



A journey through 5

Reptilian genomes

Presented by:

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Outline

- Genome papers
- Facts about the species
- Interesting facts
- Genomic information's about the species
 - Sequencing strategy
 - Sequencing method
 - Assembly
 - Annotation
- Questions
- General Comparison

Genomic papers

nature
ecology & evolution

ARTICLES

<https://doi.org/10.1038/s41559-019-0945-8>

OPEN

Genome of the Komodo dragon reveals adaptations in the cardiovascular and chemosensory systems of monitor lizards

Abigail L. Lind¹, Yvonne Y. Y. Lai², Yulia Mostovoy², Alisha K. Holloway¹, Alessio Iannucci³,

LETTER

[doi:10.1038/nature10390](https://doi.org/10.1038/nature10390)

The genome of the green anole lizard and a comparative analysis with birds and mammals

Jessica Alfoldi^{1*}, Federica Di Palma^{1*}, Manfred Grabherr¹, Christina Williams², Lesheng Kong³, Evan Mauceli¹, Pamela Russell¹, Craig B. Lowe⁴, Richard E. Glor⁵, Jacob D. Jaffe¹, David A. Ray⁶, Stephane Boissinot⁷, Andrew M. Shedlock⁸, Christopher Botka⁹,

Science

RESEARCH ARTICLE SUMMARY

AVIAN GENOMICS

Three crocodylian genomes reveal ancestral patterns of evolution among archosaurs

Richard E. Green^{*}, Edward L. Braun, Joel Armstrong, Dent Earl, Ngan Nguyen, Glenn Hickey, Michael W. Vandeweghe, John A. St. John, Salvador Capella-Gutiérrez, Todd A. Castoe, Colin Kern, Matthew K. Fujita, Juan C. Opazo, Jerzy Jurka, Kenji K. Kojima, Juan Caballero, Robert M. Hubley, Arian F. Smit, Roy N. Platt, Christine A. Lavoie, Meganathan P. Ramakodi, John W. Finger Jr., Alexander Suh, Sally R. Isberg, Lee Miles, Amanda Y. Chong, Weerachai Jaratlersiri, Jaime Gongora,

ary change rather than intrinsic differences in base-repair machinery. We hypothesize that this single cause may be a consistently longer generation time over the evolutionary history of Crocodylia.

Low heterozygosity was observed in each genome, consistent with previous analyses, including the Chinese alligator. Pairwise sequential Markov chain analysis of regional heterozygosity indicates that during glacial cycles of the Pleistocene, each species suffered reductions in effective population size. The reduction was especially strong for the American alligator, whose current range extends farthest into regions of temperate climates.

CONCLUSION: We used crocodylian, avian,

nature
ecology & evolution

ARTICLES

<https://doi.org/10.1038/s41559-018-0733-x>

OPEN

Giant tortoise genomes provide insights into longevity and age-related disease

Victor Quesada^{1,19}, Sandra Freitas-Rodríguez^{1,19}, Joshua Miller^{2,19}, José G. Pérez-Silva^{3,19}, Zi-Feng Jiang³, Washington Tapia^{4,5}, Olaya Santiago-Fernández¹, Diana Campos-Iglesias¹,

PNAS

The king cobra genome reveals dynamic gene evolution and adaptation in the snake venom system

Freek J. Vonk^{a,b,c,1}, Nicholas R. Casewell^{d,1}, Christiaan V. Henkel^{b,e}, Alysha M. Heimberg^f, Hans J. Jansen^g, Ryan J. R. McCleary⁹, Harald M. E. Kerckamp⁹, Rutger A. Vos⁹, Isabel Guerreiro⁹, Juan J. Calvete^h, Wolfgang Wüster^c, Anthony E. Woods¹, Jessica M. Logan¹, Robert A. Harrison¹, Todd A. Castoe^{k,l}, A. P. Jason de Koning^{k,m}, David D. Pollock^k, Mark Yandell⁹, Diego Calderon⁹, Camila Renjifo², Rachel B. Currier², David Salgado^o, Dávinia Pla¹, Libia Sanz¹, Asad S. Hyder⁹, José M. C. Ribeiro⁹, Jan W. Arntzen⁹, Guido E. E. J. M. van den Thillart⁹, Marten Boetzer⁹, Walter Pirovano¹, Ron P. Dirks⁹, Herman P. Spaik^{b,e}, Denis Duboule¹, Edwina McGlinn¹, R. Manjunatha Kini⁹, and Michael K. Richardson^{b,2}

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Facts About: Komodo dragon

- ***Varanus komodoensis***
 - *Native to Komodo island in Indonesia*
- **the largest living lizard in the world.**
 - weigh about 70 kg, and 3m length
- **Unique cardiopulmonary physiology**
 - Well-developed ventricular septa resulting in functionally divided heart
- **Hunting Skills**
 - Run fast (up to 20km/h).
 - Have long, forked tongue to sample the air
 - can see objects as far away as 300 meters
 - **Toxic bite?**



Interesting facts: Komodo dragon

- Positive selection across 4 genes responsible for blood clotting regulation (*MRVI1*, *RASGRP1*, *LCP2*, *CD63*).
- Saliva of komodo dragons contains **anticoagulants**, which aid hunting (Once bleeding starts, it doesn't stop)



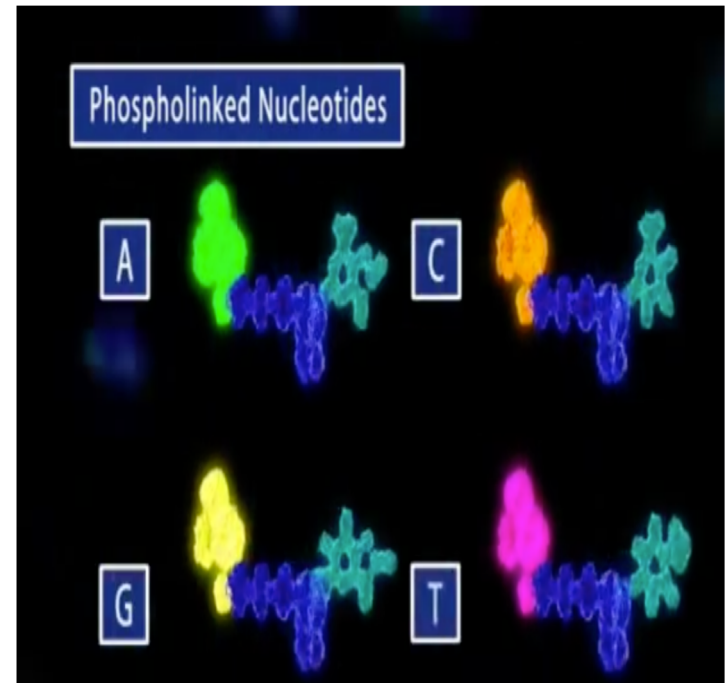
Komodo dragon's Genome

Number of Chromosomes :	40 (2n)
Genome Size:	1.89 Gb
Source of Sample:	Blood
Sequencing Method:	Illumina (Short reads)/ PacBio and Oxford Nanopore (Long range)
Sequencing Strategy:	Whole genome shotgun
Assembly method:	De novo
Contig N50:	95 Kb
%GC:	44.04%

PacBio??

PacBio calls their technology SMRT Sequencing (single molecule, real-time)

- it **doesn't** require clonal amplification of DNA – it sequences single molecules.
- while it is a form of 'sequencing by synthesis', it operates **in real-time** rather than incorporating a single base (or type of base) at a time.
- The optical system is essentially taking a **movie** as the polymerase incorporates fluorescent nucleotides.



PacBio??

Advantages:

1. The reads are quite **fast**, with runs generally lasting from 30 minutes to three hours (rather than days).
2. The reads are substantially **longer** than most other commercially available sequencing platforms.
3. The **movie** captures information about the rate of nucleotide incorporation, which can be used to determine the modification status of the template nucleotide.

Think about this question:

- 1 similarity between PacBio and Pyrosequencing?
- 1 similarity between PacBio and Illumina?
- 1 similarity between PacBio and Nanopore?
- 1 difference between PacBio and Sanger Sequencing?



Facts About: Tortoise

- Pinta giant tortoise (*Chelonoidis abingdonii*)
- **World largest tortoise.**
 - Size: 1.2 meters
 - Weight: 215 Kg
- **Longest living of all vertebrate.**
 - Average: 100 years
- Pinta giant tortoise is about to **extinct.**
- They can survive up to a year **without eating or drinking**



Interesting facts: Tortoise

- **They found:**

1. Important gene for the **defense** against pathogens and cancer.
2. A Gene that regulate the strength of DNA **repair** mechanism.
3. Coding region of ***IGF2R***.



Tortoise Genome

Number of Chromosomes :	28-66
Genome Size:	2.3 Gb
Source of Sample:	Blood
Sequencing Method:	Illumina and PacBio.
Sequencing Strategy:	Whole genome sequencing.
Assembly method:	AllPaths algorithm.
Contig N50:	74 Kb
Scaffold N50:	1.27 Mb



Facts About: Crocodile

- **Species:**

- Indian gharial(*Gavialis gangeticus*)
- saltwater crocodile(*Crocodylus porosus*)
- Alligator (*Alligator mississippiensis*)

- **Distribution:**

- Crocodiles in the wild are found all over the world while alligators are only found in the US and China.

- **Characteristics:**

- Like other reptiles, crocodiles are cold-blooded.
- Some species can weigh over 1200 kg (2600 lb) and **live for longer than 60 years** .
- Crocodiles release heat through their mouths rather than through sweat glands.
- Saltwater crocodiles have the **strongest bite**
- **largest species of crocodiles is saltwater crocodile**



Facts About: Crocodile

- **Hunting and Diet:**

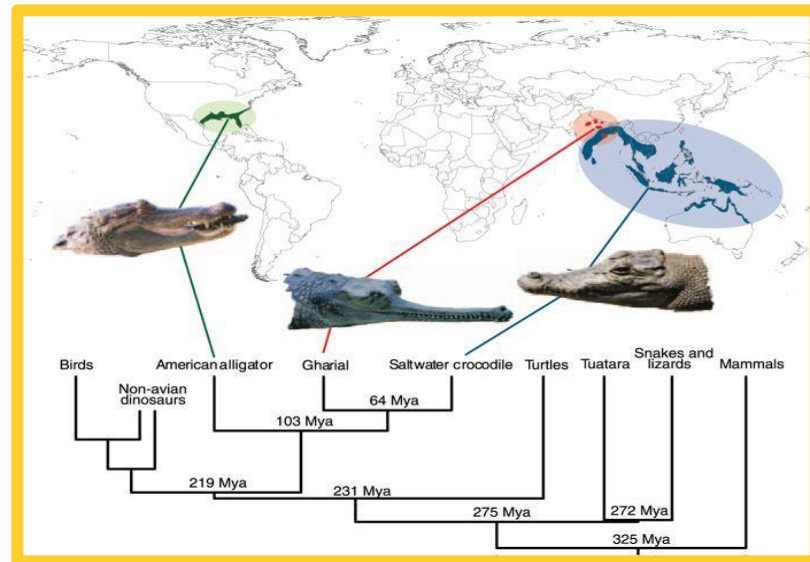
Crocodiles eat a variety of fish, birds and other animals.

Most of the young crocodiles are eaten in their first year of life – by other predators like lizards, other crocodiles, hyenas, and even fish.



Interesting facts: Crocodile

- ▶ Crocodiles carry their babies to the water in their mouth. Baby crocodiles can make noises from inside their eggs before they hatch. The mother can hear their voices, then digs up the eggs from the sand, and takes the hatchlings to the water.
- ▶ Despite being classified as “reptiles”, crocodiles (and all crocodylians, including alligators) are more closely related to dinosaurs and birds (which are actually Avian dinosaurs) than to most animals classified as reptiles.



Myths!!

- “crocodile bird” does not clean crocodile’s teeth. No bird clean crocodile teeth. This is a pure myth.
- Crocodiles are not dumb. While the brain of a crocodylian is fairly small, it is capable of greater learning than most reptiles.



Crocodile's Genome

Number of Chromosomes :	16 pairs, except Crocodylus its 17 piars
Genome Size:	<ul style="list-style-type: none">➤ American alligator 2,174.3 Mb➤ Saltwater crocodile 2,123.5 Mb➤ Indian gharial 2,882.7 Mb
Source of Sample:	Blood, Except Crocodylus (Multiple tissues)
Sequencing Method:	Illumina
Sequencing Strategy:	Whole genome shotgun
Assembly method:	AllPaths-LG, Except for Gavialis SOAP De novo v2.04
Scaffold N50:	<ul style="list-style-type: none">➤ American alligator 509.0 kb➤ Saltwater crocodile 205.0 kb➤ Indian gharial 127.6 Kb



Facts About: Lizard

- **Size:**
 - **Female** : about 5 inches
 - **Male**: about 8 inches
- **Distribution:**
 - native to North America, where it is found mainly in subtropical south-eastern parts of the continent
- **Diet:**
 - Feed on small insects



Facts About: Lizard

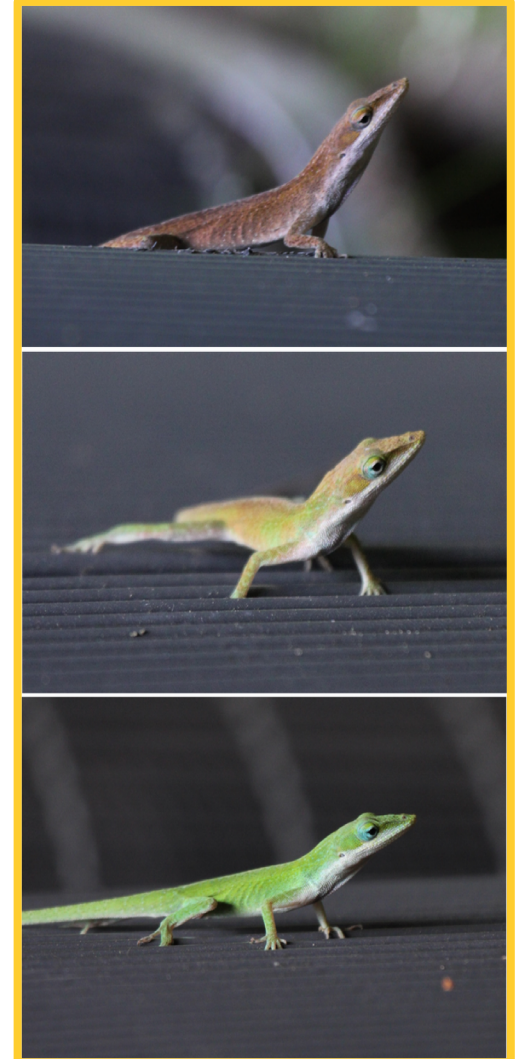
- **Characteristics:**

- Green anole lizard female will lay one **egg** every two weeks during breeding season. She may lay up to 15-18 **eggs** during the summer
- Green anole lizard male try to attract the female!



Facts About: Lizard

- **Characteristics: (Cont.)**
 - Green anole lizard is a mood



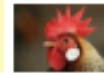
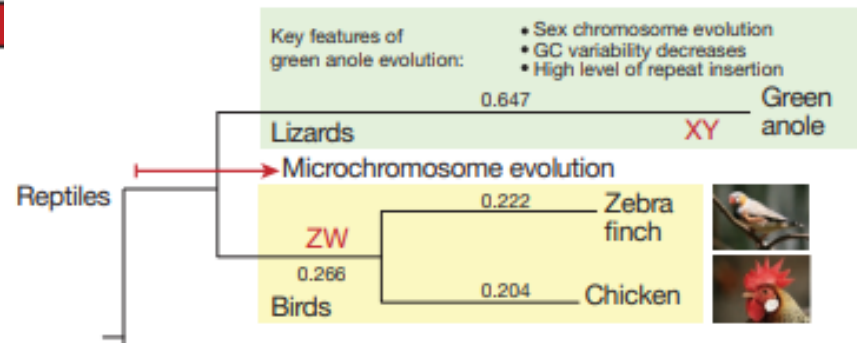
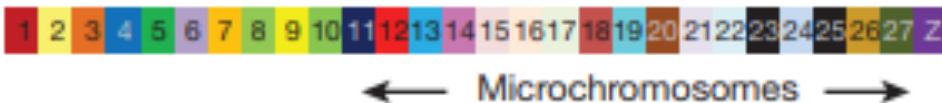
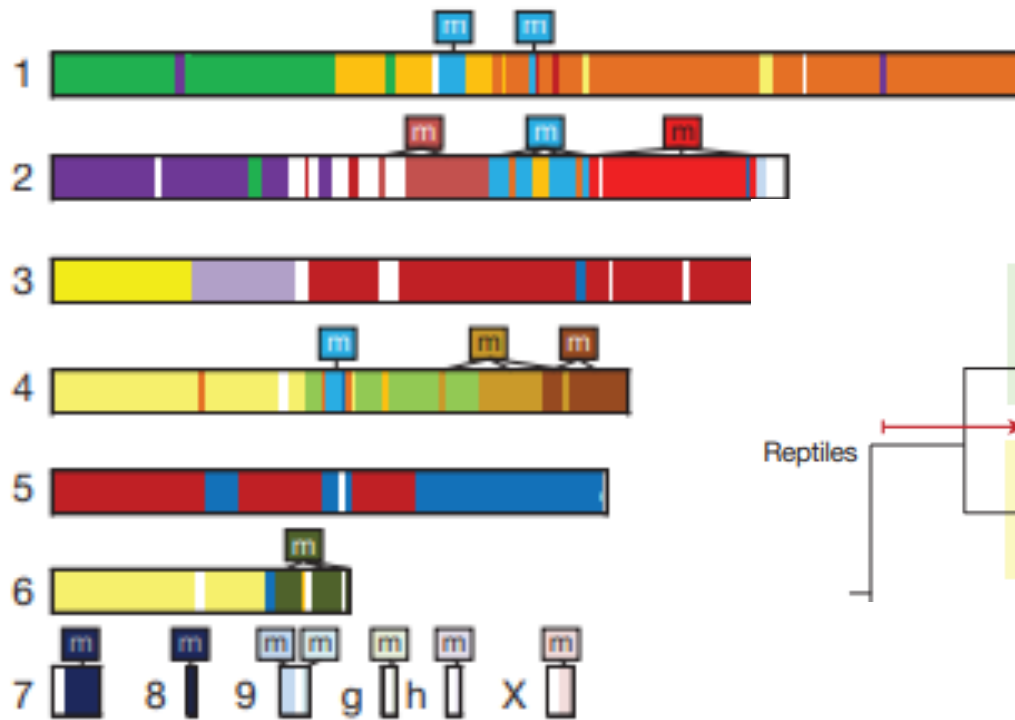
Facts About: Lizard

- **Characteristics: (Cont.)**
 - **Dead??**



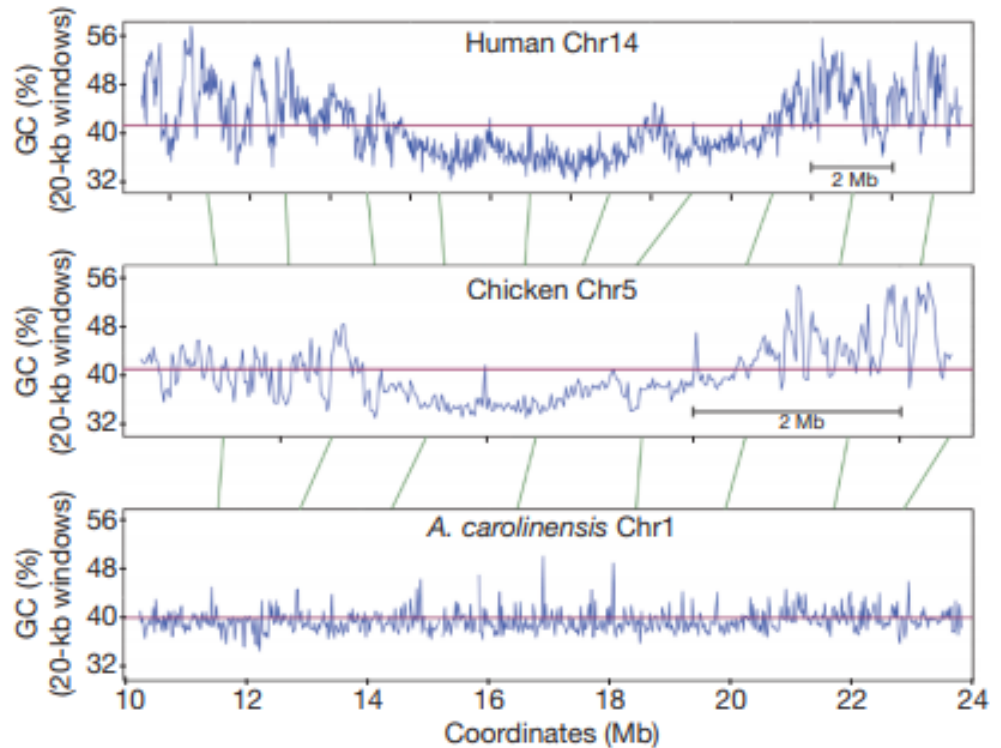
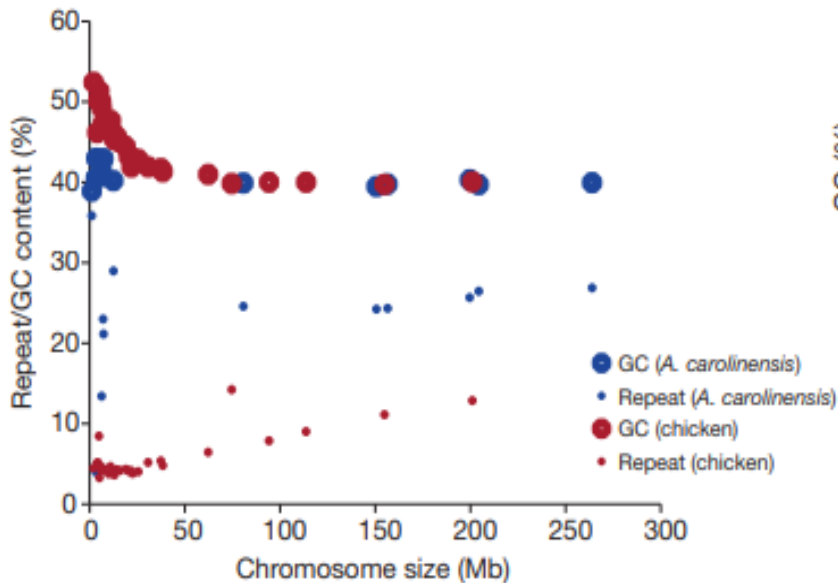
Interesting facts: Lizard

Synteny



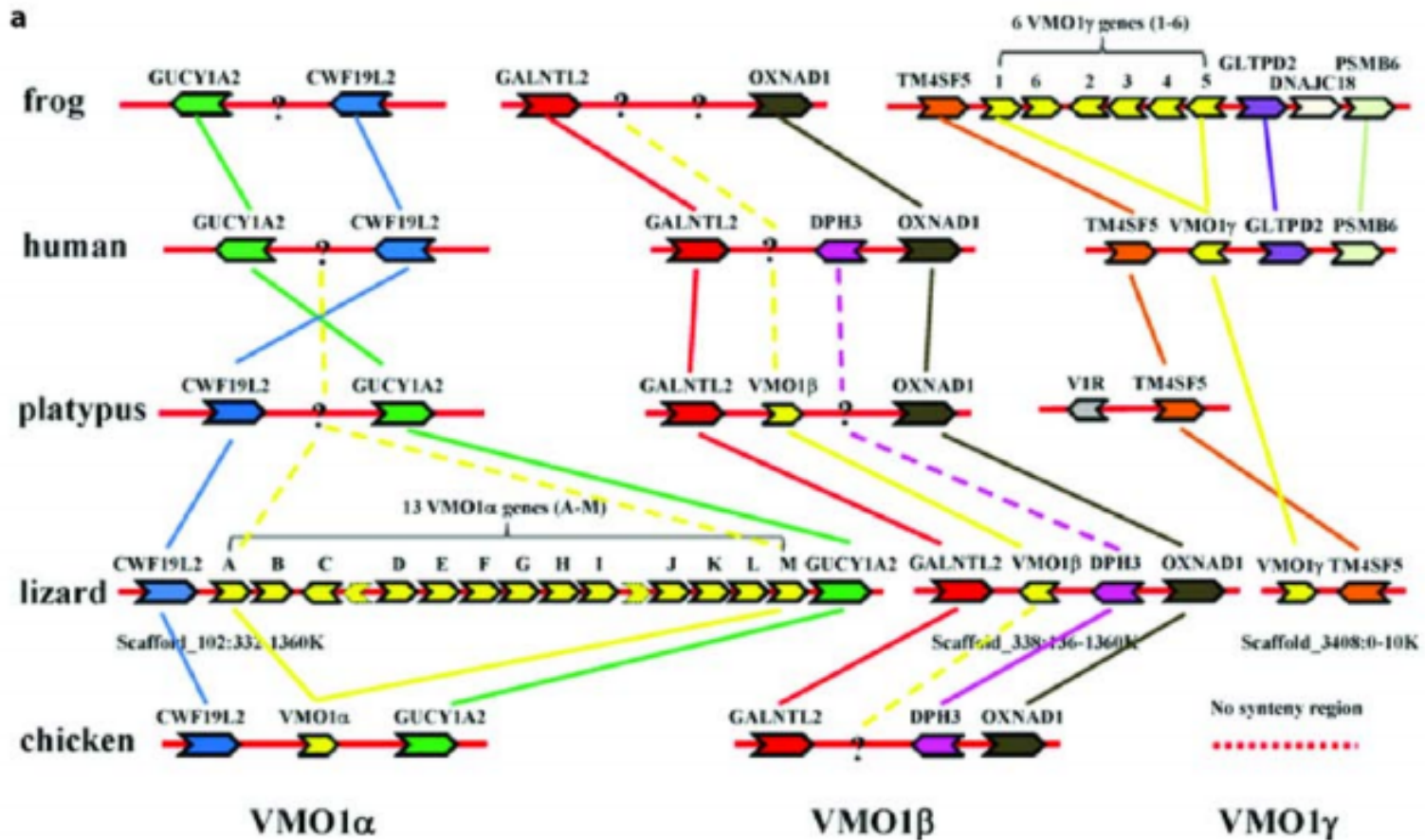
Interesting facts: Lizard

GC content is unusual!



Interesting facts: Lizard

rapid evolution of egg protein genes



Lizard's Genome

Number of Chromosomes :	18, six pairs of large macrochromosomes and 12 pairs of small microchromosomes
Genome Size:	1.78 Gb
Source of Sample:	Blood, tissues
Sequencing Method:	sanger sequencing
Sequencing Strategy:	female = Whole Genome Shotgun sequencing + male = BAC clone sequencing
Assembly method:	software package Arachne 2.0
Contig N50:	79.9 Kb
%GC	40.3%



Facts About: Snake

- King Cobra

(*Ophiophagus hannah*)

- **Characteristics:**

- It's the longest Venomous snake
- In contrast with the platypus venom that is driven by sexual selection used for male-male combats.

- **Hunting Skills:**

- Cobra snake uses a venomous cocktail that quickly shuts down nervous systems and paralyzes their prey when they bite them



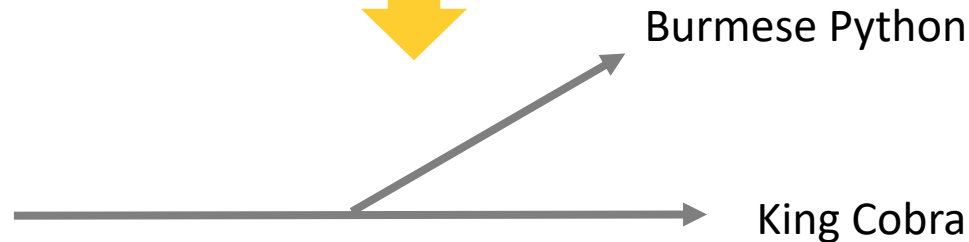
Facts About: Snake

Venomous or Non-Venomous Snakes

Snakes venom system regulatory components evolved from a pancreatic origin



Venom toxin genes were co-opted by distinct genomic mechanisms



Duplication of venom expressed genes in advanced snakes

Interesting facts: Snake

- The existence of the Hox gene clusters (responsible for the development of limbs, neck and the trunk) in the snakes prove the theory that they evolved from lizard (tetrapod reptile)

A fossil of a four legged snakes was discovered in Brazil



Snake's Genome

Number of Chromosomes :	36
Genome Size:	1.36 – 1.59 Gb
Source of Sample:	Blood
Sequencing Method:	Illumina
Sequencing Strategy:	Whole genome shotgun
Assembly method:	De novo
Contig N50:	3.98 Kb
Scaffold N50	226 Kb

General Comparison

	#Chromosomes	Genome size	Contig N50	Scaffold N50	Coverage
Komodo	40	1.89 Gb	95 kb	29 Mb	10x
Crocodile	32 except Crocodylus 34	<ul style="list-style-type: none"> ➤ American alligator 2,174.3 Mb ➤ Saltwater crocodile 2,123.5 Mb ➤ Indian gharial 2,882.7 Mb 		<ul style="list-style-type: none"> ➤ American alligator 509.0 kb ➤ Saltwater crocodile 205.0 kb ➤ Indian gharial 127.6 Kb 	5.5x - 88x 21 - 90x 50x - 170x
Lizard	36	1.78 Gb	79.9 Kb	4 Mb	7.10x
Tortoise	28-66	2.3 Gb	74 Kb	1.27 Mb	
Snake	36	1.36 – 1.59 Gb	3.98 Kb	226 Kb	

Thank You