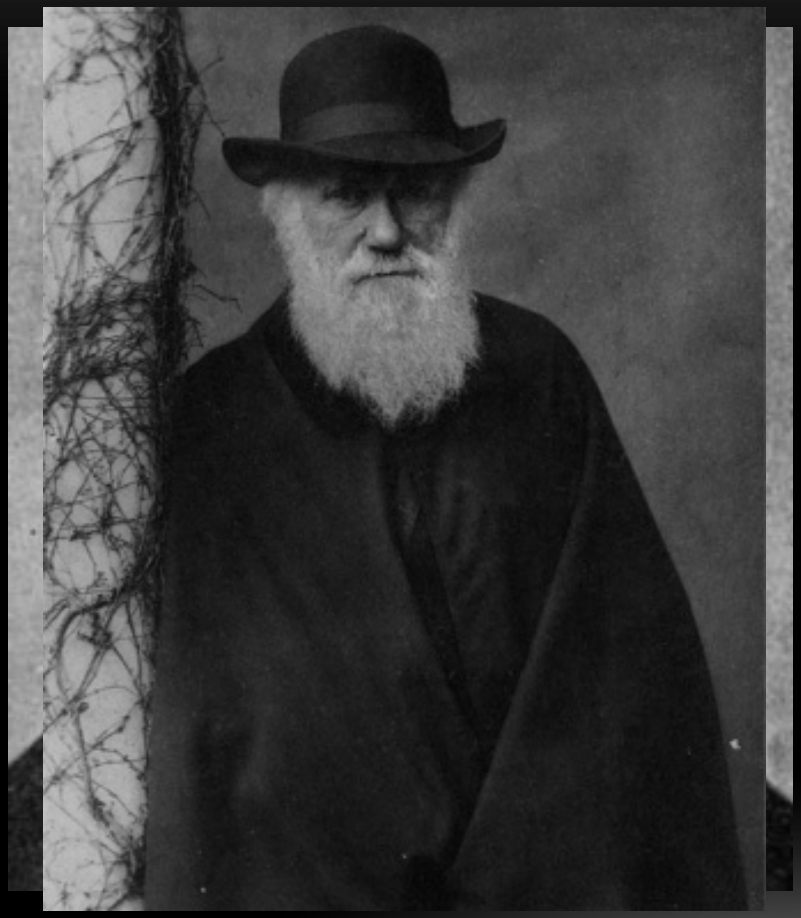
IMPORTING THE HOMOLOGY CONCEPT FROM EVOLUTIONARY BIOLOGY INTO DEVELOPMENTAL PSYCHOLOGY

Workshop: Homology in Developmental Psychology

Dalhousie University, Halifax, NS, Canada

August 16, 2011

WHAT IS HOMOLOGY?



A CATALOGUE OF TYPES OF HOMOLOGY

LEVELS OF ANALYSIS

- A non-exhaustive list:
  I. Morphological homology (bodily structures)
  II. Molecular homology (DNA)
  III. Behavioral homology
  IV. Developmental homology (processes)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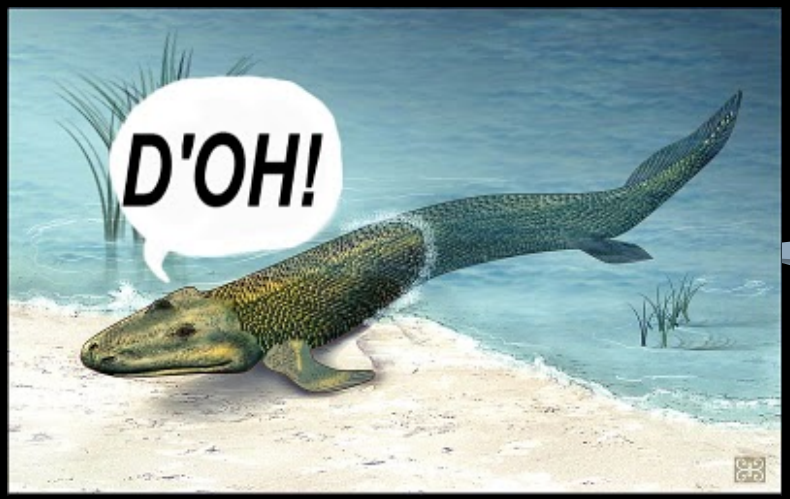
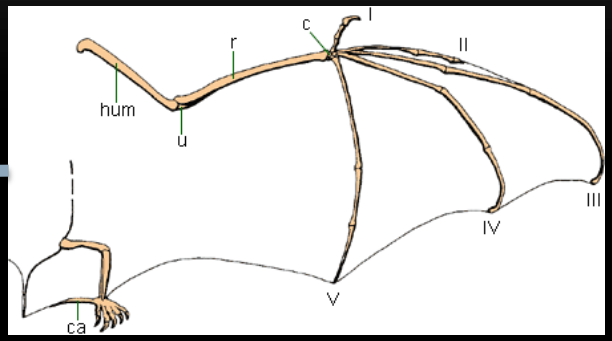
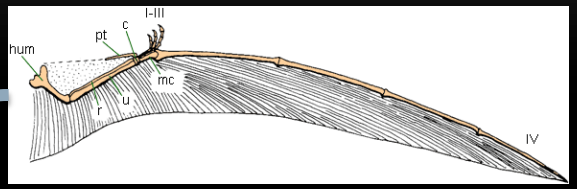
I) TAXIC/SPECIAL HOMOLOGY (MORPHOLOGY, CONTEMPORANEOUS)

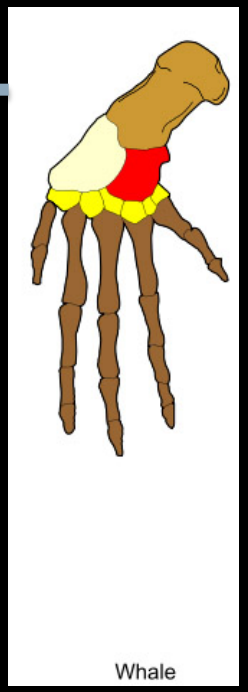


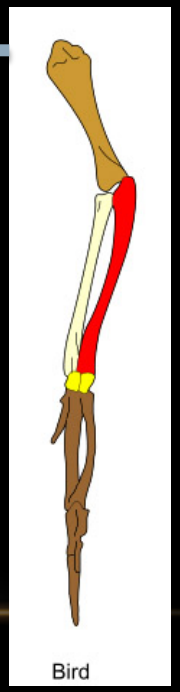


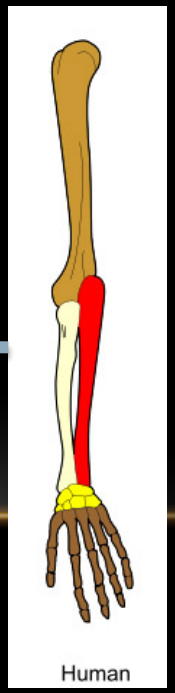
I) TAXIC/SPECIAL HOMOLOGY (MORPHOLOGY, CONTEMPORANEOUS)

I) TAXIC/SPECIAL HOMOLOGY (MORPHOLOGY, NONCONTEMPORANEOUS)

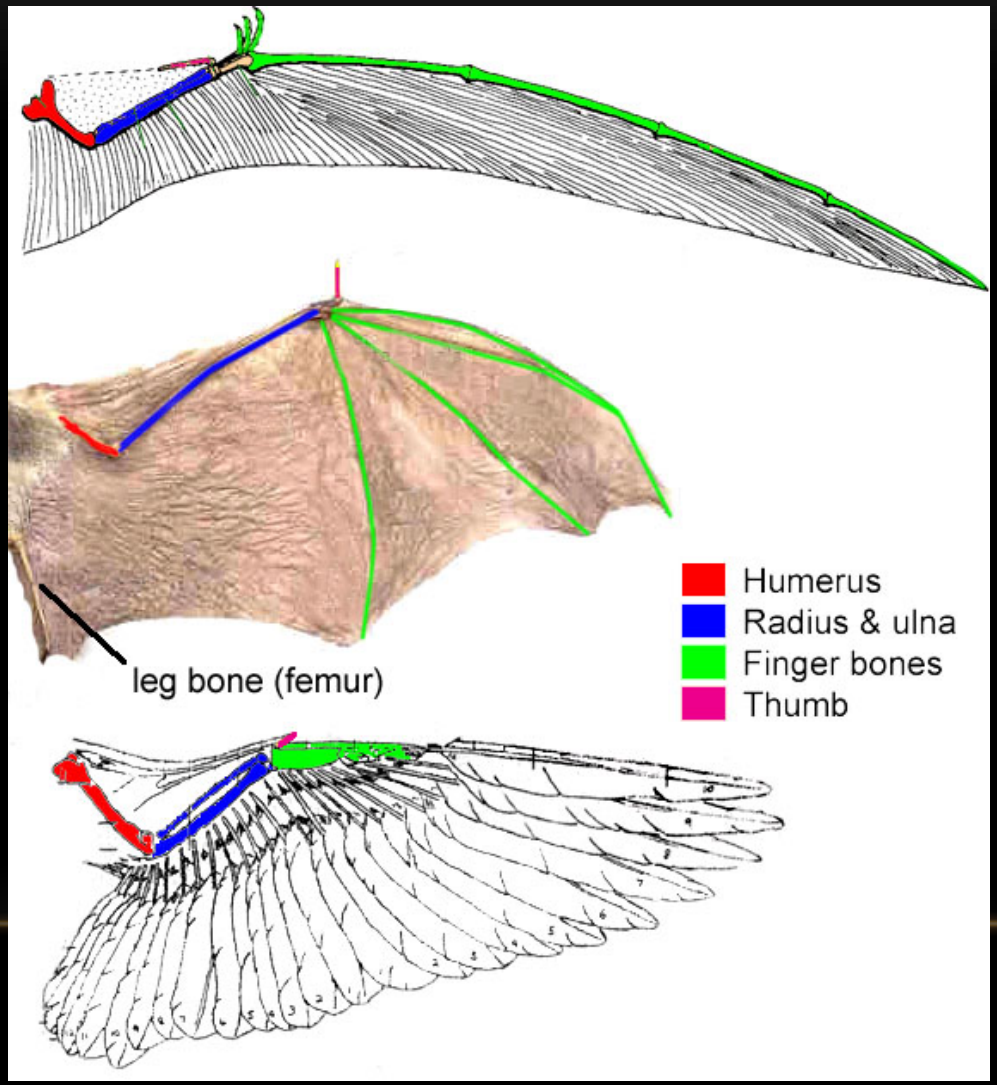






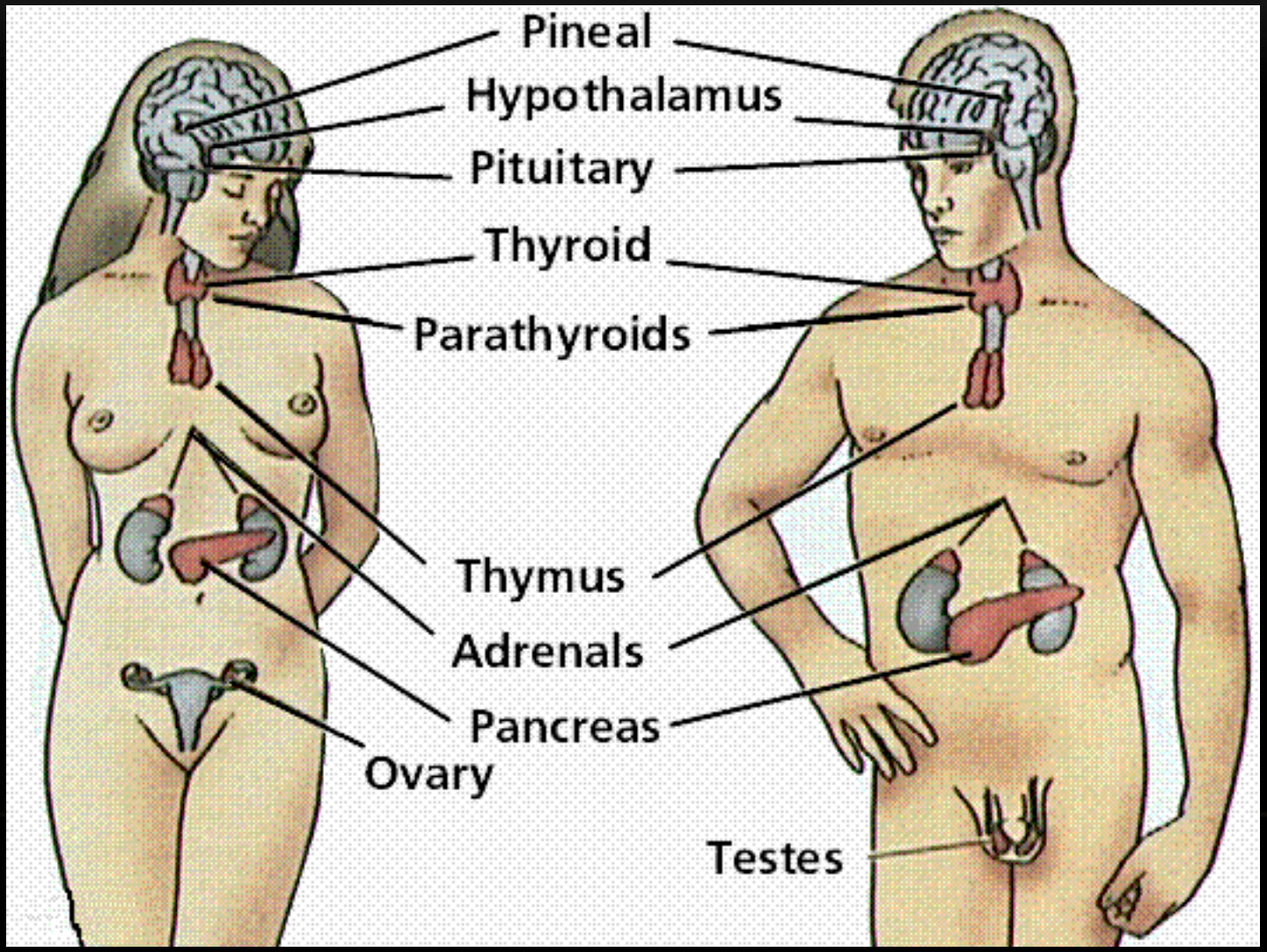


HOMOLOGY VERSUS ANALOGY

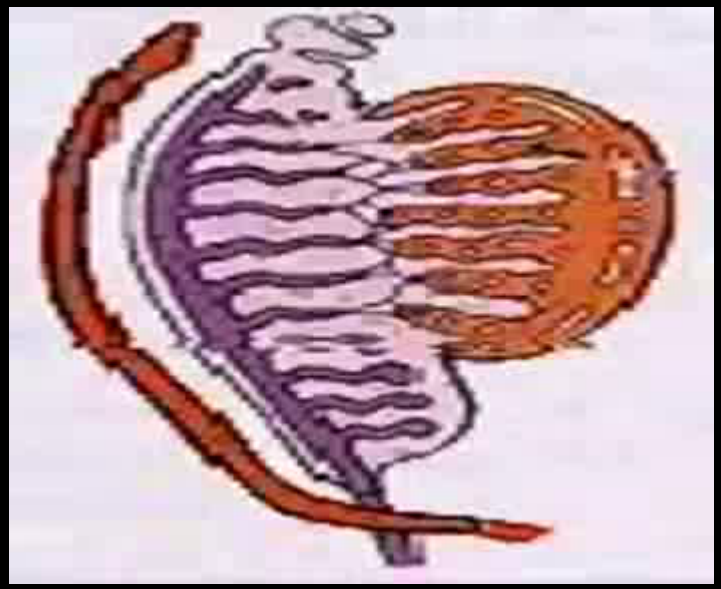


I) SERIAL HOMOLOGY (MORPHOLOGY, CONVENTIONAL)

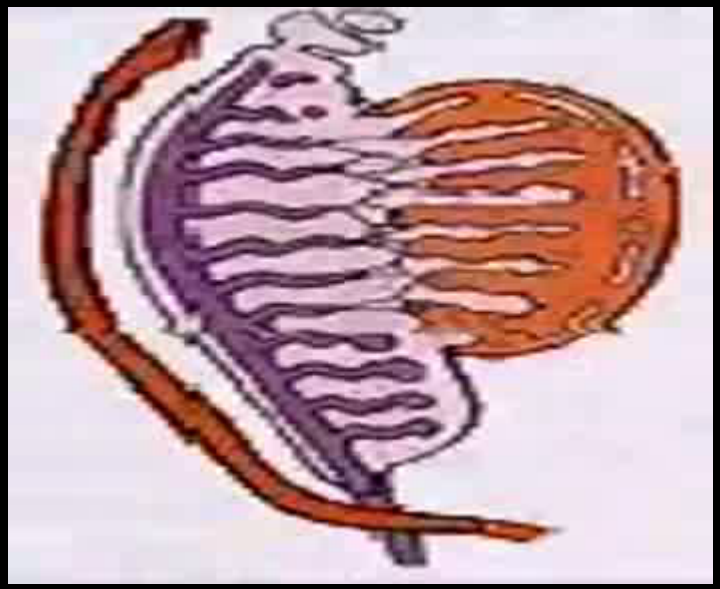
I) SERIAL HOMOLOGY (UNCONVENTIONAL, CONTEMPORANEOUS)



I) SERIAL HOMOLOGY (UNCONVENTIONAL, NONCONTEMPORANEOUS)

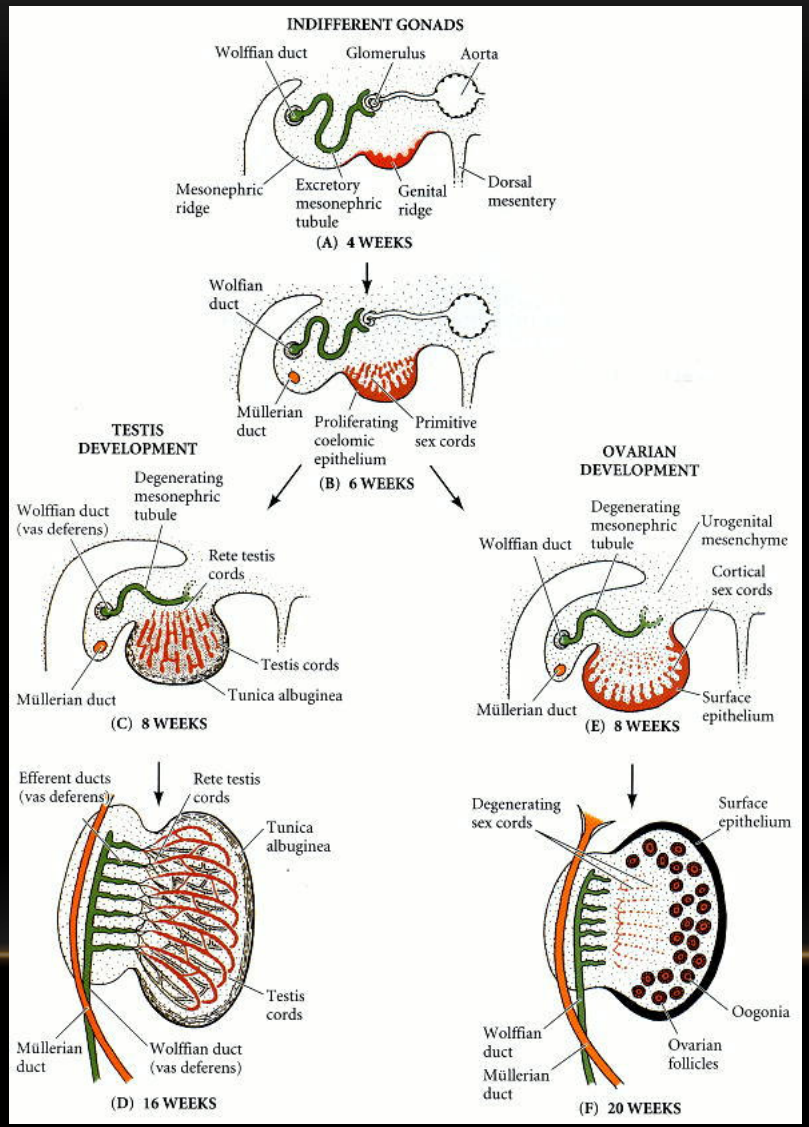


MALE GONADAL DEVELOPMENT



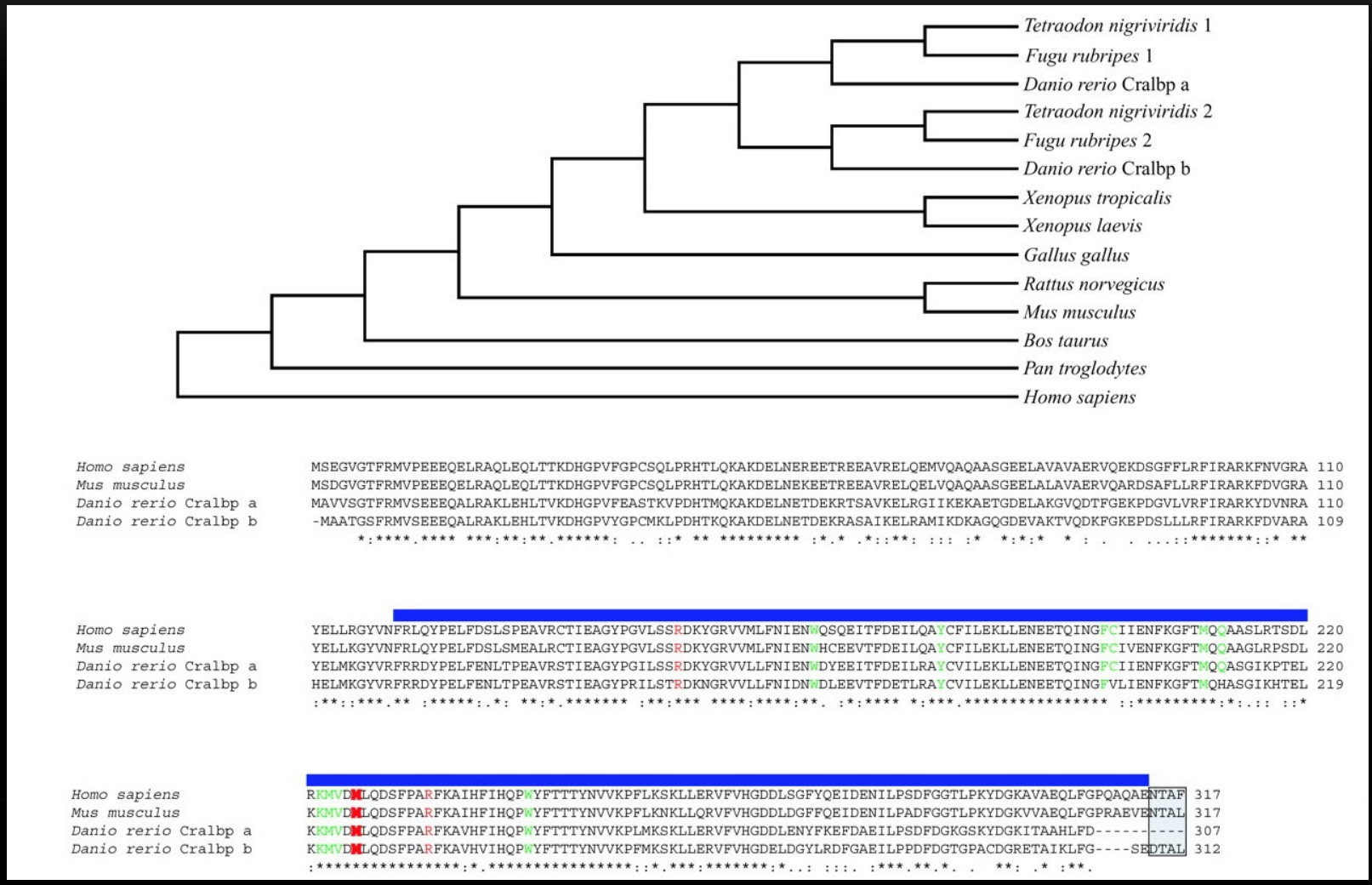
FEMALE GONADAL DEVELOPMENT

I) SERIAL HOMOLOGY (UNCONVENTIONAL, NONCONTEMPORANEOUS)



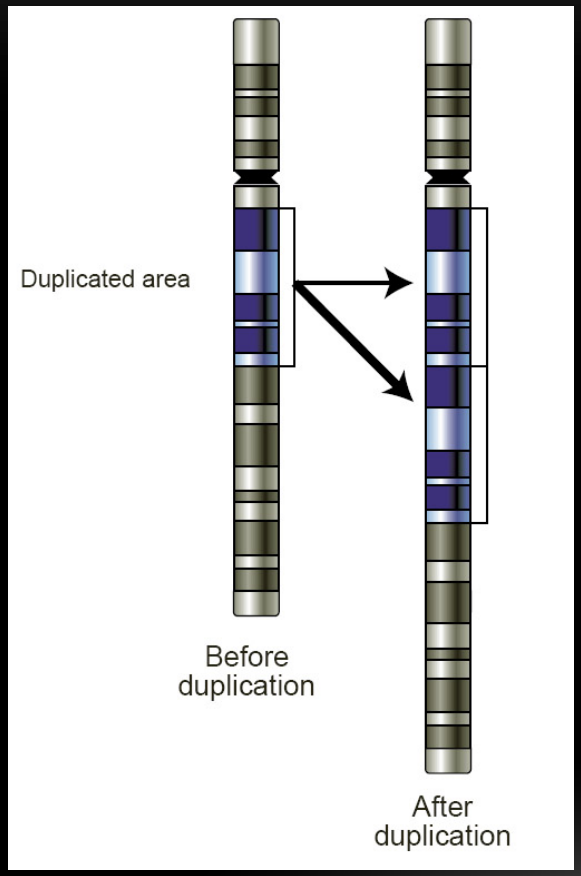
I) SERIAL HOMOLOGY (UNCONVENTIONAL, CONTINUOUS)

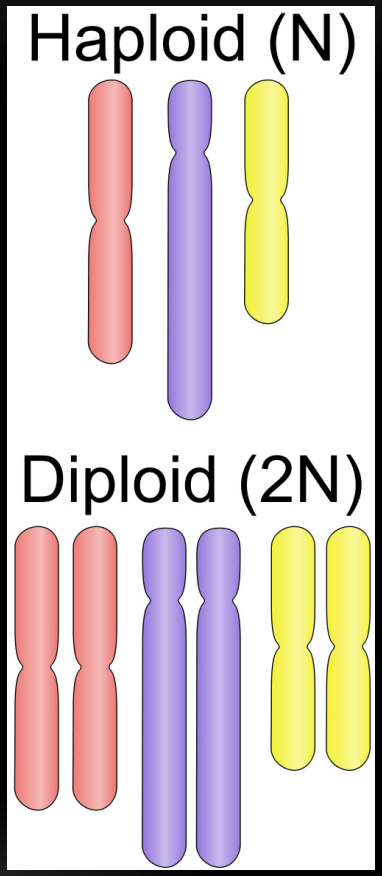
II) MOLECULAR HOMOLOGY (DNA) ORTHOLOGUES (TAXIC-STYLE)



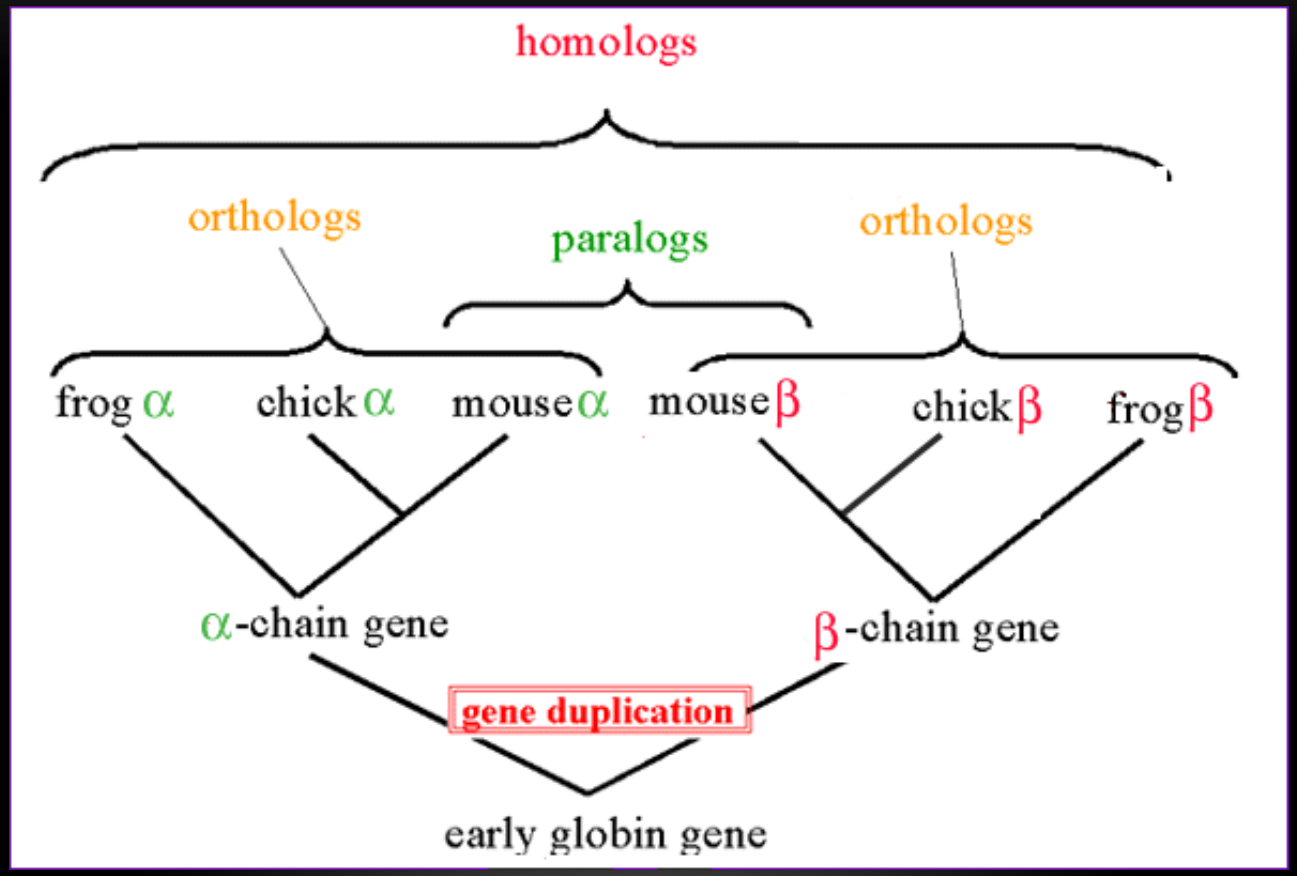
PROTEIN SEQUENCE FOR CELLULAR RETINALDEHYDE BINDING PROTEIN

II) MOLECULAR HOMOLOGY (DNA)
PARALOGUES (SERIAL-STYLE)

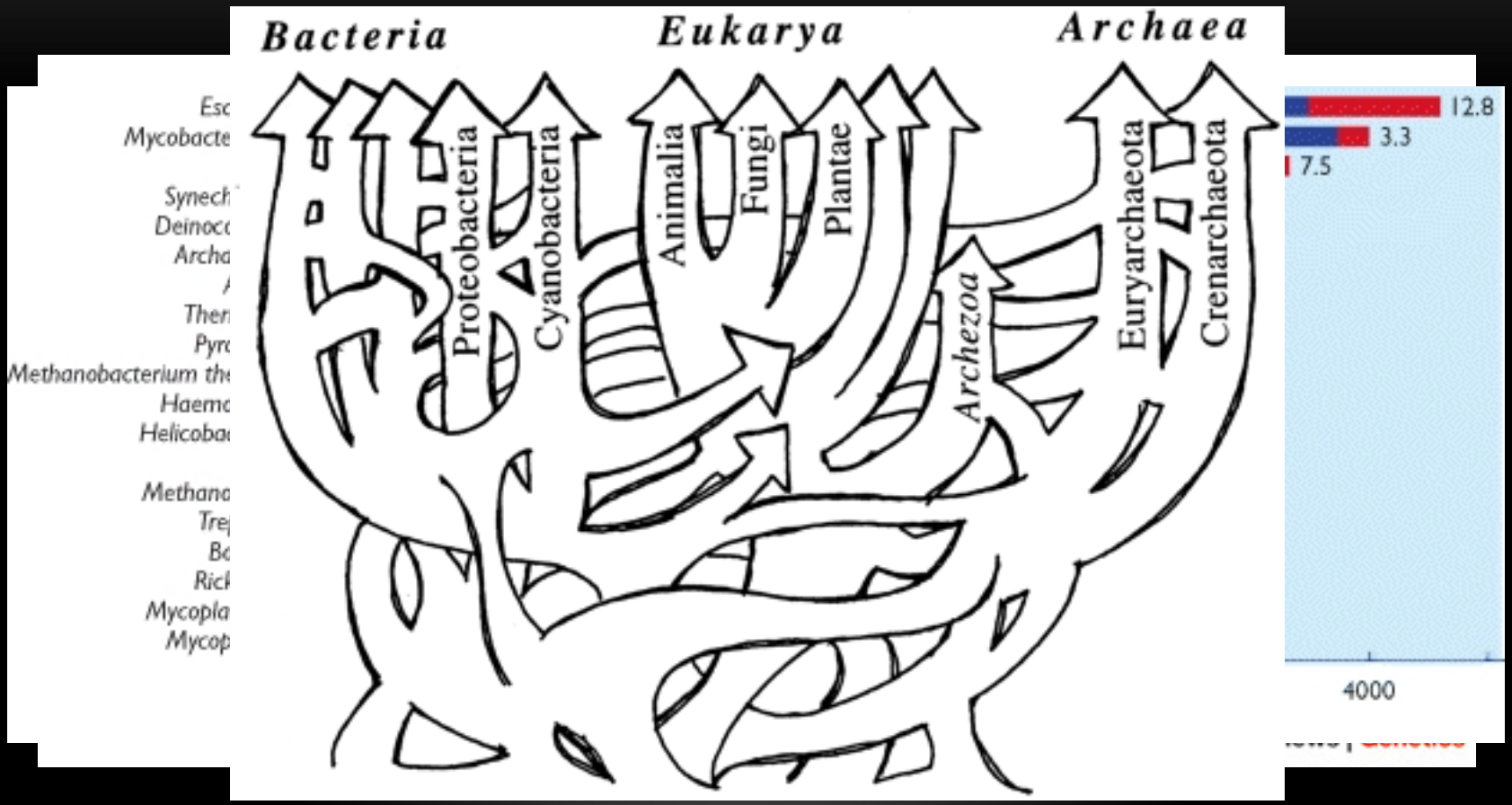




ORTHOLOGS AND PARALOGS IN EVOLUTION



II) MOLECULAR HOMOLOGY (DNA) XENOLOGUES (NO MORPHOLOGICAL COUNTERPART)



III) BEHAVIORAL HOMOLOGY

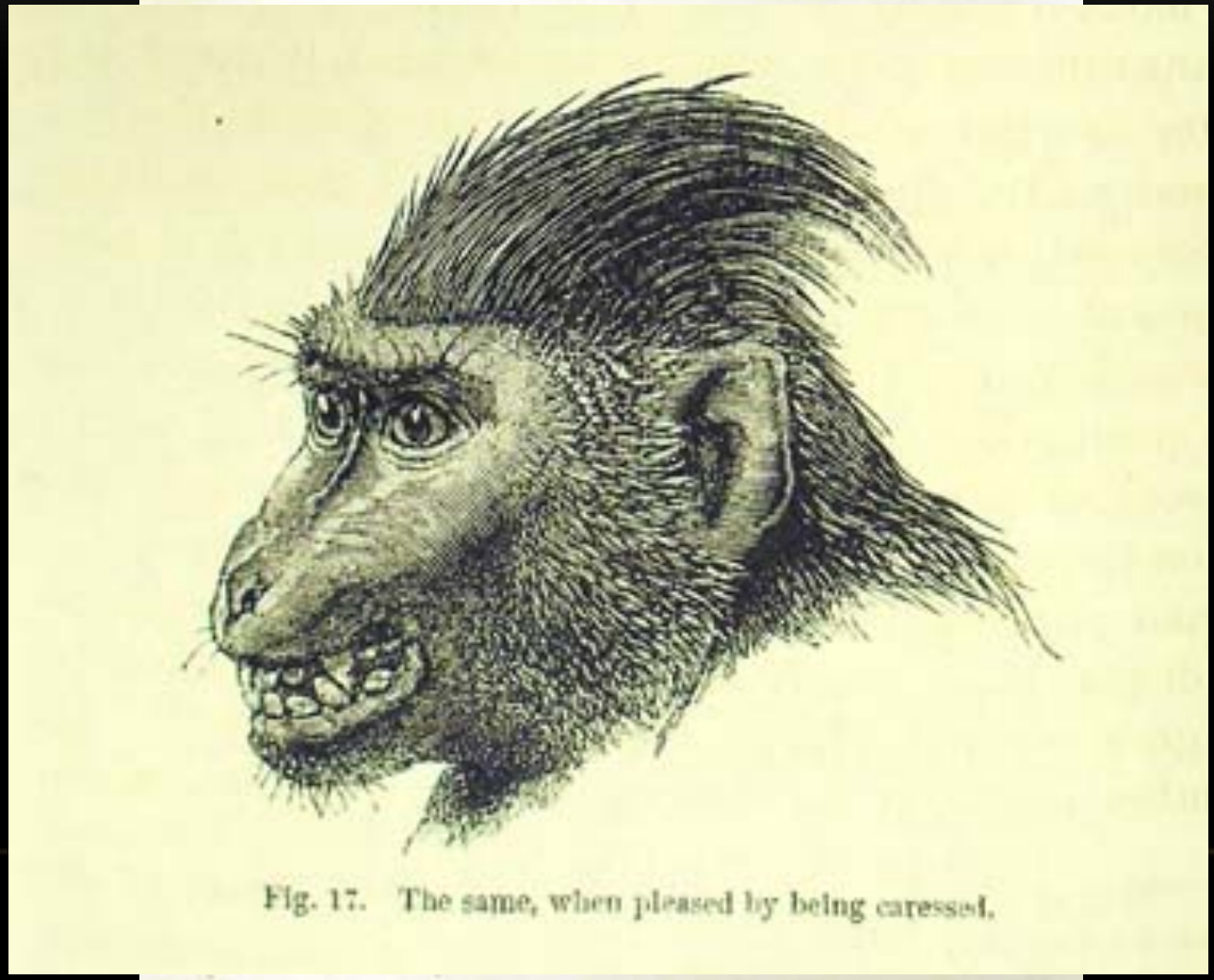


Fig. 17. The same, when pleased by being caressed.

III) BEHAVIORAL HOMOLOGY

FRONTALIS [1, 2]

CORRUGATOR SUPERCILLI [4]

J Nonverbal Behav (2007) 31:1–20

Chimpanzee

Low wrinkled forehead
Textured brow ridge

Nasal channel
Subnasal furrow

Prognathic lower face
Vertical lip wrinkles
Slight lip eversion

Common

Glabellar
Nasion
Eye-fold cover
Lower eye-lid furrow
Infra-orbital triangle

Human

Large forehead
Eye brow hair
Scleral contrast
Nasal bridge

Nasiolabial furrow
Cheek fat

Philtrum
Everted lipsBony chin boss

Fig. 1 Facial morphology in humans and chimpanzees

MENTALIS [17]

PLATYSMA [21]

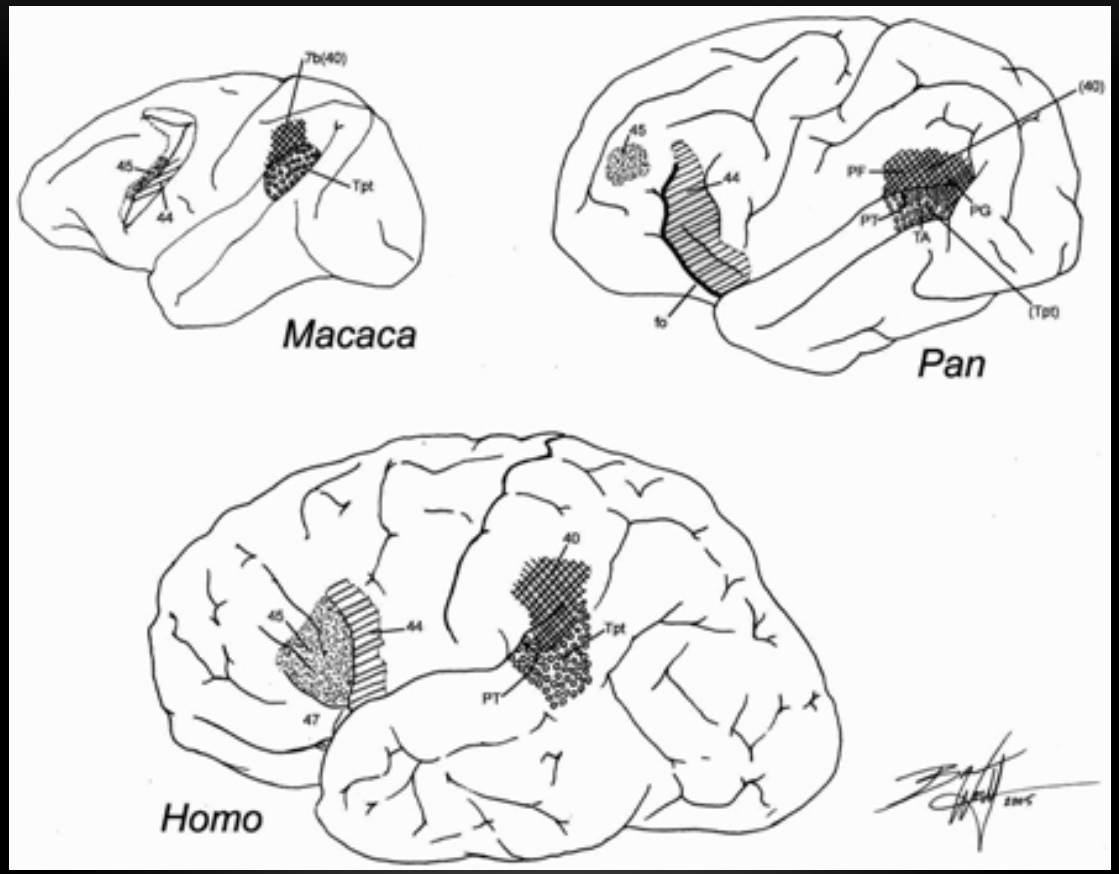
Figure 1. Comparison of the location, structure and relative size of facial muscles in human and chimpanzee. Numbers shown are human FACS action units (Ekman et al., 2002a). Where the specific muscle is not shown, the general area is circled. Muscles not shown in the central table reported only in human, but see Burrows, Waller, Parr and Bonar (2006) (Zi = Zygomatic Minor, R = Risorius). Human diagram adapted from Hager (2000) and chimpanzee dissection diagram adapted from Pellatt (1979b). All images used with permission.

III) BEHAVIORAL HOMOLOGY

INDEPENDENCE OF HOMOLOGY AT DIFFERENT LEVELS OF ANALYSIS

HOMOLOGY INDEPENDENCE, MOLECULAR

HOMOLOGY INDEPENDENCE, NEURAL



HOMOLOGY INDEPENDENCE, PROCESSES

IDENTIFYING HOMOLOGY

HOW BIOLOGISTS IDENTIFY HOMOLOGY

- Remane's (1952) criteria (taxic, serial, behavioral, process)
  1. Position (physical or temporal)
  2. Special quality
  3. Connection to evolutionary—or for us, developmental—intermediates

K. LORENZ (1958), *SCIENTIFIC AMERICAN*

"Anyone who has watched a dog scratch its jaw or a bird preen its head feathers can attest to the fact that they do so in the same way. The dog props itself on the tripod formed by its haunches and two forelegs and reaches a hindleg forward in front of its shoulder. Now the odd fact is that most birds (as well as virtually all mammals and reptiles) scratch with precisely the same motion! A bird also scratches with a hindlimb (that is, its claw), and in doing so it lowers its wing and reaches its claw forward in front of its shoulder. One might think that it would be simpler for the bird to move its claw directly to its head without moving its wing, which lies folded out of the way on its back. I do not see how to explain this clumsy action unless we admit that it is inborn. Before the bird can scratch, it must reconstruct the old spatial relationship of the limbs of the four-legged common ancestor which it shares with mammals."

CHARACTERS VERSUS STATES: CHARACTERS

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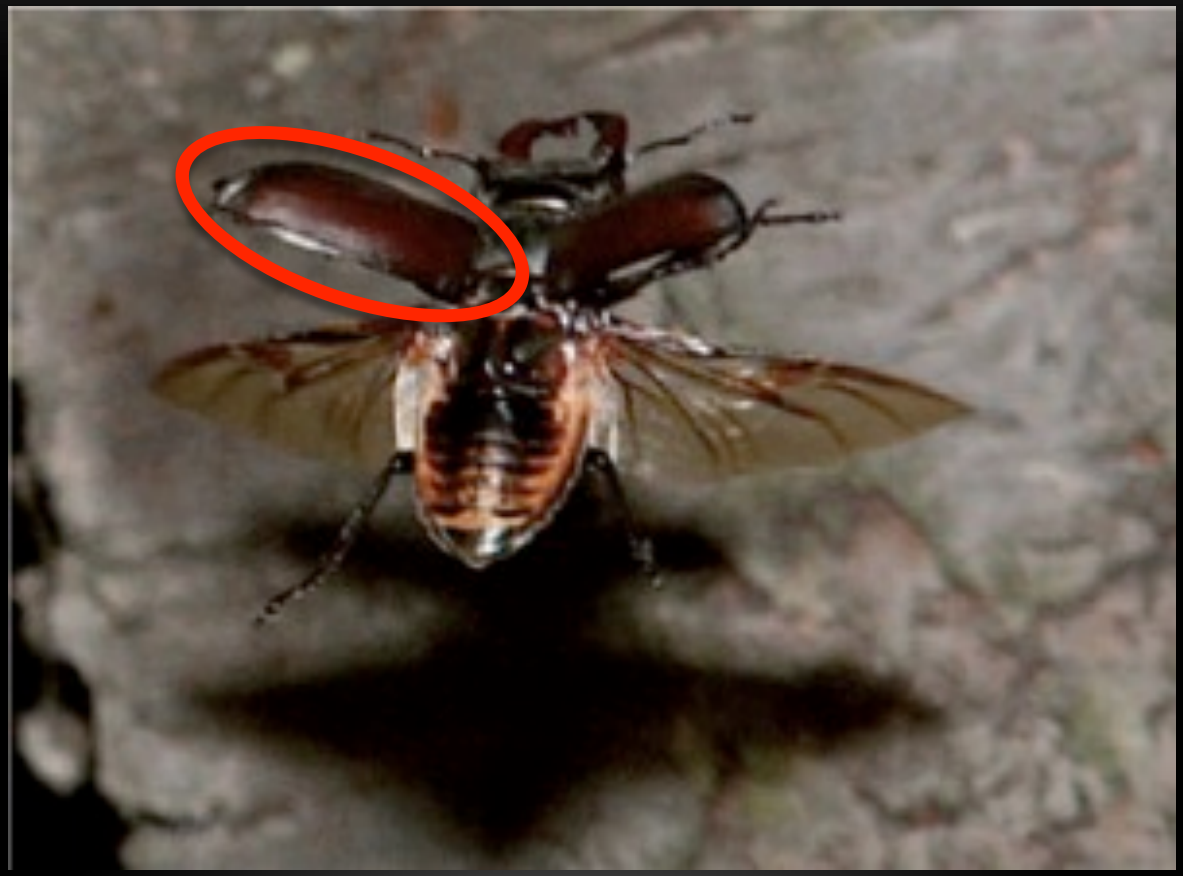
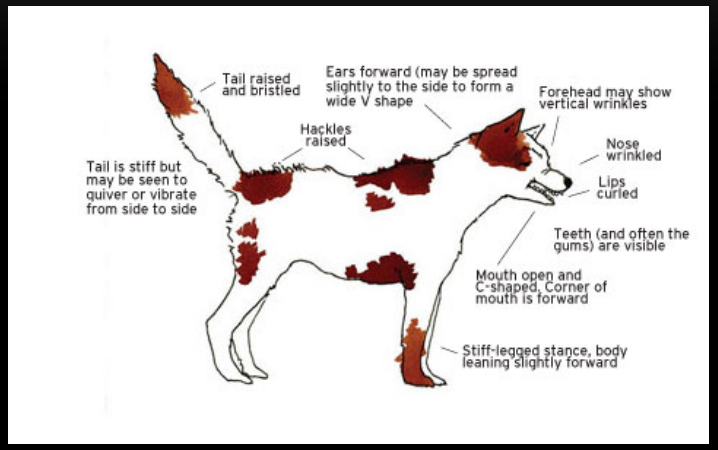
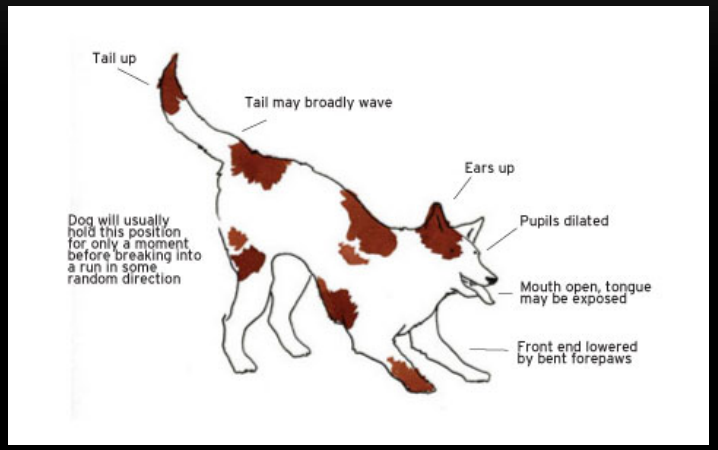
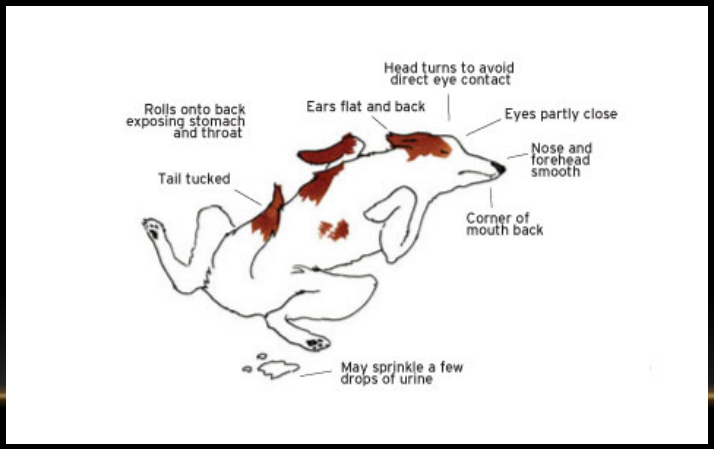


HOW CAN HOMOLOGY HELP DEVELOPMENTAL PSYCHOLOGISTS?

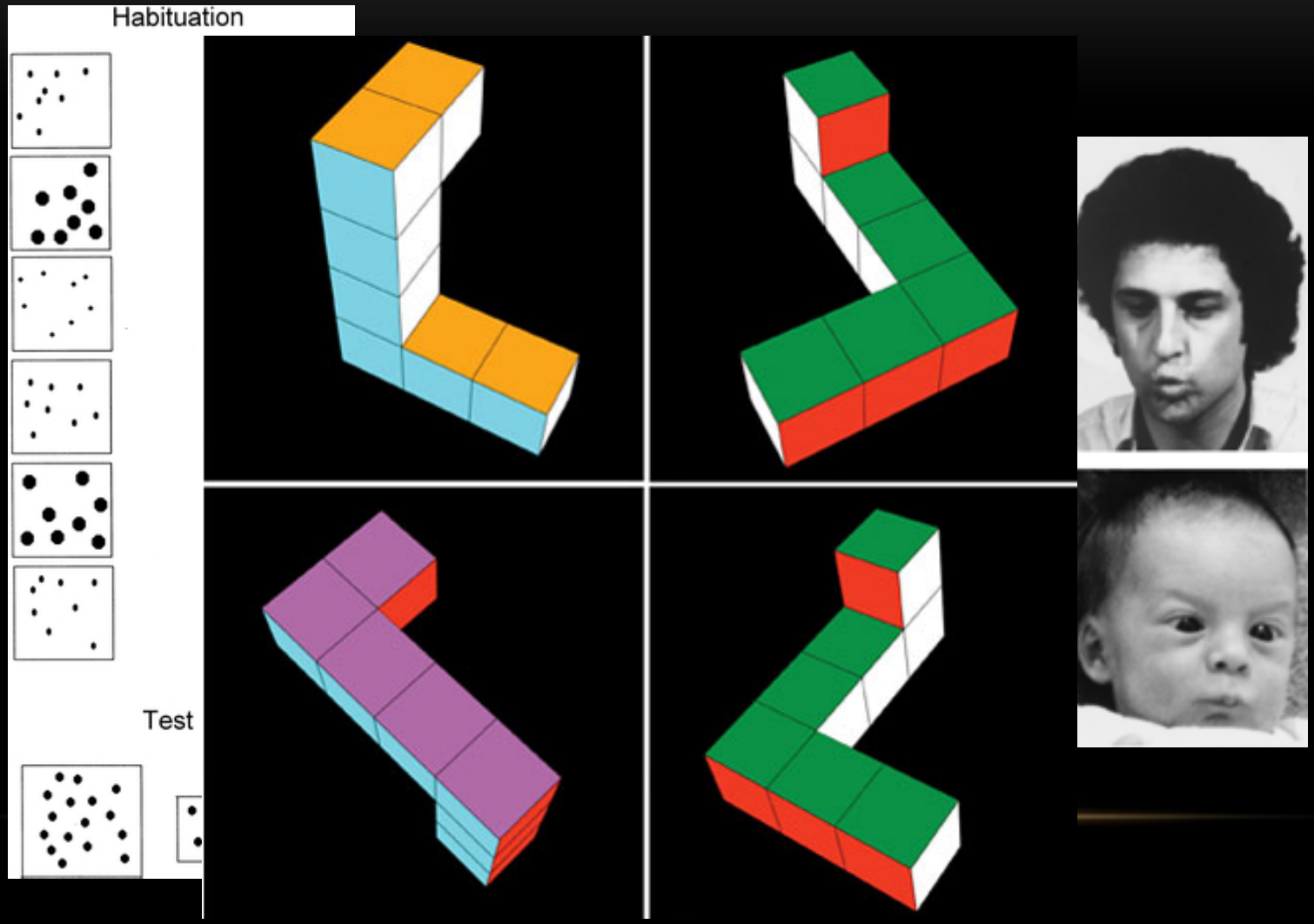
QUOTING MATTHEN (2007)



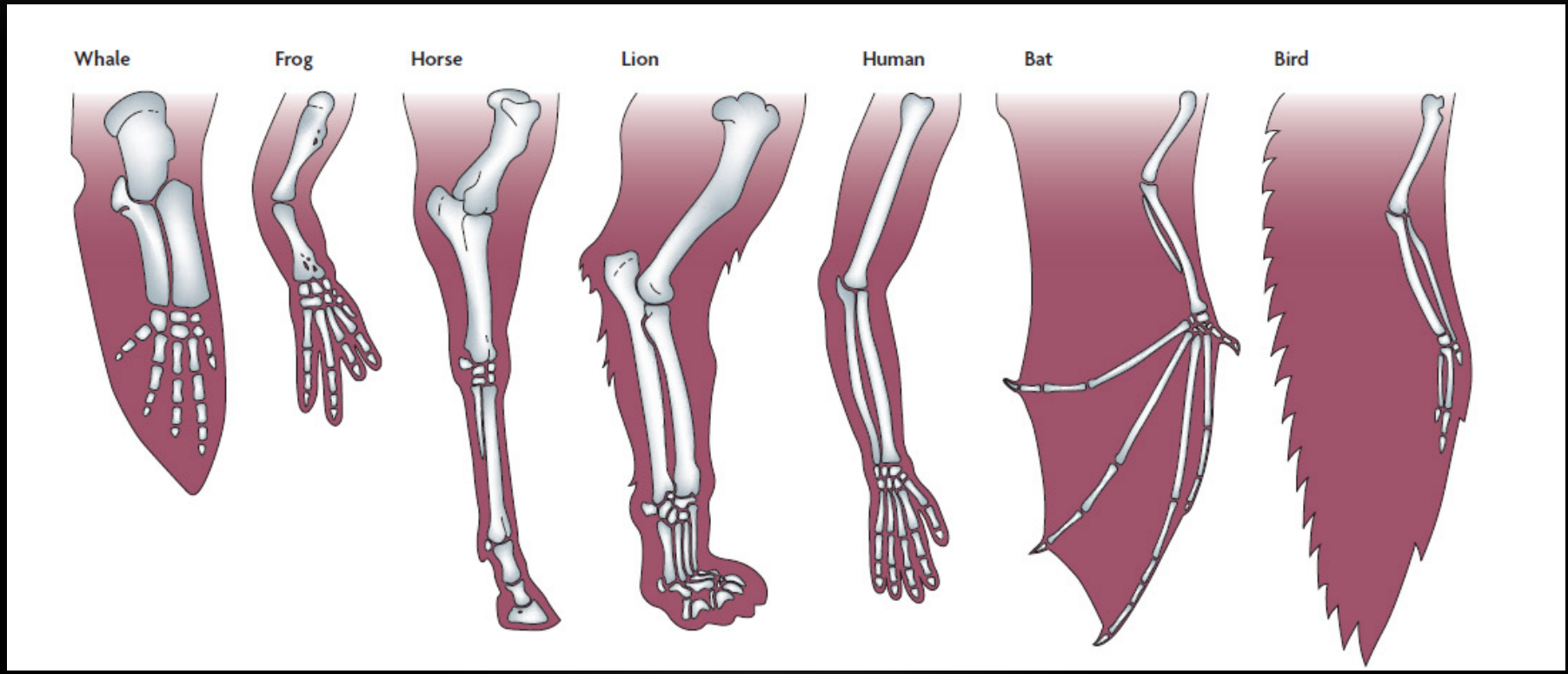




AVOIDING POTENTIALLY FALSE ASSUMPTIONS

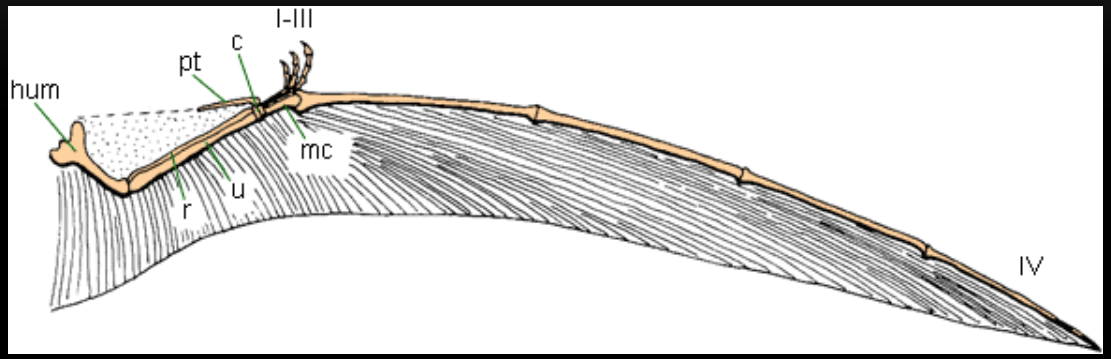


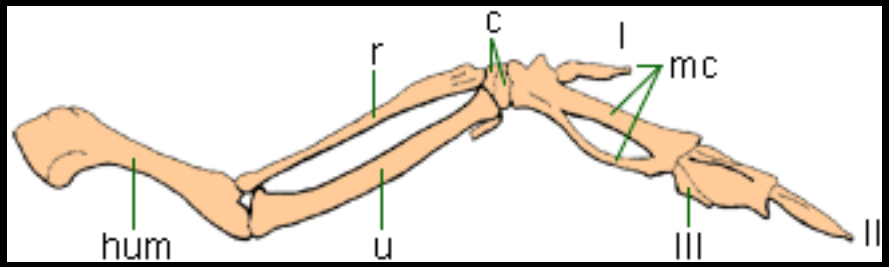
HOMOLOGIES AS NATURAL KINDS



PROBLEMS FOR US TO OVERCOME

WHAT'S NOT A HOMOLOGY?





THANKS…

- National Science Foundation and Dalhousie University
- Chris Moore and George Michel
- Dawn Moore for her superb help in creating this presentation
- The people whose work I relied on while putting together this talk: Brian Hall, Paul Griffiths, Jason Clark, Michael Anderson, Alan Love, Marc Ereshefsky, Ingo Brigandt, and Mohan Matthen