

# Procesamiento de información en células y tejidos biológicos

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Universidad de Buenos Aires

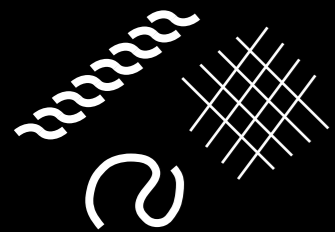


<http://users.df.uba.ar/morelli>

DDF - 07 07 14

# Física de Sistemas Biológicos

molécula



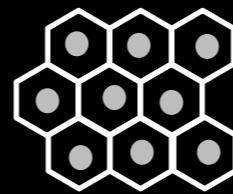
$\sim 10^{-9}$  m

célula



$\sim 10^{-6}$  m

tejido



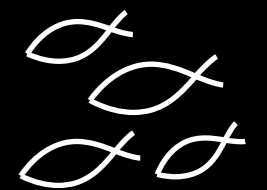
$\sim 10^{-3}$  m

organismo



$\sim 1$  m

población



$\sim 10^3$  m

# Física de Sistemas Biológicos

Bruno

Ponce Dawson

Skigin, Inchaussandague

Chernomoretz

Morelli

Balenzuela

Estrada, Pietrasanta

Amador

Mindlin, Trevisan

Grecco

Solari, Otero

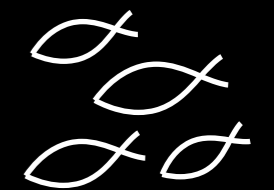
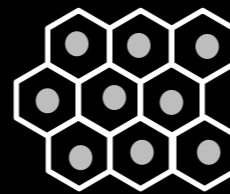
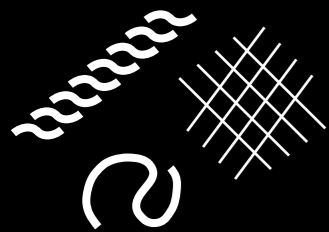
molécula

célula

tejido

organismo

población



$\sim 10^{-9}$  m

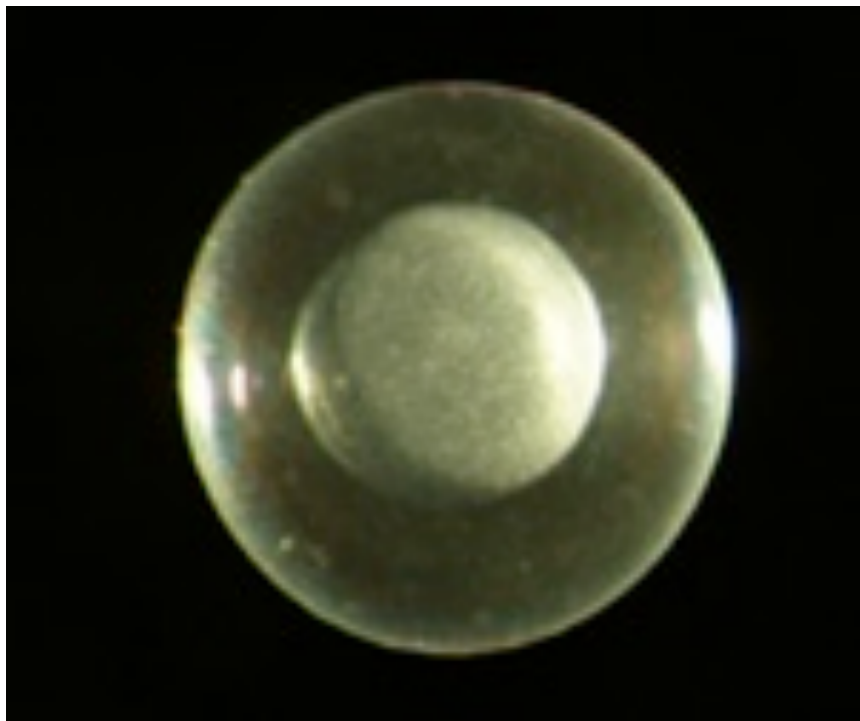
$\sim 10^{-6}$  m

$\sim 10^{-3}$  m

$\sim 1$  m

$\sim 10^3$  m

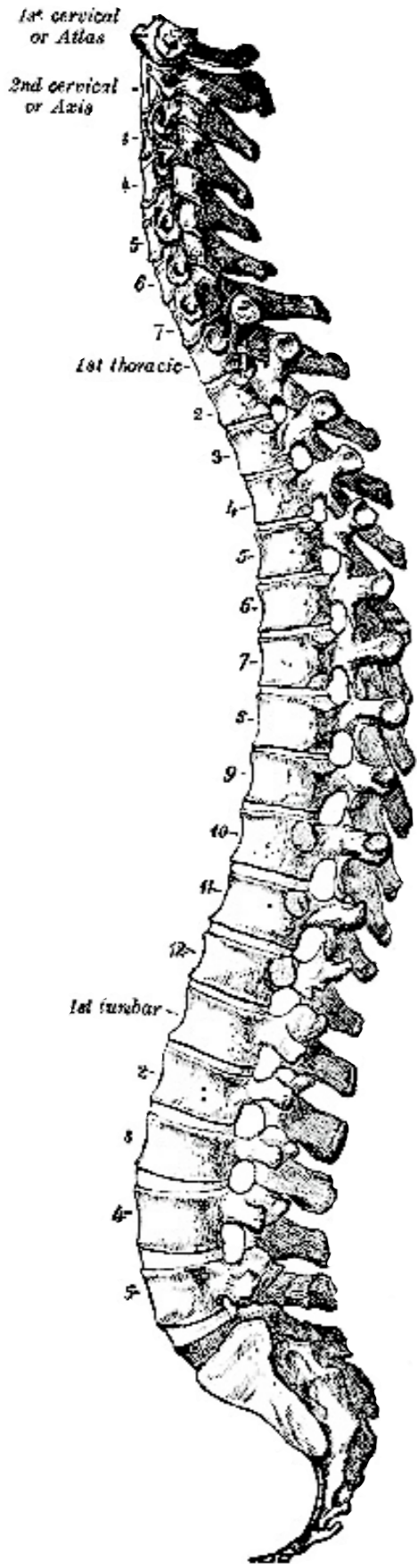
Como se forman tejidos y organismos completos a partir de células y sus interacciones?



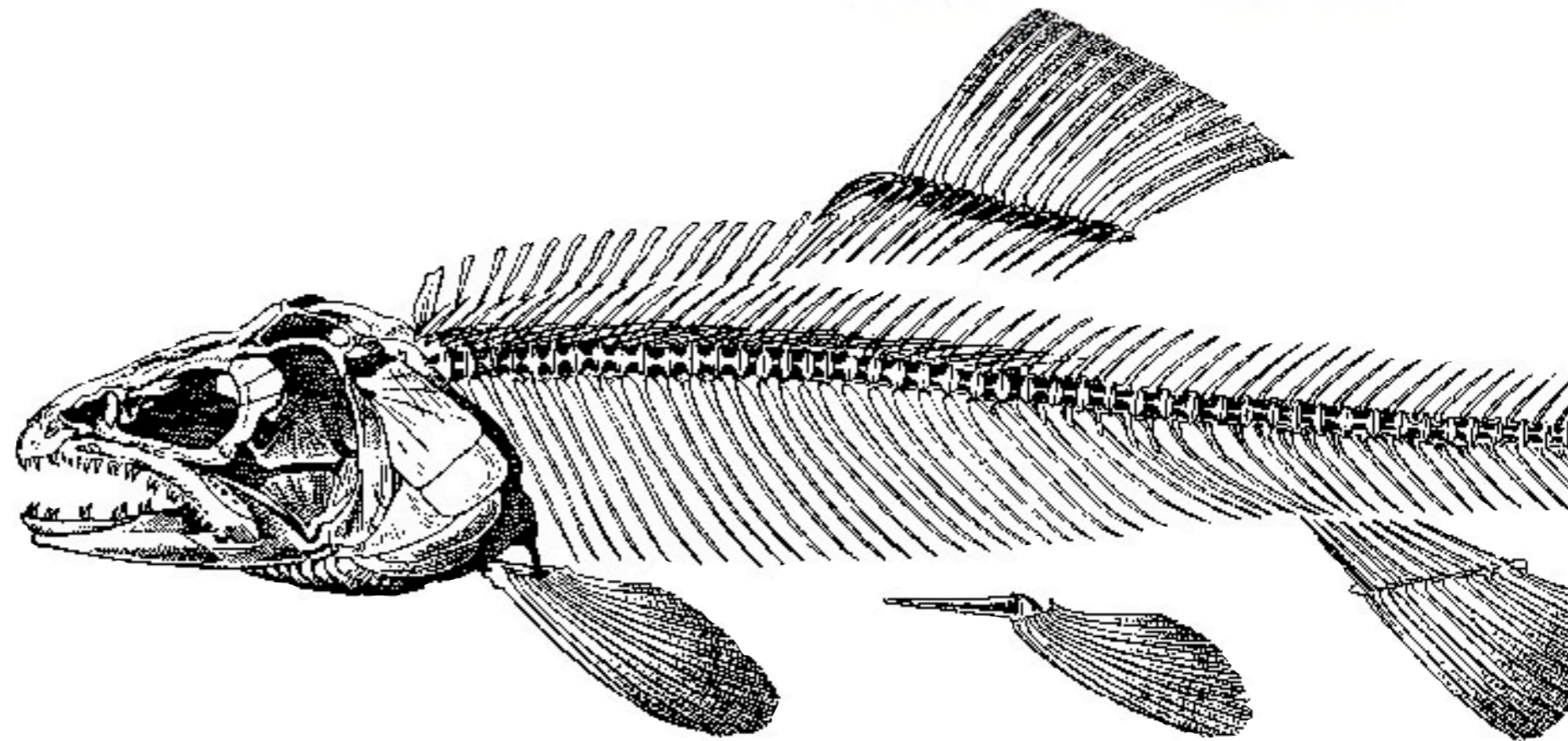
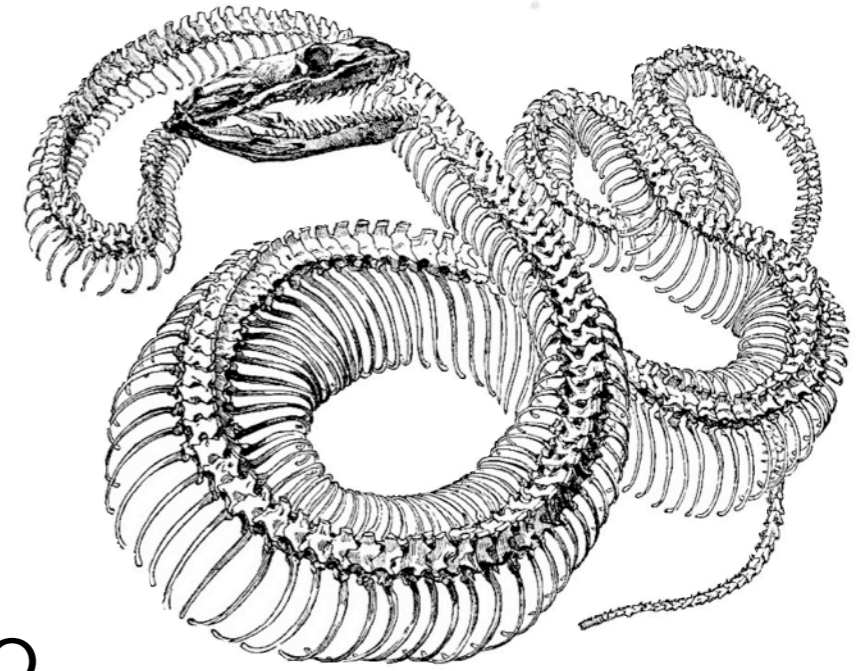
huevo

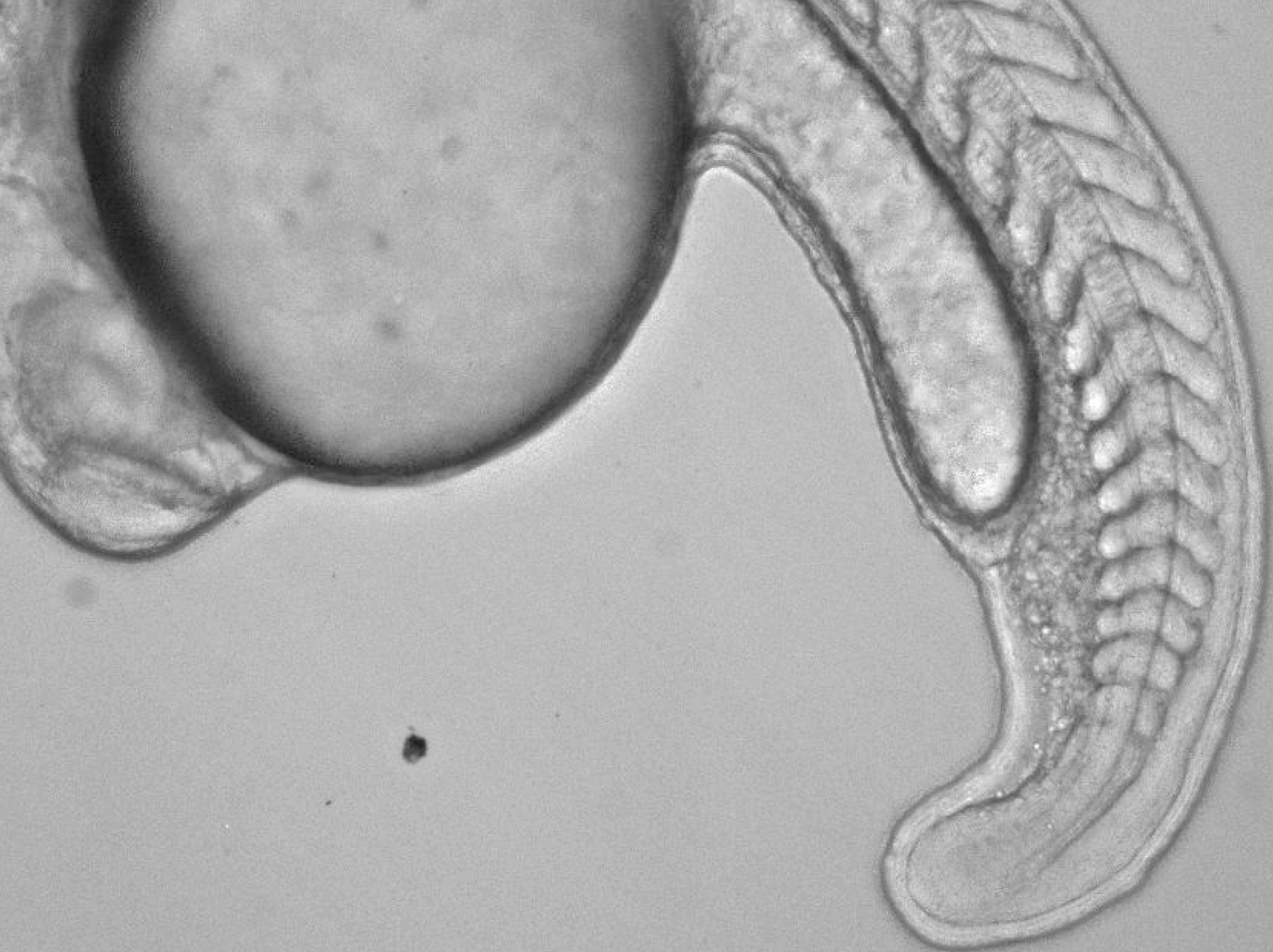


organismo adulto



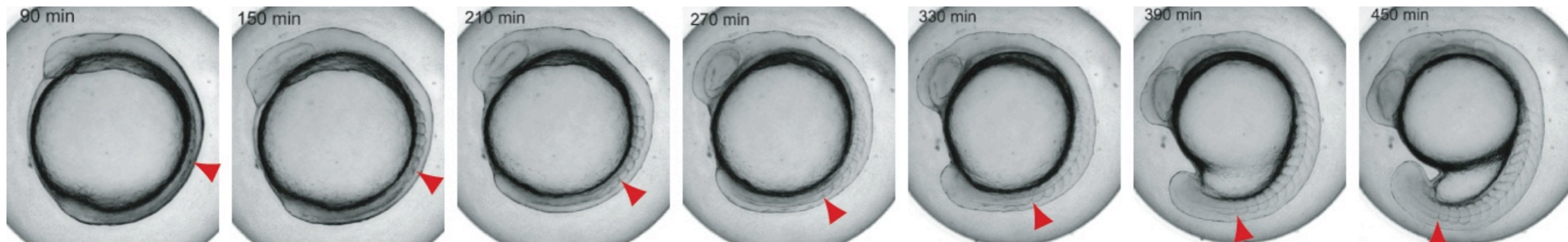
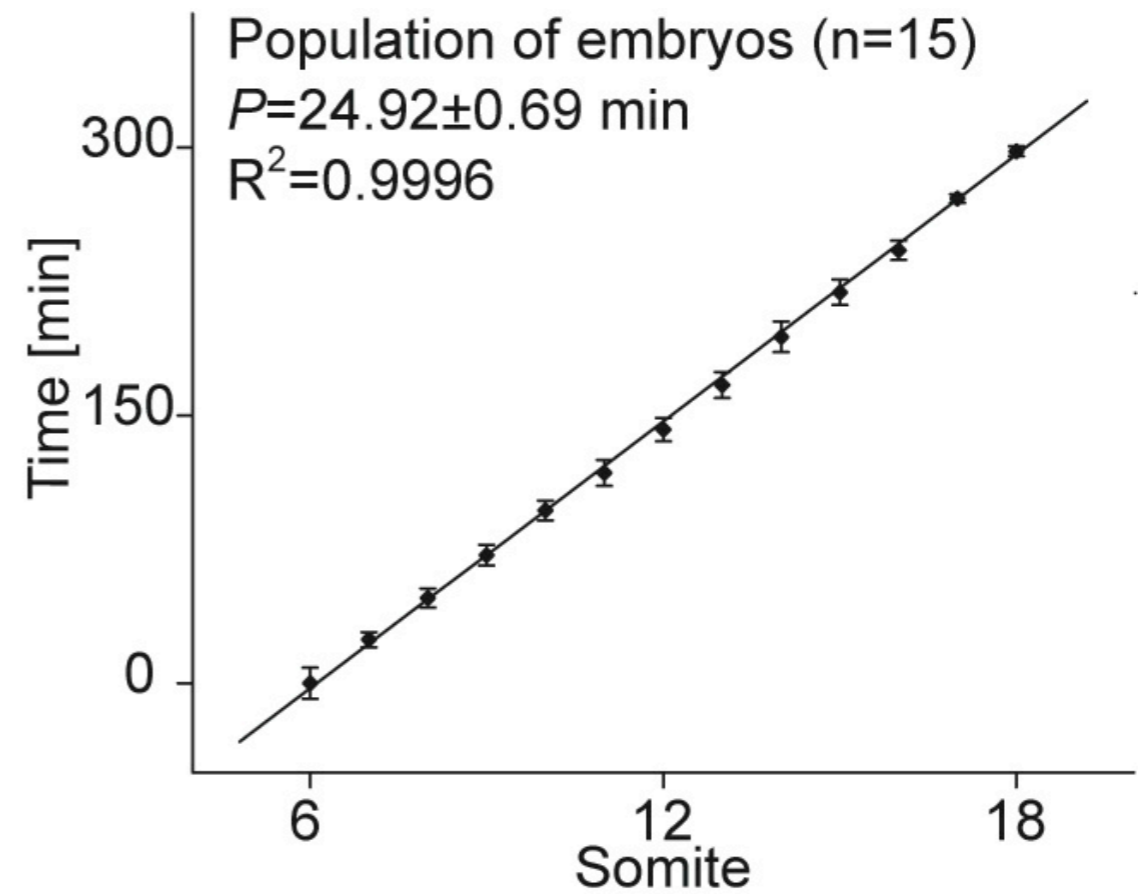
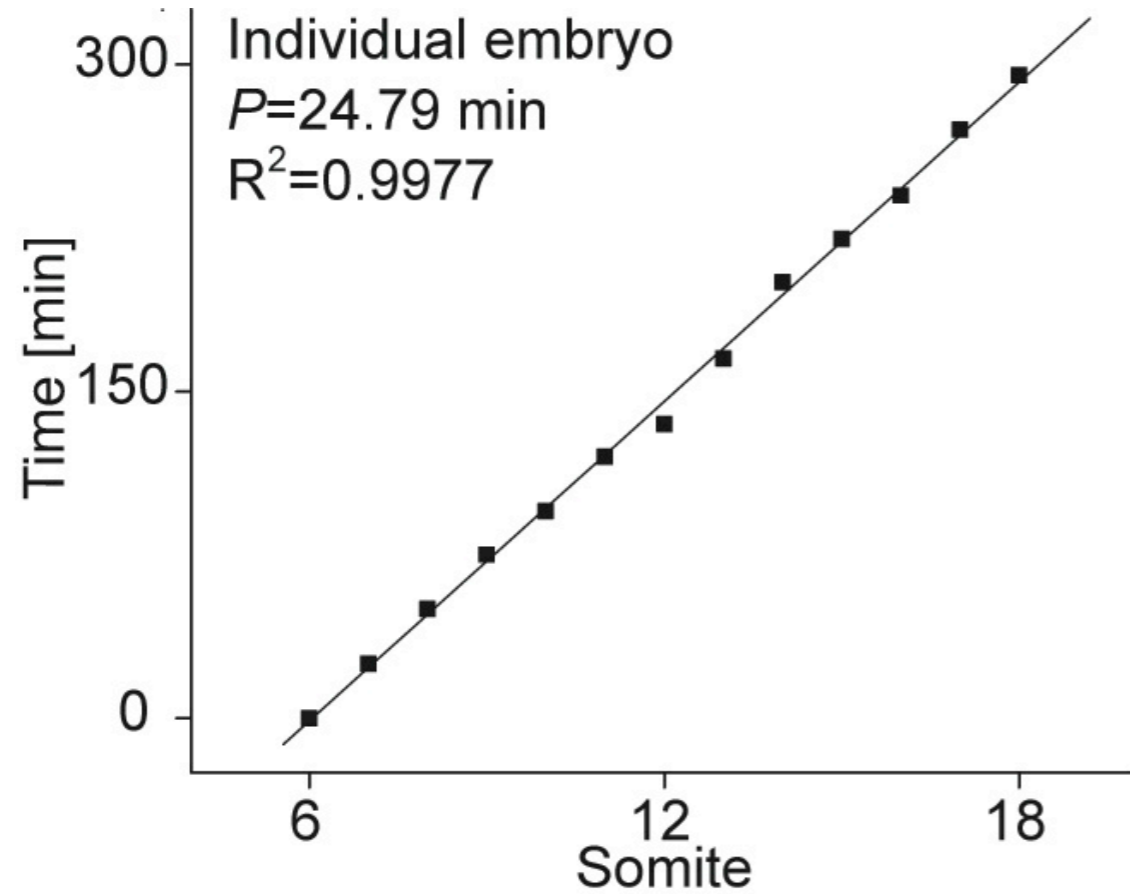
El cuerpo de los vertebrados está dividido en segmentos





Los segmentos se forman en forma rítmica y secuencial

# El ritmo de somitogénesis es preciso



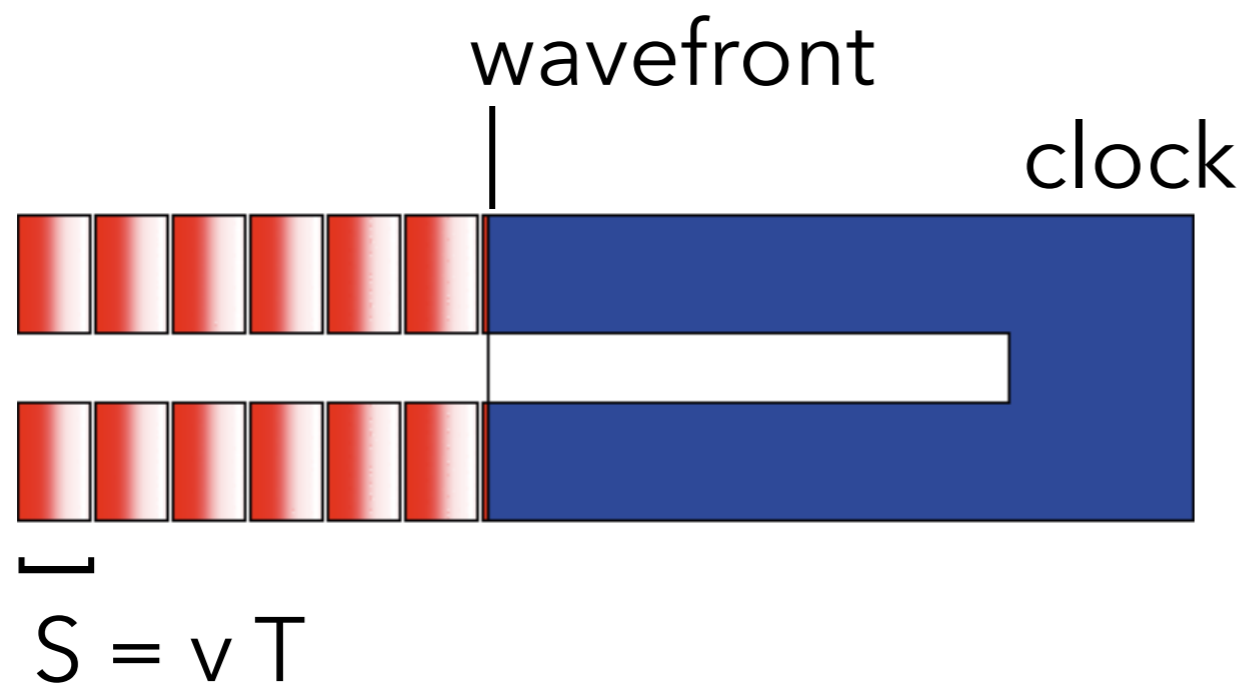
Schröter et al., Dev. Dyn. 237, 545 (2008)

# Mecanismo *clock and wavefront*

$S$  is the segment length

$v$  is the wavefront velocity

$T$  is the period of the clock

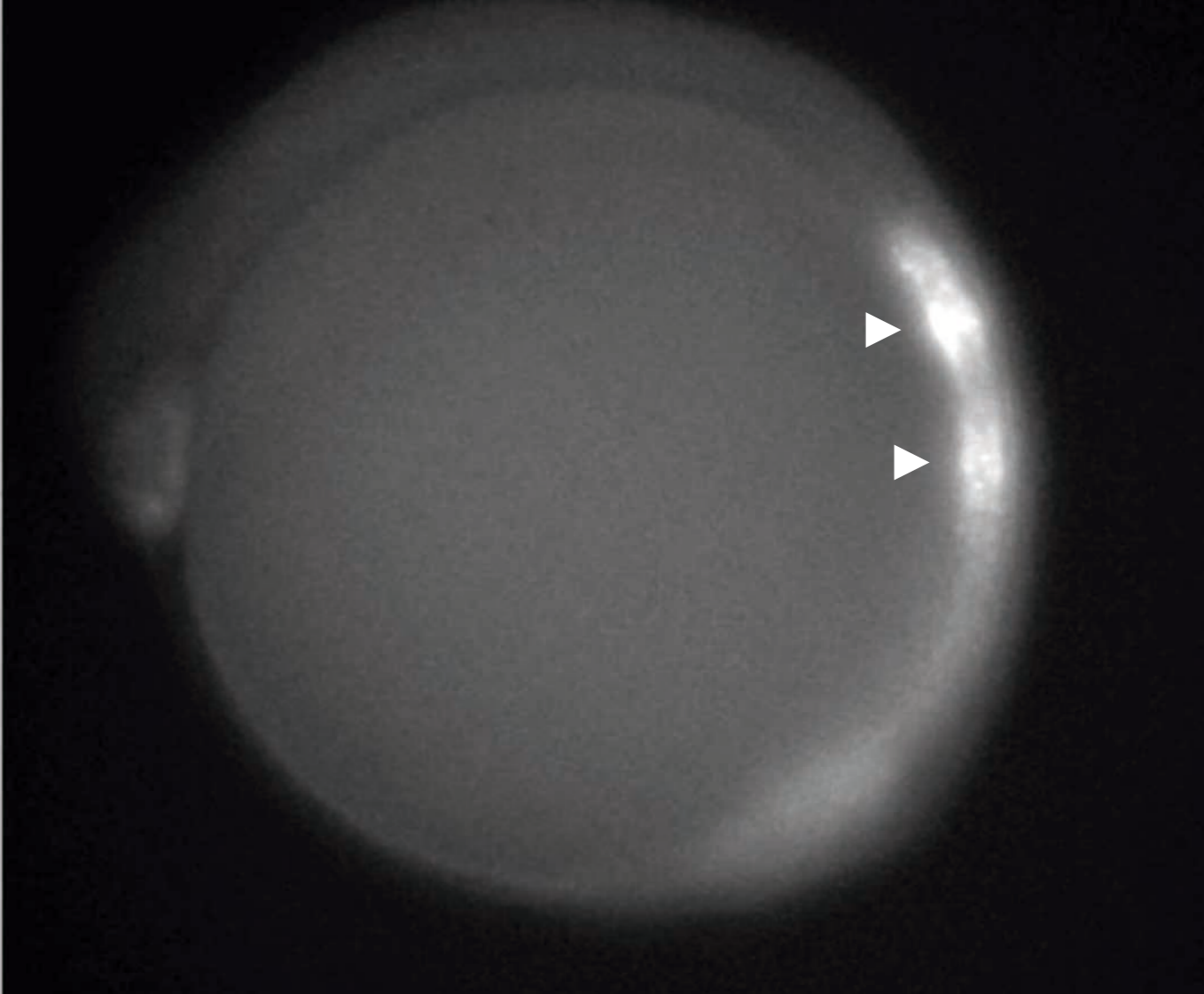
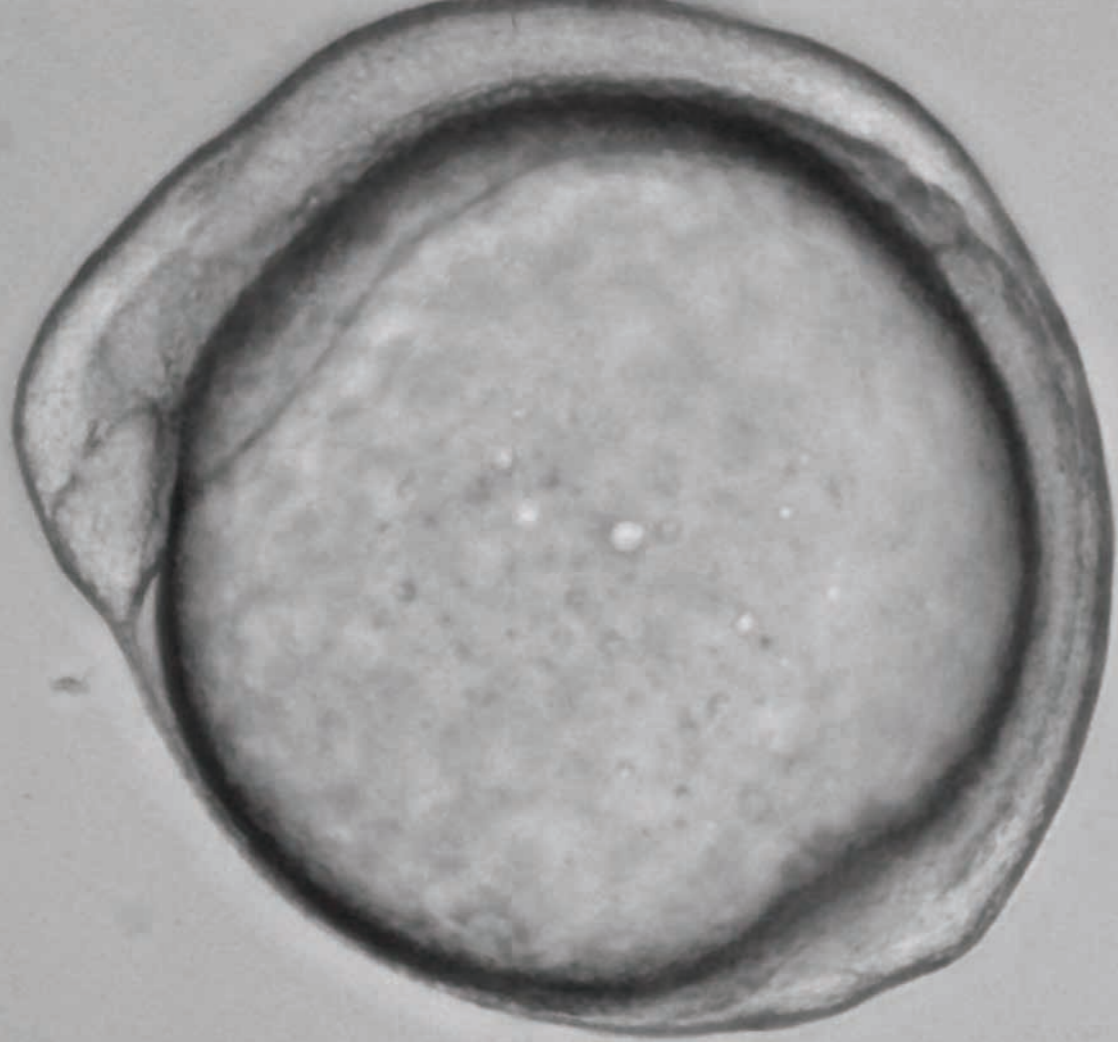


clock oscillations are stopped at different phases by a moving wavefront

the segment length  $S$  is determined by the clock period  $T$  and the wavefront velocity  $v$

Cooke and Zeeman (1976)





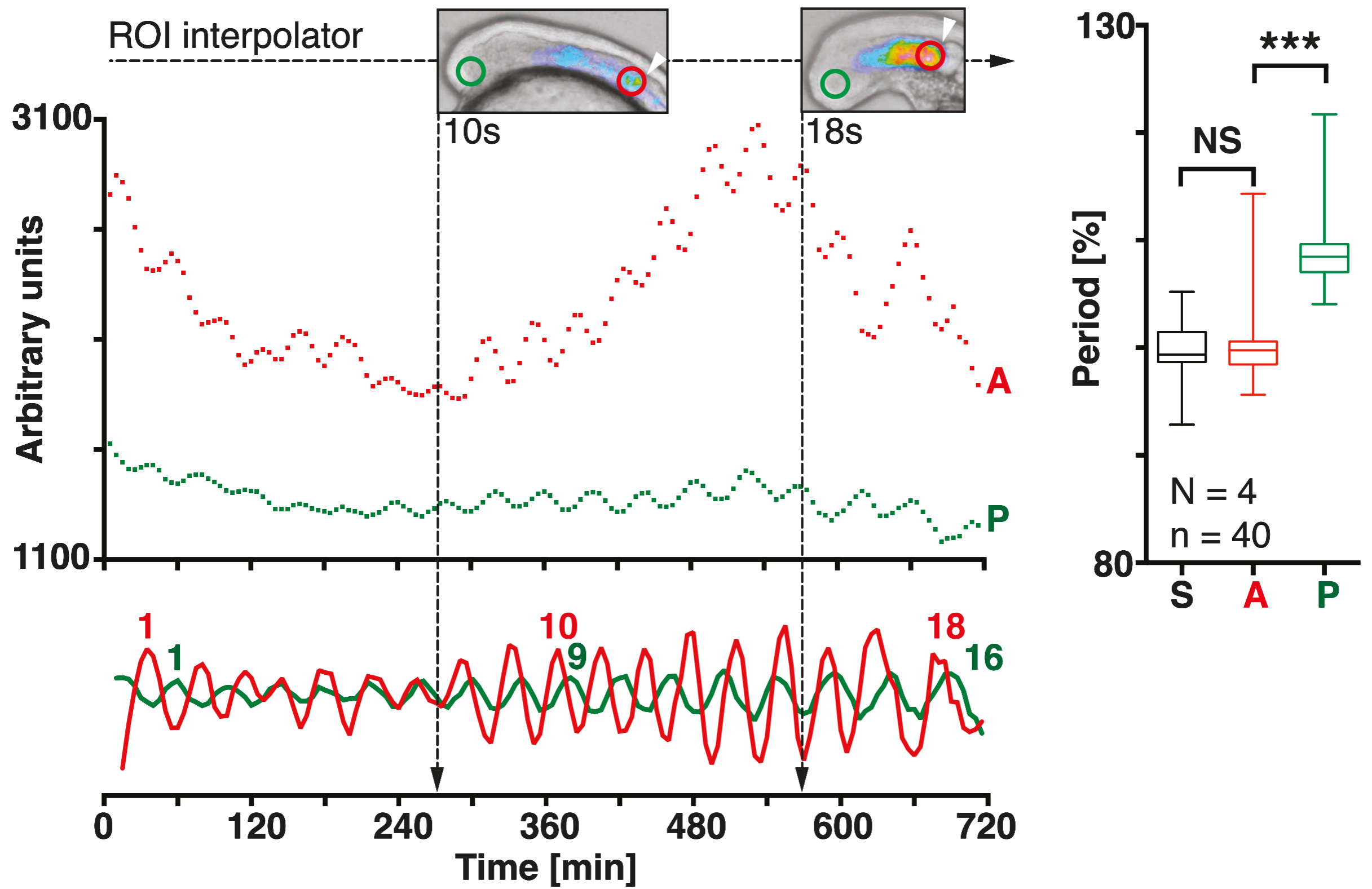
nuevo reportero fluorescente:  
observación simultánea de la  
morfología y las oscilaciones

segmentation period: **38 min**

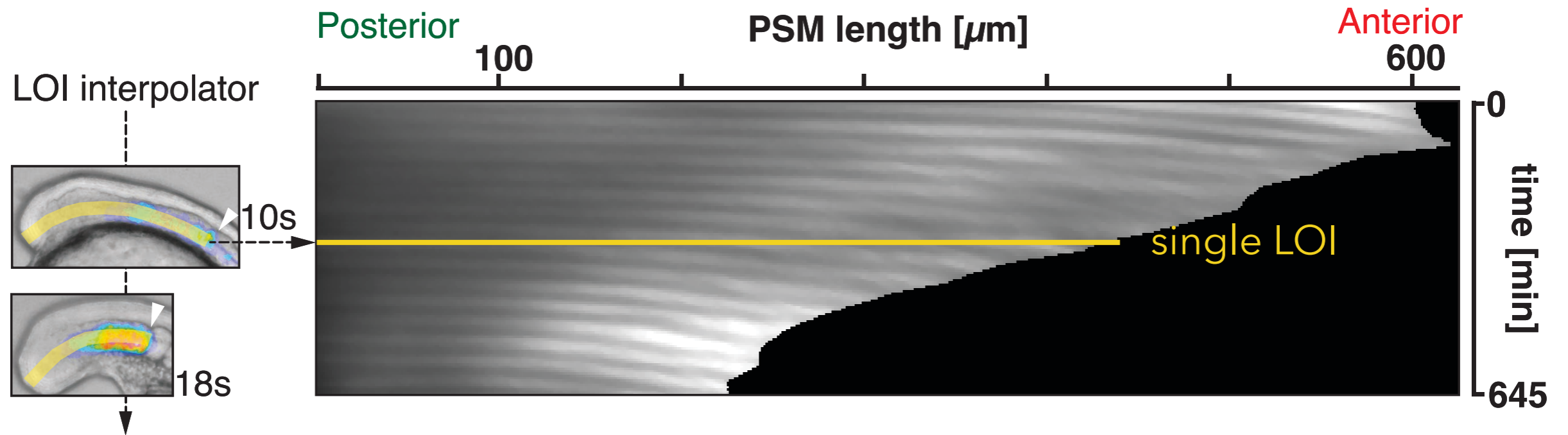
**Brightfield channel**

**Her1:YFP channel**

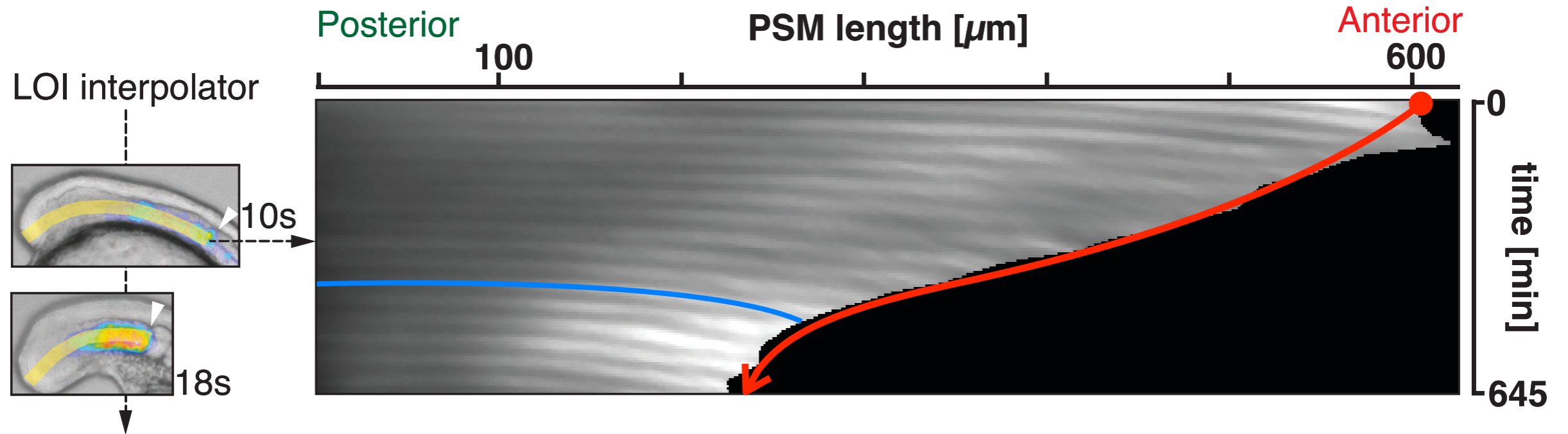
# El período de las oscilaciones y el período de somitogenesis



# Mapa espacio temporal de intensidad (kymographs)

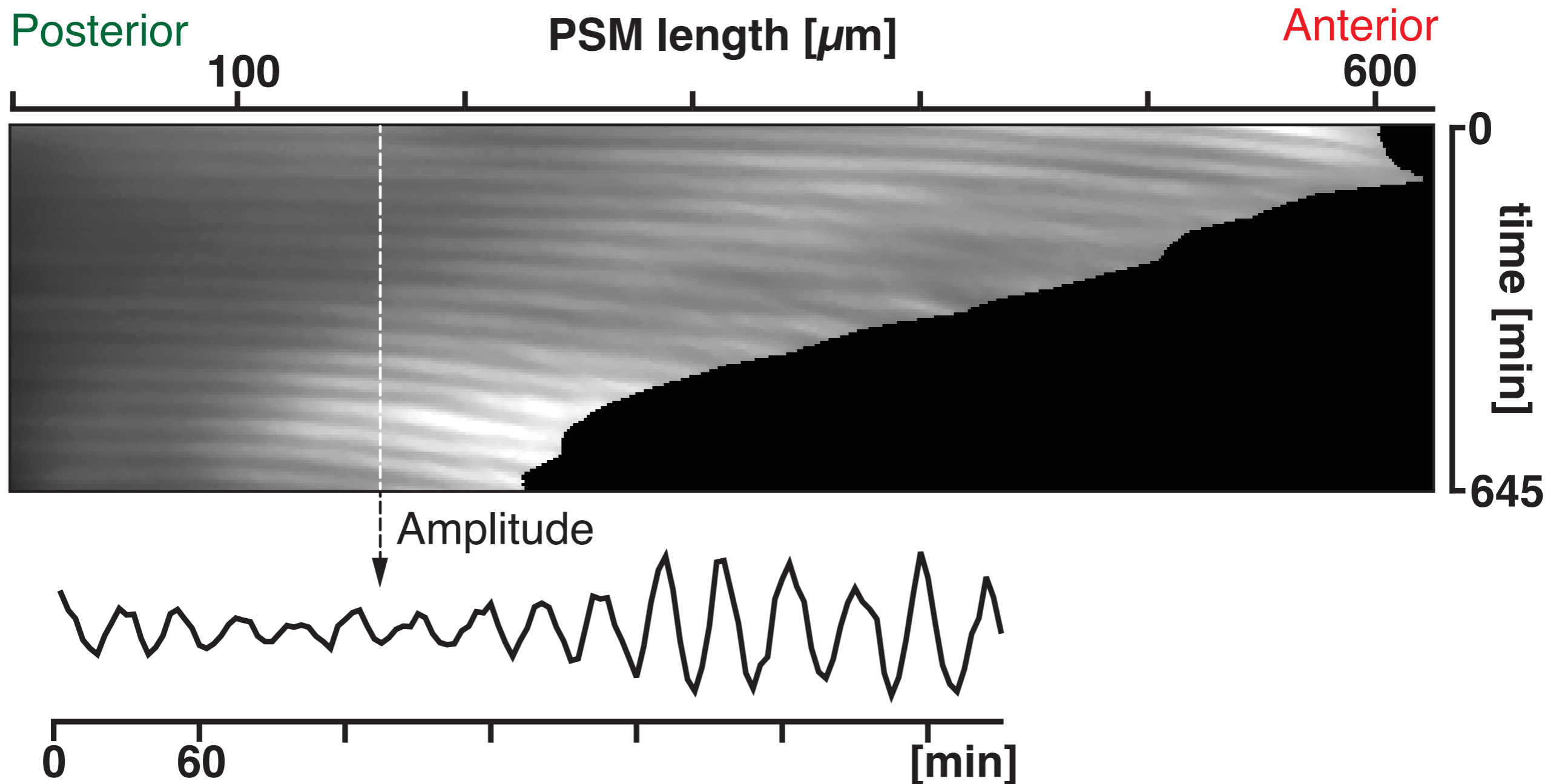


# Mapa espacio temporal de intensidad (kymographs)

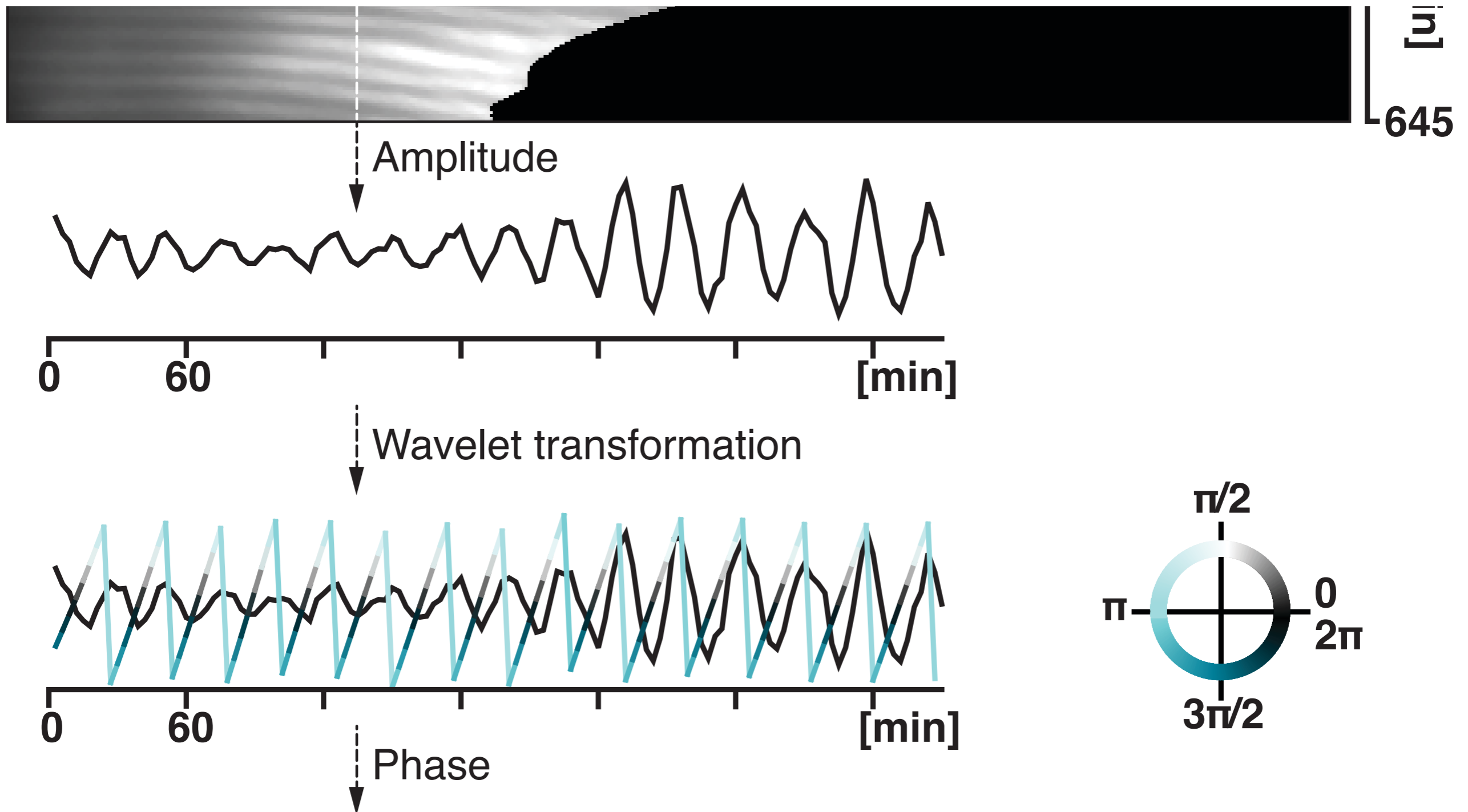


hay ondas de expresión genética  
el tejido se acorta... efecto Doppler?

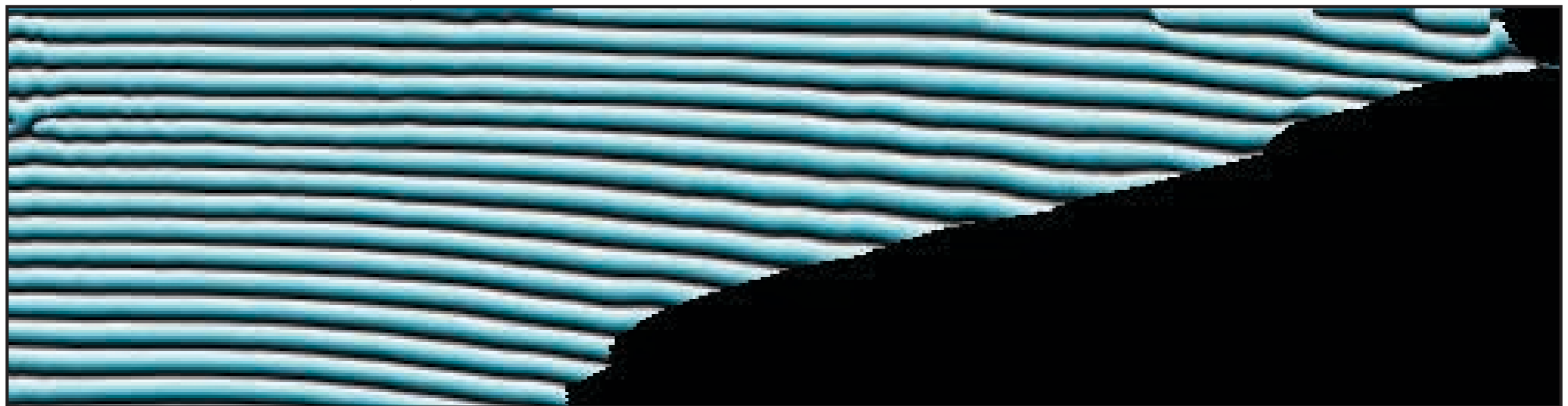
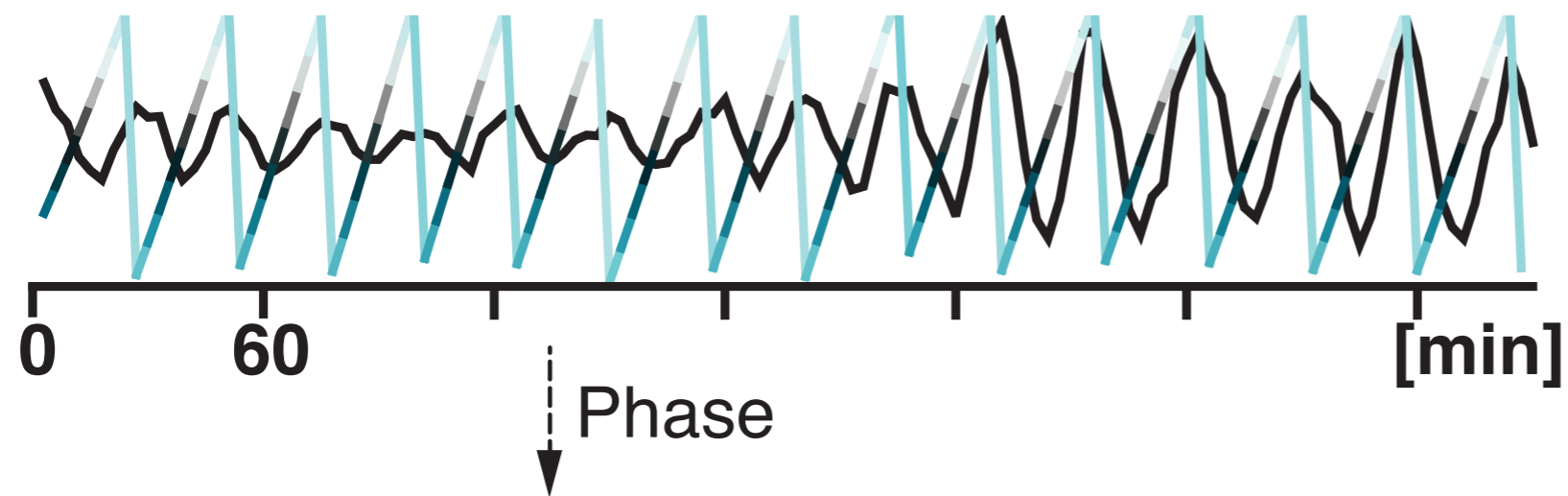
# Mapa espacio-temporal de las fases



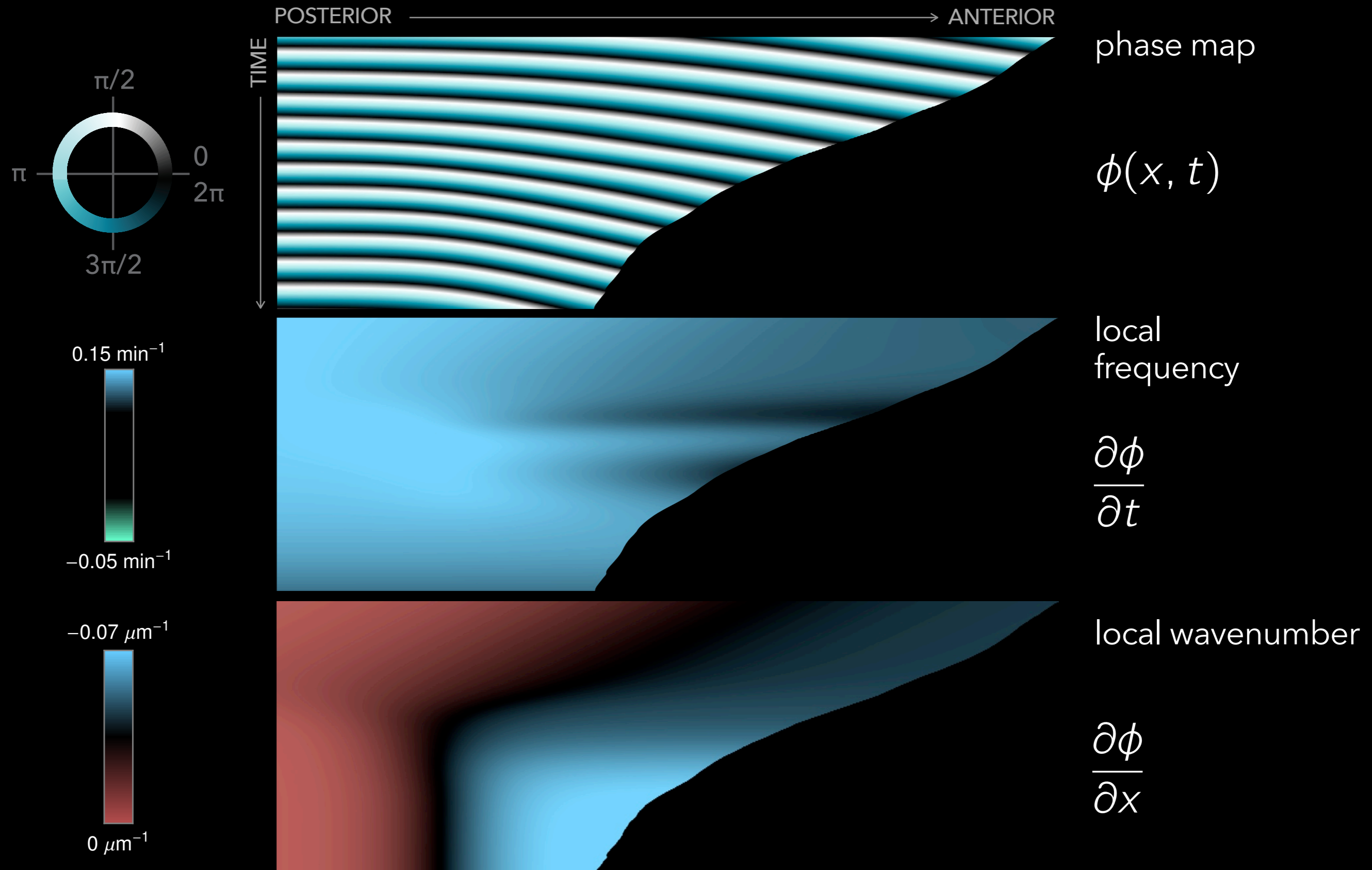
# Mapa espacio-temporal de las fases



# Mapa espacio-temporal de las fases

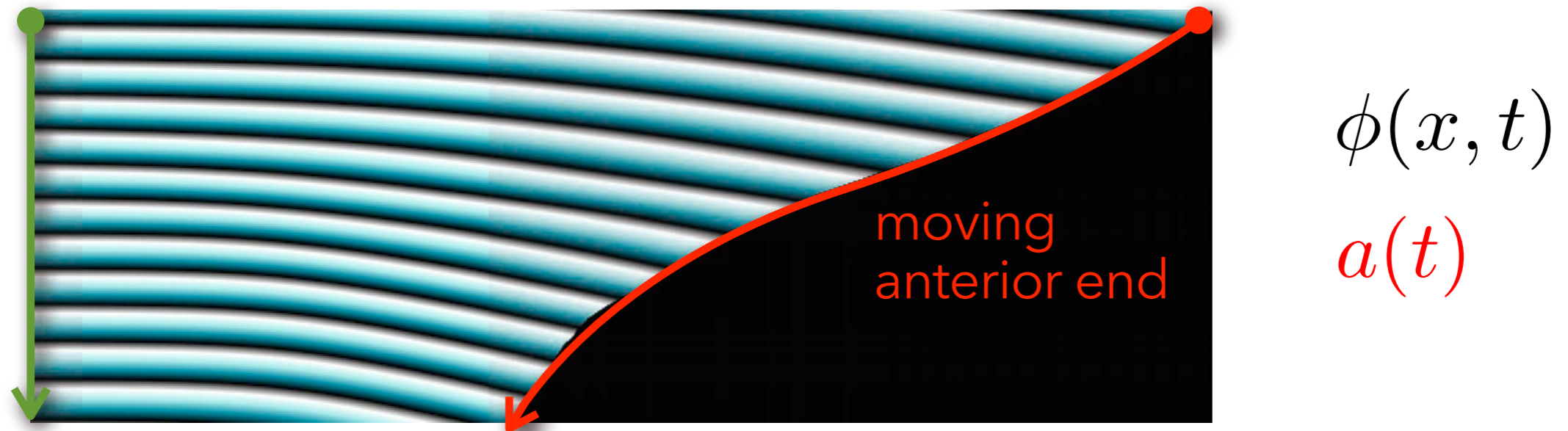


# Mapa de fases promedio para 18 embriones





# Efecto Doppler y longitud de onda dinámica



$$\phi_P(t) = \phi(0, t) \quad \phi_A(t) = \phi(a(t), t)$$

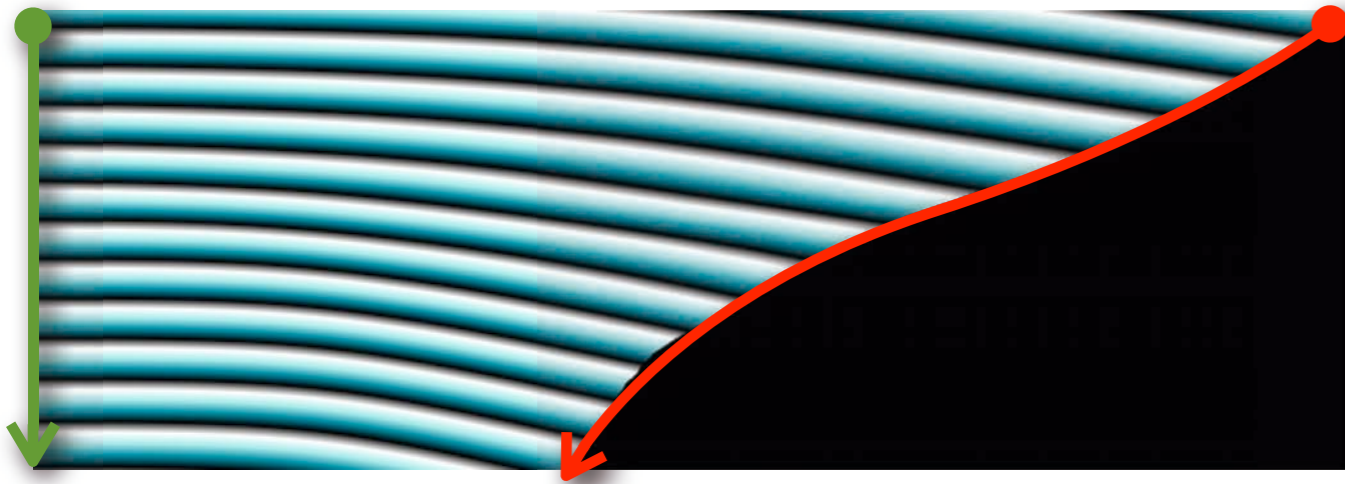
$$\psi(x, t) = \phi(x, t) - \phi(0, t)$$

$$\phi_A(t) = \phi_P(t) + \psi(a(t), t)$$

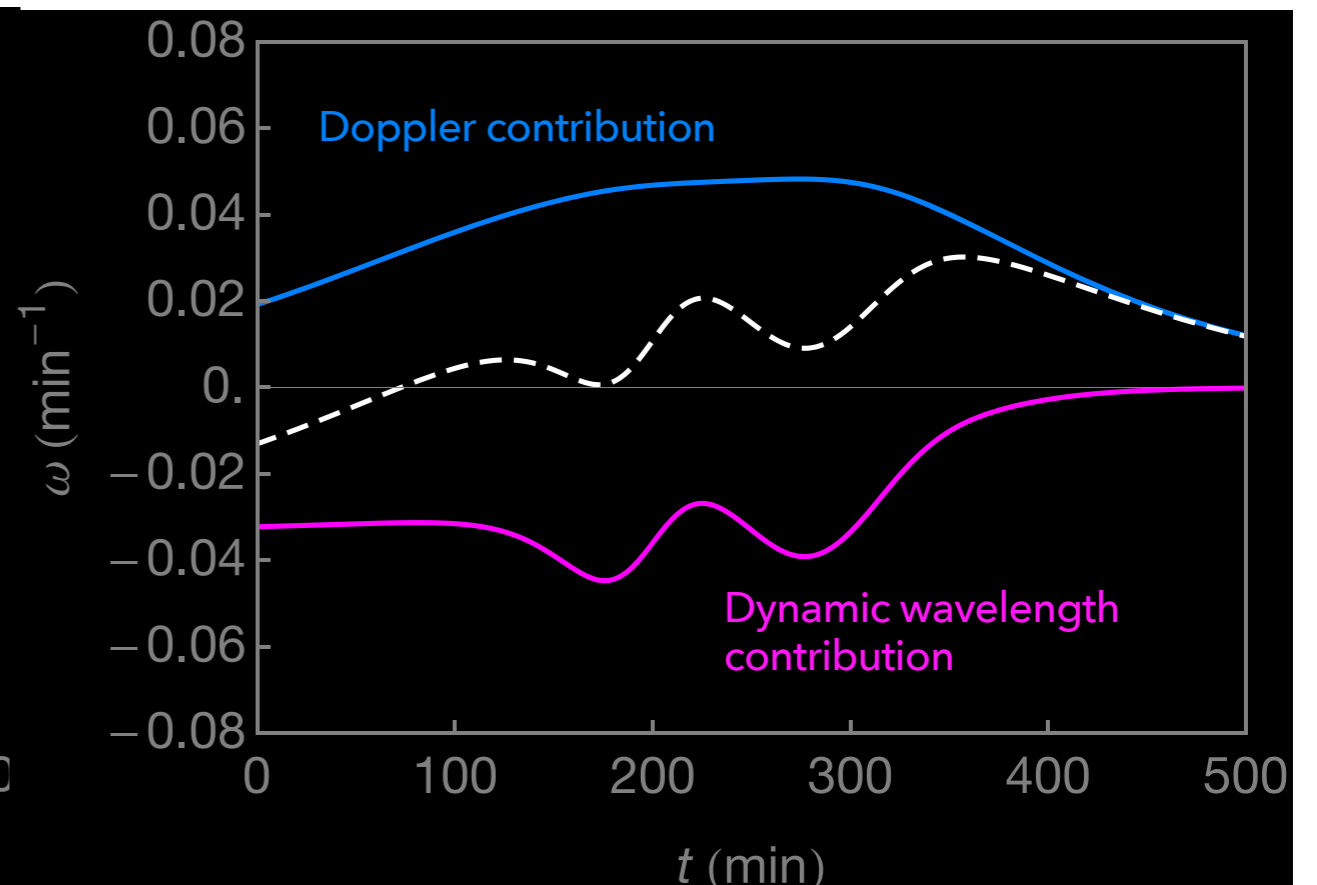
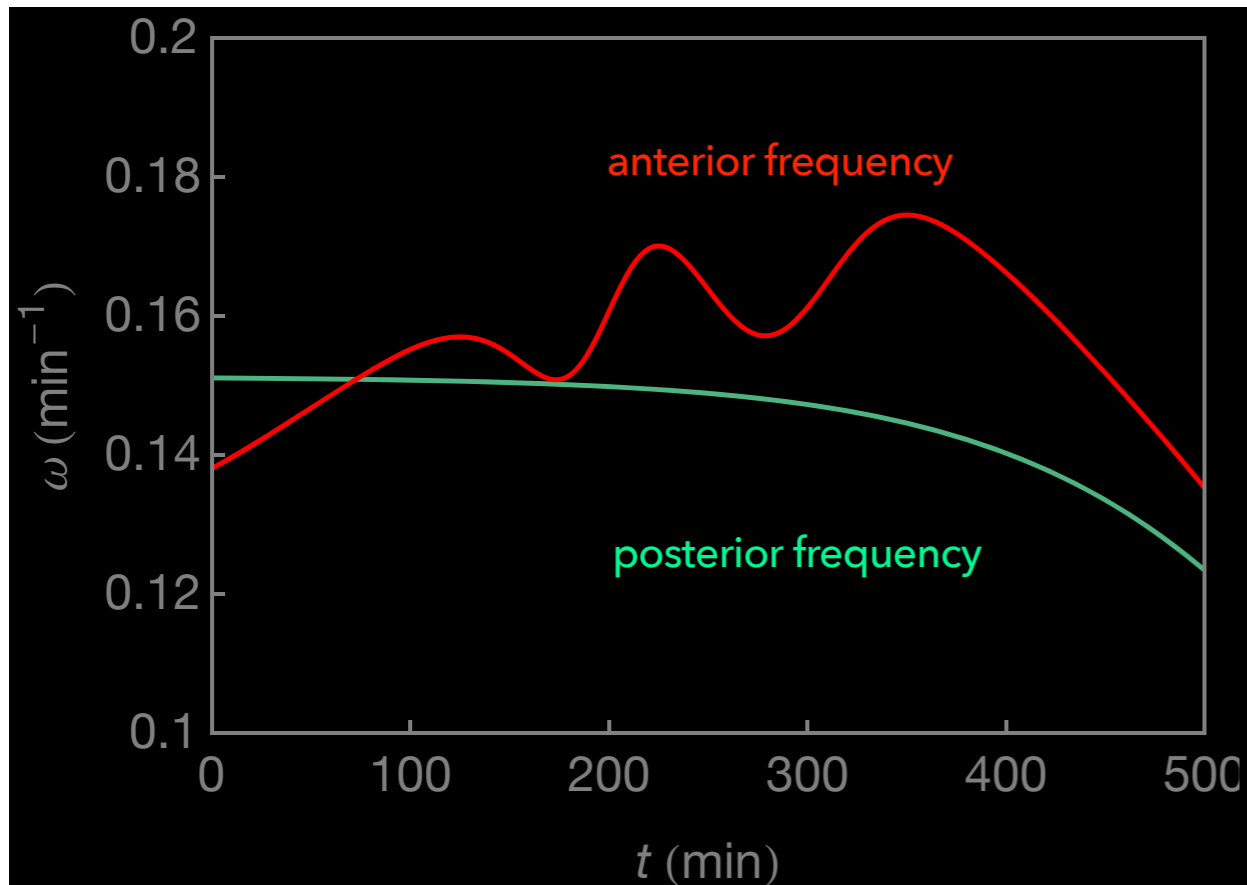
$$\omega_A = \omega_P + \left( \frac{\partial \psi}{\partial x} \frac{da}{dt} + \frac{\partial \psi}{\partial t} \right) \Big|_{x=a(t)}$$

Doppler

# Las dos contribuciones se observan en el embrión

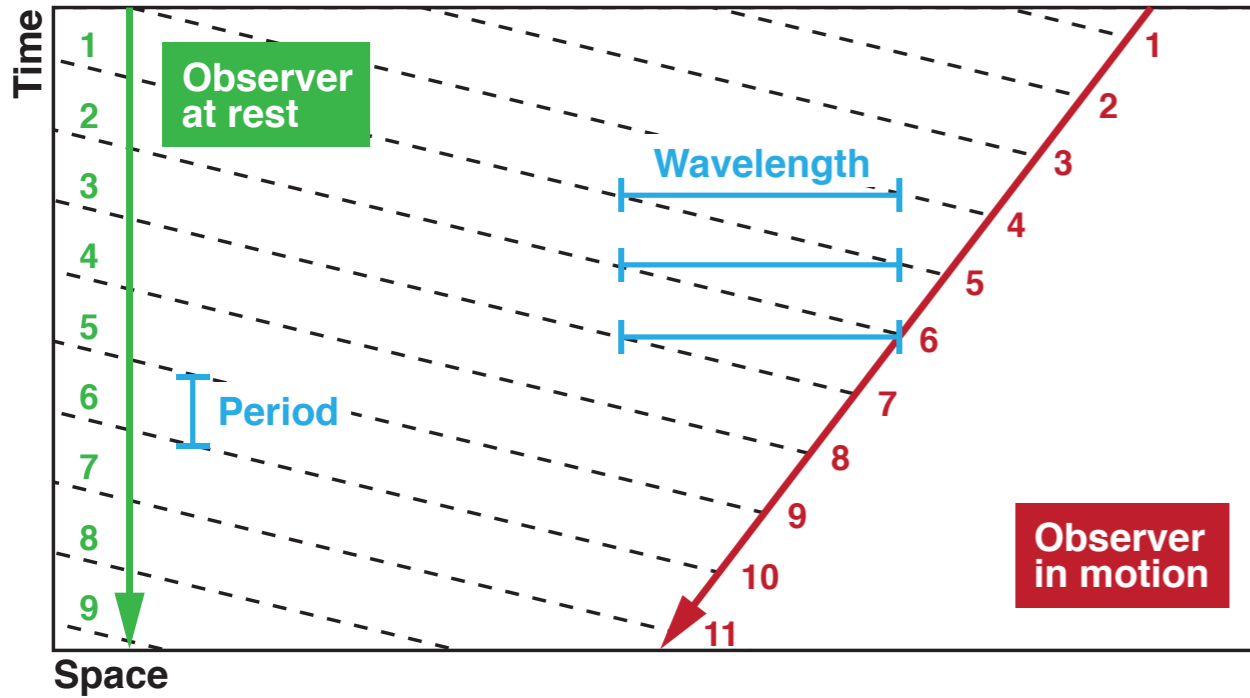


$$\omega_A = \omega_P + (\dot{a}\partial_x\psi + \partial_t\psi)|_{x=a(t)}$$

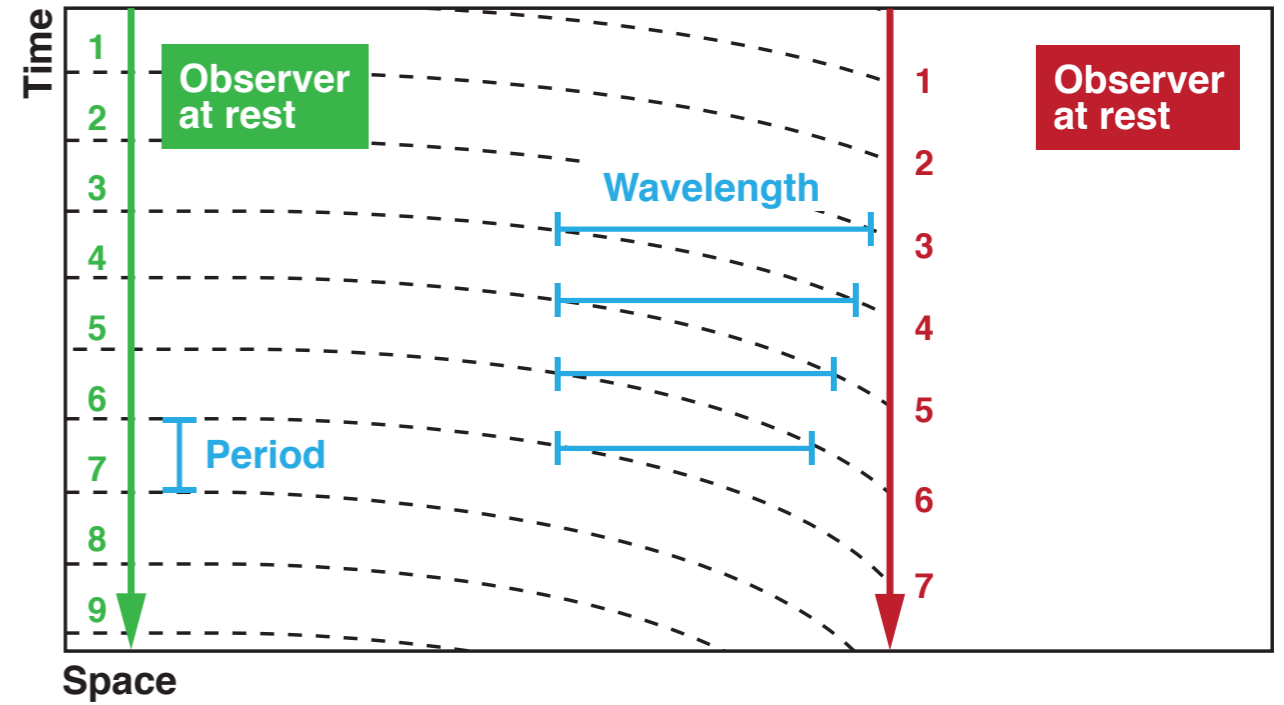


# Ilustración del efecto Doppler y longitud de onda dinámica

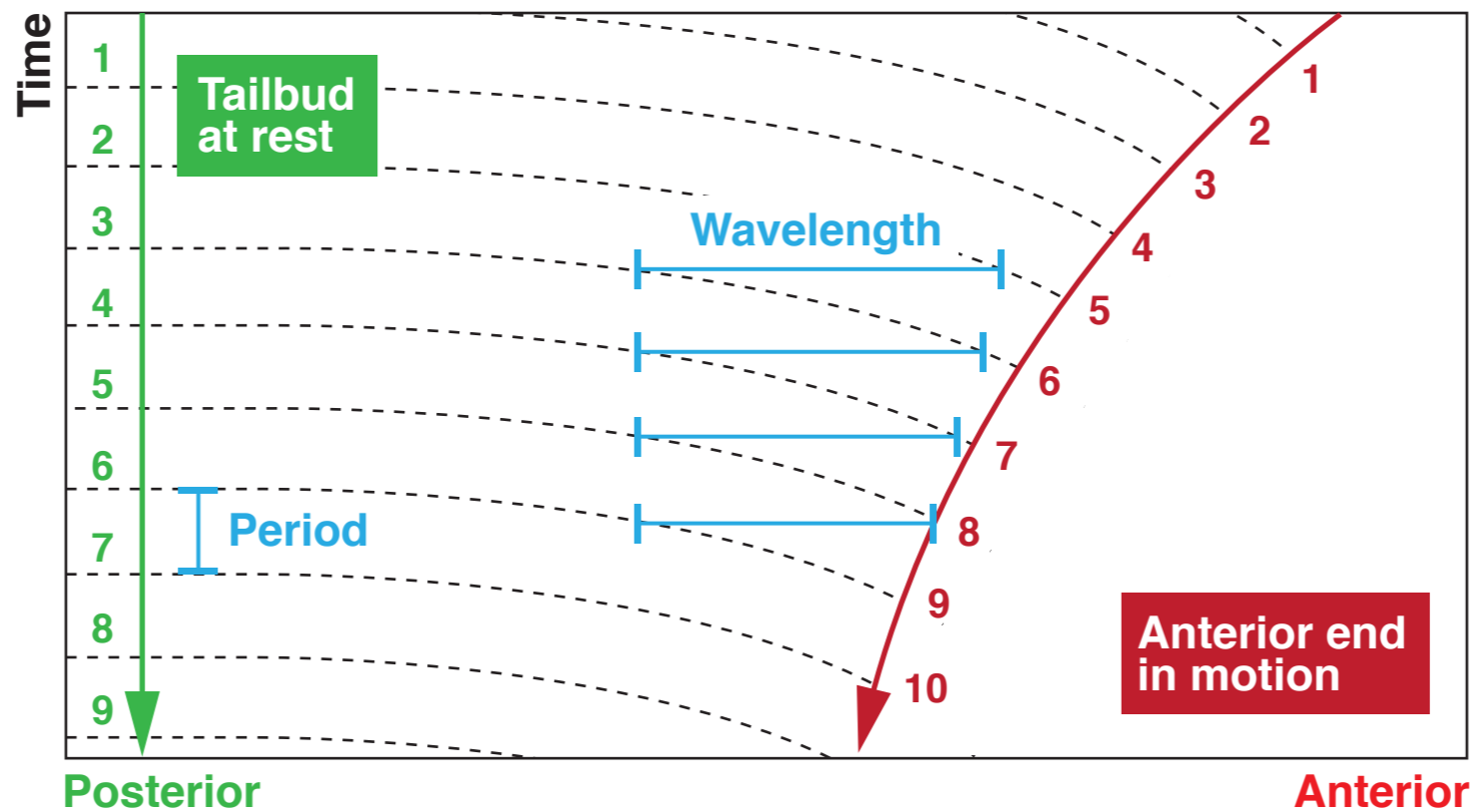
Classical Doppler effect



Dynamic wavelength effect



Embryonic segmentation: Doppler effect + dynamic wavelength





Daniele Soroldoni



David Richmond



Andy Oates



David Jörg



Frank Jülicher



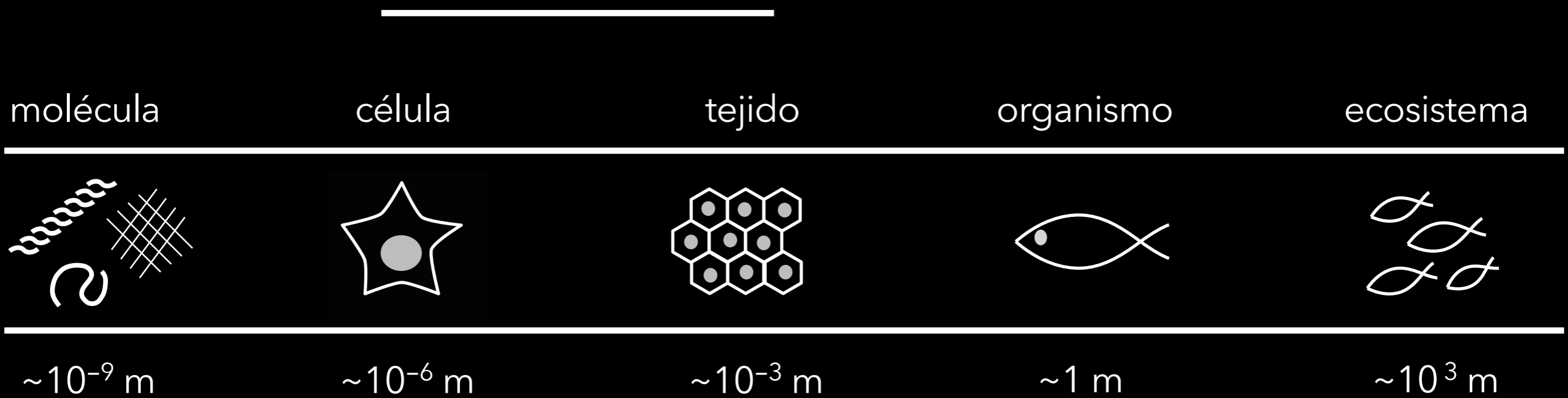
Oates Lab

Biological  
Physics

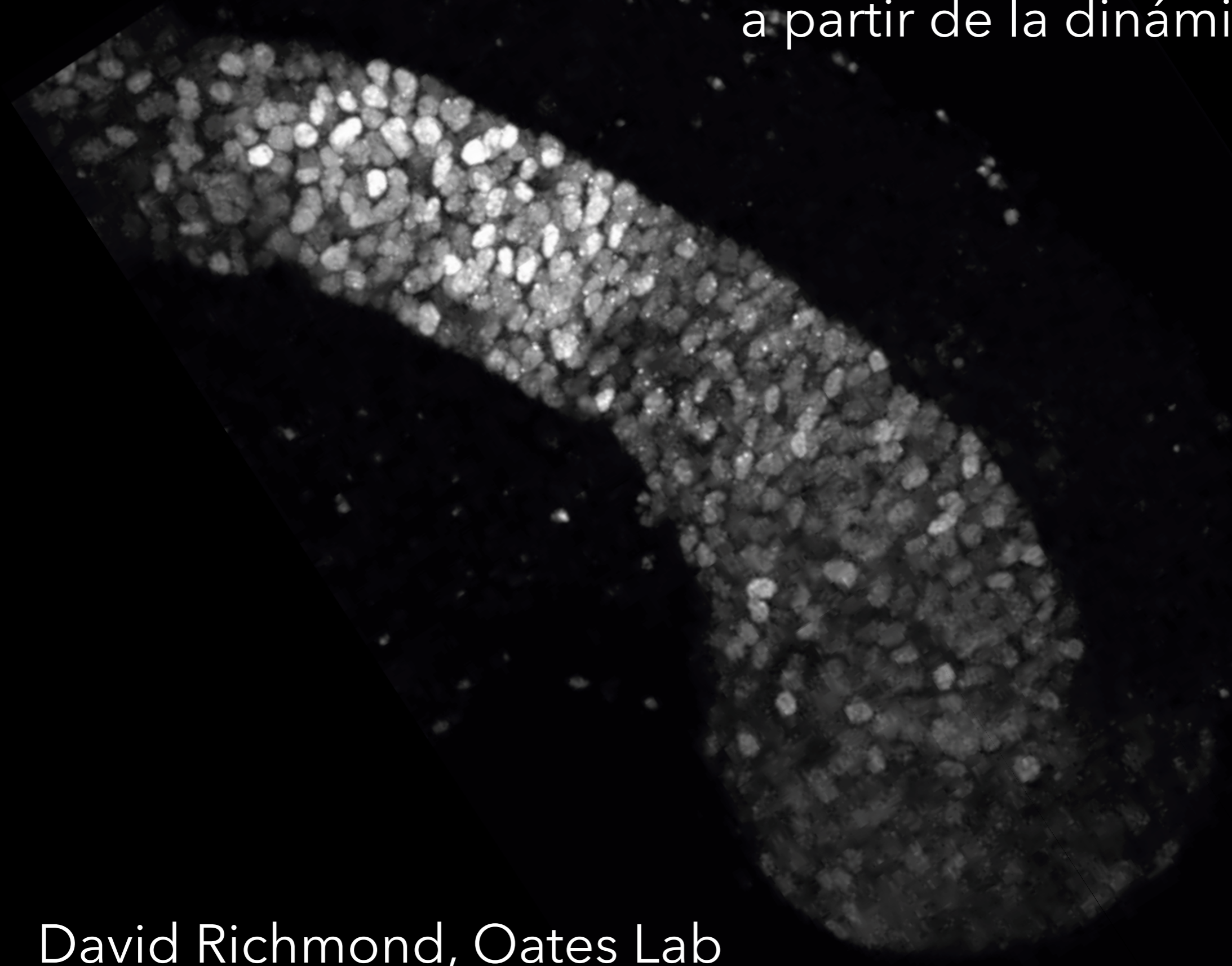


Soroldoni et al. (en prensa)

# Física de Sistemas Biológicos



Como se generan estos patrones espacio-temporales  
a partir de la dinámica celular?



David Richmond, Oates Lab  
cyclic reporter gene her1-YFP

# Procesamiento de información en células y tejidos biológicos



Iván Lengyel

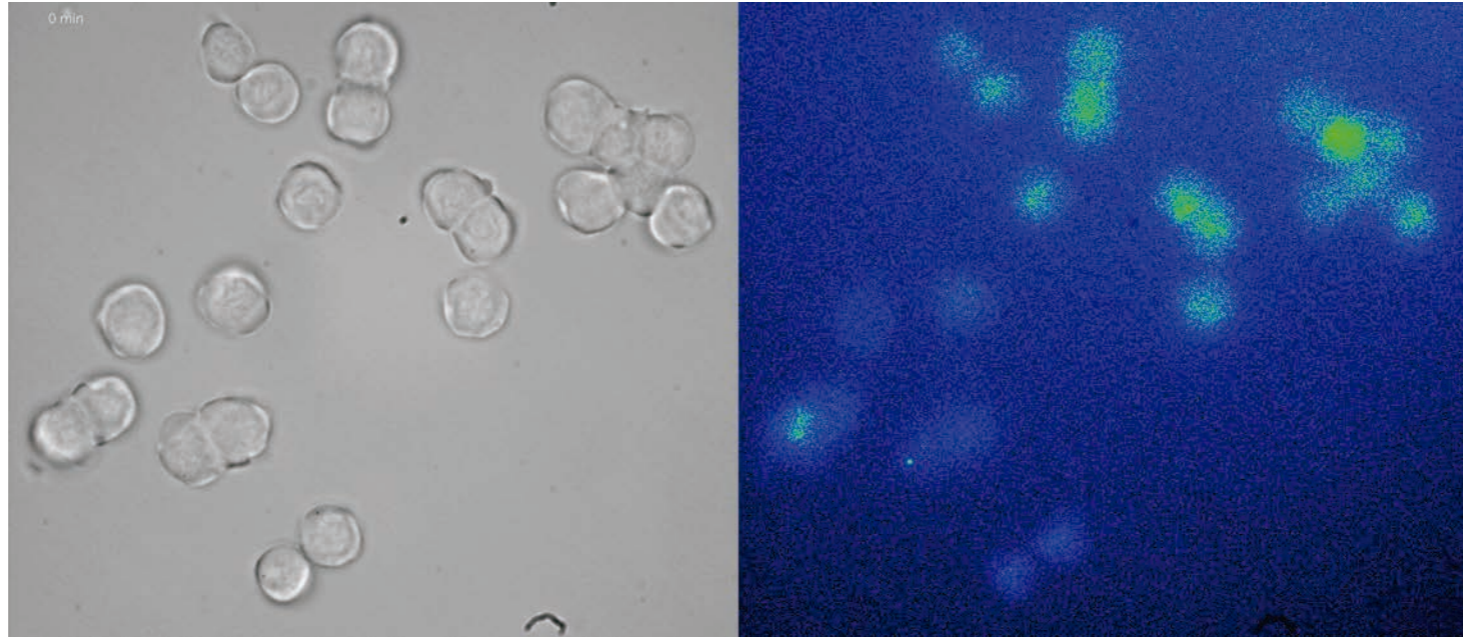


Gabriela Petrunaro

# Efectos del ruido en la expresión genética



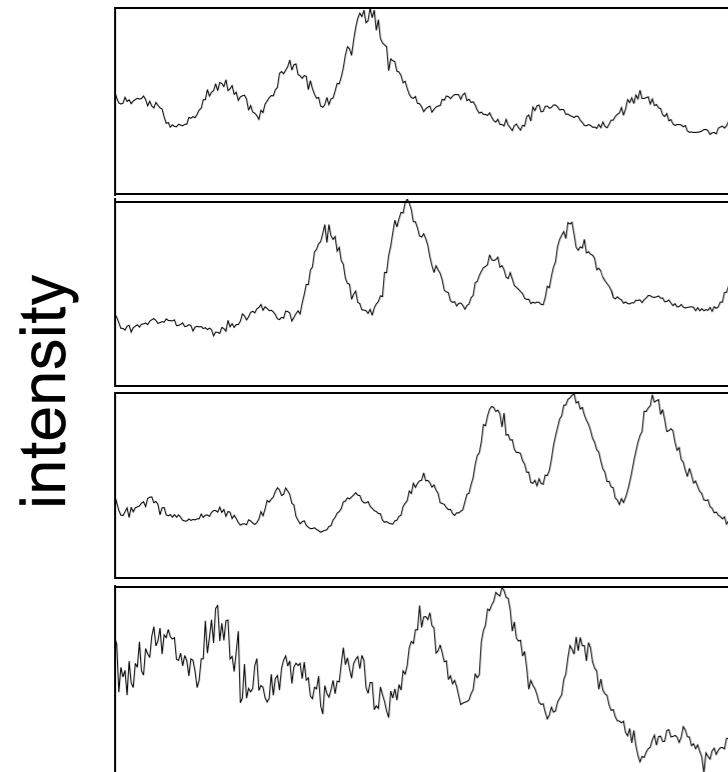
Iván Lengyel



bright field

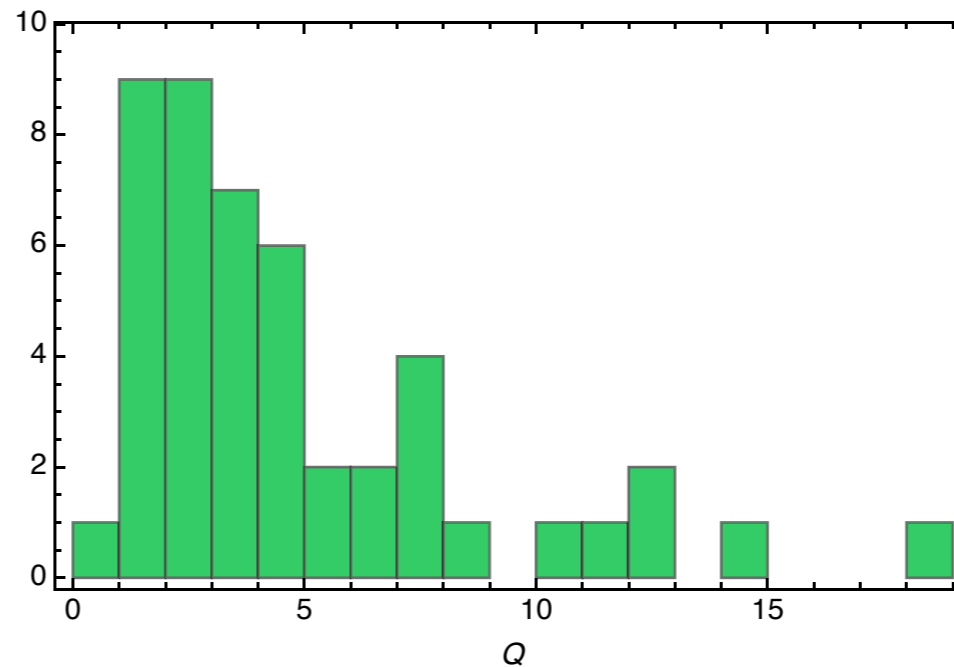
reporter gene *her1*-YFP

Annelie Oswald  
Oates Lab



time (600 min)

Low quality factor  $Q$ , noisy oscillations



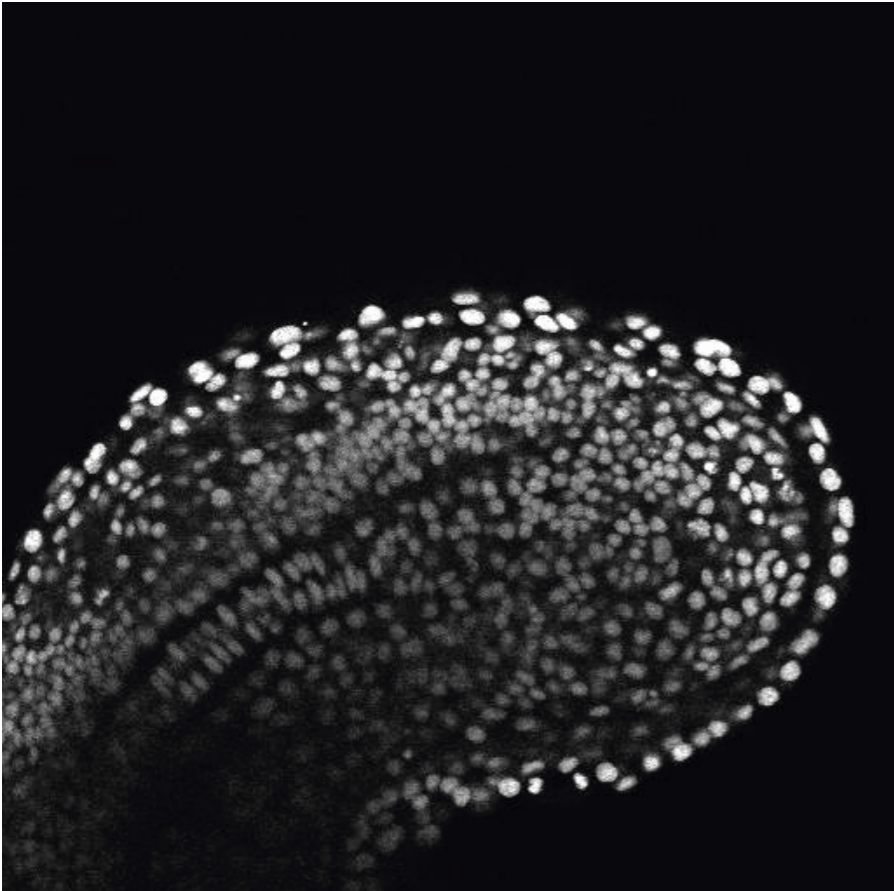
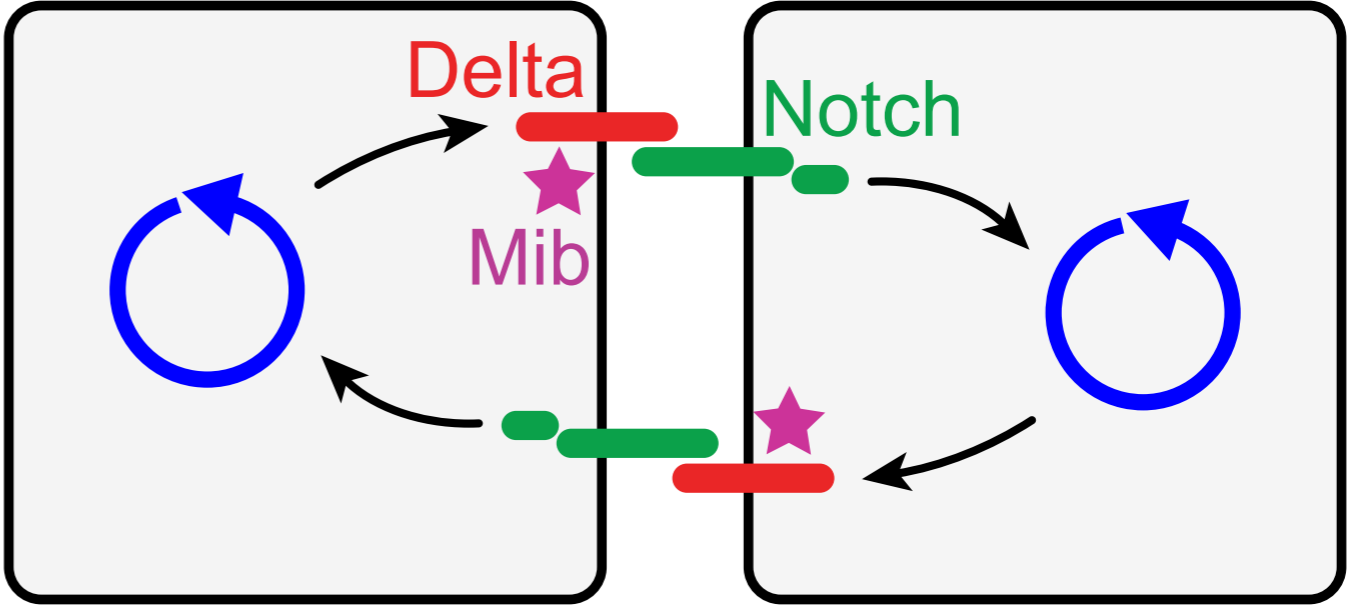
Alexis Webb  
David Jörg



# Comunicación celular y movimiento celular



Gabriela  
Petrunaro



Koichiro  
Uriu



  
universidad de buenos aires - exactas  
departamento de Física

**jueves 14hs**

# **COLOQUIOS**