanaka. 2014. Gonadal development in fish. Sexual Development. 8: 252-261.

Ortega-Recalde, O., A. Goikoetxea, T.A. Hore, E.V. Todd and N.J. Gemmell. 2020. The genetics and epigenetics of sex change in fish. The Annual Review of Animal Biosciences. 8: 47-69.

Piferrer, F. 2018. Epigenetics of sex determination and differentiation in fish. In Sex Control in Aquaculture, ed. H-P Wang, F. Piferrer, S-L Chen. Pp65-83. Chichester, UK: John Wiley & Sons.

Piferrer, F., M. Blázquez, L. Navarro and A. González. 2005. Genetic, endocrine and environmental component of sex determination and differentiation in the European sea bass (*Dicentrarchus labrax* L.). General and Comparative Endocrinology. 142: 102-110.

Pop, S., A.M. Enciu, I. Tarcomnicu, E. Gille and C. Tanase. 2019. Phytochemicals in cancer prevention: modulating epigenetic alterations of DNA methylation. Phytochemistry Reviews. 18: 1005-1024.

Purnamasari, A.Y, Rustadi, I. Hardaningsih, A. Nuriliani, H. Bimasuci, M.A. Ikhrami and D.W.K. Sari. 2025. Gonadal development and sexual maturity onset of giant gourami (*Osphronemus goramy* Lac.). Discover Animals. 2(64): 1-12.

Putri, R. H., N. Annisa dan Y. Atifah. 2021. Analisis tingkah laku reproduksi ikan guppy(*Poecilia* sp.). Prosiding Semnas Bio 2021 Universitas Negeri Padang. 692-699.

Rahelia, A. 2022. Maskulinisasi Ikan Guppy (*Poecilia reticulata* Peters, 1859) dengan Suhu 36 °C pada Tahap Post-larva. Fakultas Pertanian. Universitas Gadjah Mada. Yogyakarta: Skripsi.

Rajendiran, P., F. Jaafar, S. Kar, C. Sundhakumari, B. Senthilkumaran and I.S. Parhar. 2021. Sex determination and differentiation in teleost: roles of genetics, environment and brain. Biology. 10(973): 1-25.

Razmi, K., N. K. Tran and J. G. Patil. 2023. Gonad ontogeny and sex differentiation in a poecilid, *Gambusia holbrooki*: transition from a Bi- to a mono-lobed organ. MDPI. 12(731): 1-22.

Römer U. and W. Beisenherz. 1996. Environmental determination of sex in *Apistogramma* (Cichlidae) and two other freshwater fishes (Teleostei). 48: 714-725.

Salazar, M., M. Caballero-Huertas, T.A. van Gelderen, M.N. Krabbe, M. Gut, S. Health, A. Esteve and L. Ribas. 2025. Sexual dimorphism in the DNA methylation pattern after immune stimulation in the zebrafish (*Danio rerio*) gonads. Frontiers in Cell and Developmental Biology. 13: 1-11.

UNIVERSITAS
GADJAH MADA
Ekspresi Gen Cyp19a Ikan Gupi (Poecilia reticulata, Peters 1859) pada Proses Sex Reversal Menggunakan Induksi Suhu 36°C
Fathiyya Riyana Murti, Dr. Dini Wahyu Kartika Sari, S.Pi, M.Si; Prof. Dr. Ir. Murwantoko, M.Si
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Sardi, A.E., M. Bègout, A. Lalles, X. Cousin and H. Budzinski. 2023. Temperature and feeding frequency impact the survival, growth and metamorphosis success of *Solea solea* larvae. PLOS One. 18(3): 1-21.

Shaddock, P., 2008. Guppy Color Bank. Diakses dari <https://www.petbh.com.br/guppy/wp-content/uploads/2017/12/08-Guppy-Color-Bank.pdf> tanggal 4 November 2025.

Shao, C., Q. Li, S. Chen, P. Zhang, J. Lian, Q. Hu, B. Sun, L. Jin, S. Liu, Z. Wang, H. Zhao, Z. Jin, Z. Liang, Y. Li, Q. Zheng, Y. Zhang, J. Wang and G. Zhang. 2014. Epigenetic modification and inheritance in sexual reversal of fish. Genome Res. 24(4): 604-615.

Tao, W., J. Yuan, L. Zhou, L. Sun. Y. Sun, S. Yang, M. Li, S. Zeng, B. Huang and D. Wang. 2013. Characterization of gonadal transcriptomes from nile tilapia (*Oreochromis niloticus*) reveals differentially expressed genes. PLOS one. 8(5): 1-11.

Torres-Martínez, A., L.R. de Dios, A. Hernández-Franyutti, M.C. Uribe and W.C. Sánchez. 2019. Structure of a testis and spermatogenesis of the viviparous teleost *Poecilia mexicana* (Poeciliidae) from an active sulfur spring cave in Southern Mexico. Journal of Morphology. 1-11.

Uribe, M.C., H.J. Grier and V. Mejía-Roa. 2014. Comparative testicular structure and spermatogenesis in bony fishes. Spermatogenesis. 1-13.

Waddington, C.H. 1942. The Epigenome. Endeavour. 1: 18-20.

Waindi, E.N., A. Owori-Wadunde and N. Nkwabi. 2010. Heat induced sex reversal in *Oreochromis niloticus* in Lake Victoria basin. Fisheries & Aquaculture Cluster Proceedings. 205-213.

Wang, D., T. Kobayashi, L. Zhou, B. Paul-Prasanth, S. Ijiri, F. Sakai, K. Okubo, K. Morohashi and Y. Nagahama. 2007. Foxl2 up-regulates aromatase gene transcription in a female-specific manner by binding to the promoter as well as interacting with Ad4 binding protein/Steroidogenic Factor 1. Molecular Endocrinology. 21(3): 712-725.

Wang, Y.Y., L.X. Sun, J.J. Zhu, Y. Zhao, H. Wang, H.J. Liu and X.S. Ji. 2017. Epigenetic control of *cyp19a1a* expression is critical for high temperature induced Nile tilapia masculinization. Journal of Thermal Biology. 69: 76-84.

Wen, A.Y., F. You, P. Sun, J. Li, D.D. Xu, Z.H. Wu, D.Y. Ma and P.J. Zhang. CpG methylation of *dmrt1* and *cyp19a* promoters in relation to their sexual dimorphic expression in the Japanese flounder *Paralichthys olivaceus*. Journal of Fish Biology. 84(1): 193-205.

Yao, Z.L., Q.F. Fang, J.Y. Li., M. Zhou, S. Du, H.J. Chen, H. Wang, S. Jiang. X. Wang, Y. Zhao and X.S. Ji. Alternative splicing of histone demethylase *Kdm6bb* mediates temperature-induced sex reversal in the Nile tilapia. Current Biology. 4: 5057-5070.

Yu, H., X. Du, X. Chen, L. Liu and X. Wang. 2024. Transforming growth factor-β (TGF-β): a master signal pathway in teleost sex determination. General and Comparative Endocrinology. 355: 1-7.

UNIVERSITAS
GADJAH MADA
Ekspresi Gen Cyp19a Ikan Gupi (Poecilia reticulata, Peters 1859) pada Proses Sex Reversal Menggunakan Induksi Suhu 36°C
Fathiyya Riyana Murti, Dr. Dini Wahyu Kartika Sari, S.Pi, M.Si; Prof. Dr. Ir. Murwantoko, M.Si
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Yusuf, D.H., Sugiarto dan G.E. Wijayanti. 2014. Perkembangan post-larva ikan nilem *Osteochilus haselti* C.V. dengan pola pemberian pakan berbeda. Scripta Biologica. 1(3): 185-192.