# 解剖學與細胞生物學研究主題 之選擇、發展、與願景

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#### 解剖學與細胞生物學研究主題之選擇

探討生物體自細胞起各層次結構與功能之關係。 範圍除涵蓋細胞生物、解剖、胚胎、 組織等領域 外,並包括細胞組織分化、變異、退化與再生, 以及內、外在環境改變後從細胞到個體各層級形 態功能變異與重整之基礎與臨床等相關研究領域。

細胞生物學: 包山包海,大小通吃,老少咸宜

選對上天堂!選錯住套房!



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- Disease Modeling
- Epigenetics and Genetic Regulatory Networks
- Epithelial Stem Cells
- Gene Editing
- Hematopoiesis
- Metabolism and Aging
- Mechanisms of Reprogramming I: To Pluripotency
- Mechanisms of Reprogramming II: Transdifferentiation Between Lineages

- Muscle Stem Cells
- Nervous System Disease
- Neural Development
- Organoids in Modeling Disease and Development
- Road to the Clinic I
- Road to the Clinic II
- Stem Cell Niches
- Stem Cells and Cancer
- Stem Cells in Organ Development and Maintenance
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B1016-B1043
B1045-B1067

#### **Session Titles**

	Science Education 1
	Light and Electron Microscopy in New
	Imaging Technologies
	New Technologies for Cell Biology 1
	Actin and Actin-Associated Proteins 1
	Regulation of Actin Dynamics 1
	Kinesins 1
	Microtubule Dynamics and Its Regulation 1
	Ciliary Signaling and Ciliopathies
	Cytokinesis 1
	Kinetochore Assembly and Functions 1
	Centrosome Assembly and Functions 1
	Chromosome Organization
	Spindle Assembly 1
	Cancer Therap <b>y</b> 1
	Oncogenes and Tumor Suppressors 1
	Invasion and Metastasis
	Tumor Microenvironment 1
	Regulatory and Non-Coding RNAs
	RNA Localization, Transport, Stability, and
	Modification
	The Nuclear Envelope and Nuclear Pore
	Complexes 1
	Endocytic Trafficking 1
L	ER and Golgi Transport
	Rab GTPases
	Cell Signaling and Polarity
	Neuronal Morphogenesis and the

Cytoskeleton

B1069-B1088	Establishing and Maintaining Organelle Structure 1
B1100-B1118	Mitochondria, Chloroplasts, and Peroxisomes 1
B1119-B1139	Lipids and Membrane Microdomains 1
B1140-B1165	Signaling from the PM/Cytoplasm to the
	Nucleus
B1200-B1216	Signaling Scaffolds and Microdomains
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B1242-B1247	Intermediate Filaments
B1249-B1265	Cell-Cell Junctions 1
B1266-B1289	Integrins and Cell-ECM Interactions
B1301-B1323	Cell Death
B1324-B1343	Chaperones, Protein Folding, and Quality Control 1
B1345-B1361	Physical Approaches to Cell Biology
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B1406-B1423	Germ Cells, Gametogenesis, and Fertilization
B1424-B1445	Cell-Cell Interactions in Tissue Development and Morphogenesis
B1446-B1457	Cell Fate Determination 1
B1459-B1473	Prokaryotic Cell Biology
B1475-B1493	Defining Therapeutic Targets and New
	Therapeutics 1

# Intermediate Filaments (IFs)

- 10 nm filaments
- Cytoskeletal component
- Tissue-specific proteins
- 6 types:
  - Type I (acid keratins)
  - Type II (basic keratins)
  - Type III (vimentin, desmin, GFAP, and peripherin)
  - Type IV [neuronfilaments (NFs), α-internexin, synemin, and syncoilin]
  - Type V (lamins)
  - Type VI (nestin)



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#### Seven Intermediate Filament Proteins in Neural Differentiation



Gene, 149 (1994) 289–292 © 1994 Elsevier Science B.V. All rights reserved. 0378-1119/94/\$07.00

GENE 08245

# Characterization of the mouse gene encoding the neuronal intermediate filament protein $\alpha$ -internexin

(Neurofilament; sequence homology; genomic sequence; recombinant DNA)

#### Chung-Liang Chien and Ronald K.H. Liem

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Fig. 1. Restriction map and genomic structure of the  $m\alpha INX$ . Exons I, II and III are shown as filled boxes in the gene structure. The lengths of intron I and II are about 5.6 kb and 1.6 kb, respectively. B, *Bam*HI; H, *Hind*III; R, *Eco*RI; S, *SacI*; X, *XbaI*.

#### $\alpha$ -internexin and NFM in new-born mouse retina



<u>Chien</u> and Liem, 1995. The neuronal intermediate filament, alpha-internexin is transiently expressed in amacrine cells in the developing mouse retina. *Exp. Eye Res.* 61:749-756.

# Mouse $\alpha$ -internexin is transiently expressed in amacrine cell

Immunoreactivity of neuronal intermediate filament proteins in the developing mouse retina

Age	Horizontal cell processes	Amacrine cell processes	Ganglion nerve fibers	Glial (Müller) processes	Glial processes in ganglion nerve fibers
newborn	α-internexin, NFL, NFM, Vimentin	α-internexin.	∝-internexin. NFL, NFM	Vimentin	Vimentin
P 3	4	4			
P 5	$\alpha$ -internexin,	$\alpha$ -internexin.	$\alpha$ -internexin.		
	NFL, NFM,	(NFM)	NFL, NFM,		
	Vimentin, (NFH)		(NFH)		
P 7	$\alpha$ -internexin,	$(\alpha$ -internexin)	$\alpha$ -internexin,		
	NFL, NFM.		NFL, NFM,		
	NFH, Vimentin		NFH		
P 9	1	n.a.			
P 11		n.a.			
P 14		n.a.			4
P 21		n.a.			Vimentin, (GFAP)
4 weeks	↓ ·	n.a.	↓	+	Vimentin, GFAP
6 months	$\alpha$ -internexin.	n.a.	$\alpha$ -internexin.	Vimentin	Vimentin, GFAP
	NFL, NFM,		NFL, NFM, NFH		
	NFH, Vimentin				

n.a.: no detectable immunoreactivity: arrow indicates the same level of immunoreactivity as detected at earlier stage(s): parenthesis indicates the weak immunoreactivity.

#### Neural Expression of α*-Internexin* Promoter In Vitro and In Vivo

#### Journal of Cellular Biochemistry 9999:1-13 (2005)

#### Pei Wang, Seu-Mai Wang, Chia-Ju Hsieh, and Chung-Liang Chien\*

Department of Anatomy and Cell Biology, College of Medicine, National Taiwan University, Taipei, Taiwan





b



Fig. 4. PCR screening of 1.3intfs-Cre/R26R transgenics. The data represent a typical example (this litter contains nine newborns) from three independent litters. R26R allele-specific PCR and 1.3intfs-Cre allele-specific PCR were performed on mouse tail genomic DNA from the1.3intfs-Cre transgenic 1.3intfs-Cre/R26R mouse can be identified from the wild type (wt), 1.3intfs, and R26R mice. M: 100 bp DNA ladder marker, +: positive control, -: negative control.



# Example for a PhD student training

The Journal of Comparative Neurology | Research in Systems Neuroscience 521:2147-2164 (2013)

# Molecular Cloning and Characterization of Chicken Neuronal Intermediate Filament Protein $\alpha$ -Internexin

Chi-Hsiu Liu and Chung-Liang Chien\*

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#### Experimental Eye Research Neuronal intermediate filament $\alpha$ -internexin is expressed by neuronal lineages in the developing chicken retina

#### Chi-Hsiu Liu<sup>a</sup>, I-Jong Wang<sup>b</sup>, Fong-Di Wei<sup>a</sup>, Chung-Liang Chien<sup>a,\*</sup>

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劉紀秀博士接受 楊院長撥穗後合影

#### cDNA and Protein Sequences of Chicken $\alpha$ -Internexin (chkINA)

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RVR

R T.

ASLH

C

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CTG	AGG	GAG	TAC	CAG	GAC	CTG	CTG	ATO	FTC2	AAG.	ATG	GCCC	TGG	5A TA	TTG	AGA	TTO	CTO	\$CC
г	R	Е	Y	Q	D	г	$\mathbf{L}$	N	v	к	м	А	г	D	I	Е	I	А	А
TAC	AGG	AAG	CTG	CTG	GAG	GGA	GAG	3AA/	ACC	TG	TTC.	AGC A	TGO	GGA	GTG	TTG	GCO	TTC	CA
Y	R	к	L	L	Е	G	Е	Е	N	г	F	s	м	G	s	v	G	L	Р
GCC	ATG	AAC	ccc	CTC	ccc.	AACO	ccci	rcc3	FACT	FCT	TTC	ceec	CAC	GCI	rcc1	CCA	сто	CAT	rcc
А	м	N	Р	L	Р	N	Р	т	Y	s	F	R	Р	R	s	s	т	Р	s
TTC	AAG	AAA	GAG	GAG	CAA	AGA	5A GO	<b>FCA</b>	FT7	AGA	GCG.	ACCI	rc c <i>i</i>	AGA	TAC	CAT	сто	GTC	AG
F	к	к	Е	Е	Q	R	Е	А	v	R	А	т	s	к	I	P	s	G	Q
GCT	GGA	GTG	CTT	GAC	GGG.	ACCI	ATA/	vcc3	CTO	GCT.	AAG.	AGAA	CGG	AGA	GAT	TCA	ACO	TGO	AT
А	G	v	г	D	G	т	I	т	т	А	к	R	т	Е	R	F	N	v	н
GGA	GGA	ATC	ATT	GCA	AAT	GCT	AAA	TGG	AAT	rgg	TGG	GAAC	ccc	ATC	:cc1	TTT	GC1	TT1	GA
G	G	I	I	А	N	А	к	v	Q	W	ស	Е	Р	н	Р	F	С	I	*
GGG	GGA	GCA	GTC	TTC	AGT	TGGG	ccc	rtt <i>i</i>	AT2	FGC	стс	TTGO	;GC	CTG	GGI	TGT	GCT	FCAG	эта
GCT	CTG	ATT	ACA.	AGG	ACC	ccci	ATA(	GGI	CAG	GGG	стс.	AGC A	GCC	тст	GGC	ААА	GC /	LAGO	\$GC
CGA	GCT	CAG	CAC.	ACT	GCT	ccc	FC TO	CAAG	FTC2	GG	TGG	ceec	CAC	ACG	GGI	CGC	TGO	GTO	5CA
TGC	TGG	TGG	GTG	TTG	TGG	GTG	CAC	GGG	ATT	rcg	TGG	CAGO	GAG	CAG	GAG	ACT	cGC	TGC	:AA
TTT	GGG	GAG	GGG	GTG	GC G.	AGG	5C AJ	CGG	FAA(	CTC.	AAC	TACA	AC:	TAGG	ATI	AAG	GCI	FAC A	fec.
сст	TCA	сст	ACT	GTC	CAA	ATC	CAT	FTGI	CAGO	TA	AAG	TGTI	TCC	тст	TCT	TCA	AGO	CGI	CAG
CCA	тсс	ACG	TTT.	AAC	CCA	GAA	GCAG	CAG	1441	FAG	CCA	TAA	CAC	ACC	TTO	TTT	сто	GTC	TG
TGA	GCC	ACT	TGT.	ATT	TTA	AAC:	FA TZ	AGG	FAA?	rgg	GGT	TTTT	TCO	TTC	TGA	CAA	сто	TTT	ст
GTT	тст	TAG	TAG	CGT	TAG	TCTO	GCC	CACO	TGO	CAT	GGG	GTTI	GT:	rggi	TGG	GAA	сто	GC	rcc
CAG	TGC	CTG	тст	CCA	TGT.	ACAG	3C A C	GG2	GCG	FCT	GGG	TGCI	reco	:AAA	TGC	CAC	ATC	CAC	AC
стс	CAC	тсса	AGC	CTT	CCA	ACA:	FGT	scc.	-	гст	GAT	GTAG	GA:	TTA	CAA	CTG	TAC	GT	гтс
TTT	CAA	TGC	CTT.	<b>AAA</b>	ATT	GC CJ	AGC:	TCI	rgc <i>i</i>	ACG.	AGC	CAG	GAG	TGC	GTG	TGT	GTO	стл	ΔTA
TGT	CGG	TGC	CCG	GGC	GAG	GTT	scci	ATC?	TG?	GA	сст	TATI	GCC	сто	TCA	GTG	TTO	scc.	<b>GA</b>
GTA	GTT	сст	GGA.	ACC	AGC	AAA	TG	TTC	FCTO	CAC	ACT	сттт	rc c:	сто	CTA	CTG	TAZ	reed	AC
AAG	TTA	ATA	ATT	ההה	AAG	AAA	GAA	ATA	GTT.	ATG	TGA	ACCI	نمما				LAA		

#### **CDS: 1302 bp** Putative protein: 433 a.a.

12

Gene CDS structure 0.5 kb UTR Intron

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LAQSPRRTEGAEPRRA

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AHGERAQAALERARLAE

R L R A R C E E E A R G R A E A E

R A R O O A A D G A A R A R A D L

P D L A A A L R E L R A Q Y E A L

DWYRARC

S

RHSAE

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Р P A s G Р P

CGCCGCCTGCTCGCCCAGTCCCCGCGCGCGCACGGAGGCGCTGAGCCGCGCCGTGCTAGC

GAGAAGGAGCAGCTGCGGGGCCTCAACGAGCGCTTCGCCGGTTACATCGAGCGTGTCCGG

QLRGLNERFAGYIE

ERNRALAGELAELR

CAGGCGTTGCGCGCCGGCAGCAGGCGGCCGACGGGGCGGCCCGGGCCCGCGCCCGACCTG

GAGCGGCGGGCGGAGGCGCTGCGGGAGGAGCTGGCGGAGCTGCGGCGCGCCCACGCCGAG E R R A E A L R E E L A E L R R A H A E CAGC TGGCCC AGC TGGGA GC CGC GC TCC GCGCC GCC CCC GCCC TCCGGGCCC CCG

ACGGCGCGGCCCGACCTGGCGGCTGCGCTGCGGGAGCTGCGCGCTCAGTACGAGGCGCTG

CCGGCCCGCAACCTGCAGGCGGCCGAGGACTGGTACCGCGCCCGCTGCGCCAGCCTCCAC

E R A A R S Q E A V R A S R R E A G E

CGCCGGCAGCTGCAGGCCCGGGTGGTGGAGATGGAGAGCCTGCGCGGAGCTCACGAGTCC

CTCGAGAGGCAGCTGCAGGAGCTGGAGGAAAGGCACAGCGCCGAGGCCGCCGGGCTGCAG

GACACCATTGGGCAGCTGGAGGCTGACCTGCGTAGCACTAAAACCGAGATGGCTCGGCAC

ADLRS

AQLGAALRAAA

LQARVVEME

NLQAAE

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A L MSYSVEPPALAA

#### Percent Identity and Similarity between Predicted Protein Sequence of chkINA and Other Species



Sequence alignments were done by online tool, **ProDom**, and modified by Photoshop software. http://prodom.prabi.fr/prodom/current/html/form.php

✓ High Similarity✓ Conserve structure

## Custom Antibody – CHK 366-384

#### Predicted chicken $\alpha$ -internexin (chkINA)

•433 a.a.

•Theoretical pl/Mw: 9.37 / 48435.59 (48.4 kDa)

MSYSVEPPALAASSRRLLAQSPRRTEGAEPRRASEKEQLRGLNERFAGYIERVRALEERN

RALAGELAELRRLPPEPRRLGQLLGGELRALRARLEEAHGERAQAALERARLAEETQRLR

ARCEEEARGRAEAEQALRARQQAADGAARARADLERRAEALREELAELRRAHAEQLAQLG

AALRAAAPPASGPPTARPDLAAALRELRAQYEALPARNLQAAEDWYRARCASLHERAARS

QEAVRAS RREAGECRRQ LQARVVEMES LRGAHES LERQ LQELEERH SAEAAG LQDT I GQL

EADLRSTKTEMARHLREYQDLLNVKMALDIEIAAYRKLLEGEENLFSMGSVGLPAMNPLP Epitope NPTYSFRPRSSTPSFKKEEQREAVRATSKIPSGQAGVLDGTITTAKRTERFNVHGGIIAN



AKVQWWEPHPFCI\*GGAVLITSEF.

#### **Antibody Characterization**

J. Comp. Neurol. 2013; 521:2147-64



#### The antibody is specific for recognizing chkINA protein.

#### Expression of chkINA and Cell-type-specific Markers in the Developing



#### Distribution of chkINA and NFs in the Developing Retina



Scale bars 17725 μm

#### **Chicken Retina**



Dynamic pattern of <u>chkINA</u> during development
•Early stage → all neuronal lineages
•Late stage → ganglion cells, amacrine cells, and horizontal cells.

Dynamic pattern of NF triplet proteins during development
•Early stage → ganglion cells
•Late stage → ganglion cells, amacrine cells, and horizontal cells.<sup>18</sup>

# The developmental expression of neuronal intermediate filament inaa in the zebrafish retina



Dr. Meng-Lin Liao 2013 Travel Fellowship from the Japanese Society of Developmental Biologists (JSDB)

## zebrafish $\alpha$ -internexin Homologs

sapiens Ina	1 IS FOR FAILS ASSAULTION STRATT AND CONTAINED STRATT AND A CONTAINED AND A CONTAI
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usculus Ina	1 IS FOSE HYLOAD SY FKUFOD OS RLOBR LSCAGES (SFRSOSLS RSHUAS A ACSSADS LGLAY RBPATE OLD SO AAARTHE W. I IRT NE KEOLOG LHOR FAUT
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roglodytes Ina	109 IEKVHQLET QNRALE AELA ALRORNAE PSRVCEL FORELREL RAQLEE ASSARAQALLERDGL AEEVORIR ARCE EE SRGREG AERALKA QORDUD GATLARLDLEKKVE SL
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roglodytes Ina	221 LDEL AF VROUNDE EV AELL AT LOASSO AAAEVD VE <mark>V AKPDLT SALRE I RAOVESLA AKRLOSAEEWYKSKTANLNEO AARSTE A IRASRE EI HEVRROLOART I E IEGLR GA</mark>
familiaris_Ina	221 LDEL AF VROUNDE EV AELL AT LOASSO AAAEVD VII VAKPDLT SALRE IR AQVESLA AKRLOSAEEWYKSKTAMLNEO AARSTE A IR ASRE EI NEVRROLOART IE IEGLRGA
au rus_In a	221 LDEL AF VROVNDE EV AELL AT LOASSO AAAEVD VI <mark>U AKPDLT SALRE IR AQVESLA AKULOSAEEWYKSKFANLNEO AARSTE AIR ASRE EINEYRROLOART IE IEGLR GA</mark>
s_norvegicus_Ina	221 LDEL AF VROUNDE EV AELL AT LOASSO AAAEVD V <mark>R</mark> U AKPDL <mark>A</mark> SALRE IR AQVESLA AKRLOSAEEWYKSKT ANLNEO AARSTE AIR ASRE EINE YR ROLOART IE IEGLR GA
us culus_Ina	221 LDEL AF VROVNDE EV AELL AT LOASSO AAAEVD VAV AKPDLSSALRE IR AQVESLA AKVLOSAEEWYKSKTANLNEO AARSTE A IR ASRE EI NEVRROLOART IE IEGLRGA
s gallus Ina	163 E_LAELREANA QLAQLEARLRAAAPP 25 P PTARPDLAAALRELRAQYEALFERNLQAAE WERARCASLHERARSQEAVRASRE AGEORROU QARWEMESLRE H
rerio Gefiltin	21.5 ADD DA GKAR DEVARE DW. (189(US) T. ANDLTSEL IR (UTA) ASIALYSAEDWYKKTADIS 2020 SDA URASKED DR REOLOS TIPESARCT
rerio_Inaa	221 LDB DE SKONDEORDET DE 1980 OF SKOLTSEL IK OVELLESKE DE SKOLTSEL IK OVELLESKEVESKESTESTE DE DE DE DE DE VERDLOS FIELERIES
ns us	241*******
	Rod Tail
sapiens_Ina	333 mesler (helefrisaevag vods ig gle <mark>s</mark> derntksemarhere vodelnvkmald ie laa vrkele g <mark>i</mark> etrf st <mark>e</mark> ges is genplpnps velppr ilsstä <sup>s</sup> skvsst ge
roglodytes_Ina	333 mesler (ileleer) saevag vods ig qle <mark>s</mark> derntksemar hlrev odlinvkmald ie iaa yrklie geetrf st sgls is glippip nps villp pr ils stt skuss <mark>a</mark> gl
familiaris_Ina	333 mesler ( ileleerk saev ag yods ig qlendlrntksemarklre yodllnukmald ie iaa yrklie geetrf st sgls is glipplpnps yllp pr ils <mark>e</mark> tt skusst gl
au rus_In a	333 mesler (il eleern saevas voos is glendlantksen armer vollinvknald ie 1 aa yrklie geetryst sgls is glippip ny vlippr ils stt skusst gl
s_norvegicus_Ina	333 mesler (il eleern saeva <mark>s</mark> vods 16 glendlrat ksemarhlre vodllavkmald ie 1 aa yrklie getr fst sgls 13 glinp <mark>o</mark> pnb <mark>y</mark> llp prilsstt skusst gl
usculus_Ina	333 mesler (ileleern saev as vood is glendlent ksemarnlre voollnvkmald ie 1 aa vrkle geetr fst sgls is gluplpups vllp prilsstt skeset gl
s_gallus_Ina	273 ESLERQLQELEERHS AE AA 🗓 QDT IGQLEADLR STKTEMARHLREYQDL DAVM AL DIE IAAYR 🛛 DEGDAL ISMG BUGL PAMAPLPAP TYS IR 💁
<i>rerio</i> Gefiltin	324 RESLERO ROTE RURAE (6 VODSIGDERDERT KSENARHEREVODELNOKNALD IE I AAVRKEE GEERSI (5 (6 11 YPT) ASU (5 1 SY (5 1 YST) M
rerio_Inaa	330 DESLERORDED MURANES VON 160L D. RATKSEHARALREVODLIVKAALD IE JAAVRKLE GETAUSS6 🖅 FSSTPSIT- 1640 SZAPE TR
ns us	361

\* Inaa

- NP\_001138256
- 474 a.a. in length
- ~ 58 kDa
- \* Inab
- NP\_571107.2
- 469 a.a. in length
- ~ 58 kDa
- \* Both genes have highly conserved central rod domain.

Nomo\_sapiens\_Ina GEGFEETLCE & UISTKKTG 444310223101010000 SKKT S Fan troglodytes Ina 4443LKCCDEEEEE KKTS GESFEE Canis familiaris Ina 444810(00 GESFEE GESFEE Bos taurus Ina 444810/0/08-12 EXEE ASKOASKKTS Rattus norvegicus Ina 444SLKKC 0 0 00 0 SKKTS GESFEE Mus musculus Ina 44430/00 DINNE Gallus gallus Ina 3733 1103 Danio rerio Gefiltin 42 58 Danio rerio Inaa 43 ON F 481.

Β. Honeo Pan t Canis

> Bos t Rattu Mus m Gallu

Danio Danio conse

> Xoneo Pan t Canis

Bos t Rattu Mus m

Gallu Danio Danio conse:

> Xoneo Pan t

Canis Bos t Rattu Mus\_m

Galla Danio Danio

> conse Xoneo

> Fan t Canis Bos t

Rattu Mus m Gallu Danio Danio conset

consensus

-E ORE AUR AT KIP SEQ AGU DET ITT AK TER FRUNGE **Epitope for anti-inab antibody** -VKD DD D - - KQQ SEKP 6 K 633 Q 3DD KKW 14 ID 36 -- EEEGI PKSKT AAKREENT EN GI SKUHSND AV **Epitope for anti-inaa antibody** 

# Transcription of *inaa* gene in zebrafish developing CNS

Whole-mount in situ hybridization



#### Distribution of inaa and inab protein in adult zebrafish retina



Inaa: mainly in outer nuclear layer (ONL) Inab: mainly in the ganglion cell layer (GCL), optic fiber layer and optic nerve (ON)<sup>22</sup>

# Expression patterns of inaa and inab in developing zebrafish retina



#### Inaa localized to the double-cone photoreceptors



Zpr-1: marker for double-cone

#### Inaa is predominantly expressed in cone photoreceptors of adult retina.





IFs could be found in the cell body and the inner fiber of the cone photoreceptors.

Inaa could be a good marker for identifying the cone photoreceptors in the zebrafish.

#### Inaa dynamically distributed in the developing retina

	Cell typ	dpf bes	3	5	9	14	Adult		
	Gangli	on cell	++	++	++	+	+		
	Amacrine cell			-	+	+	+		
	Bipola	r cell	-	-	-	-	+		
photoreceptor			+	+	+	++	++		
	(dpf)	123	5	9	14			Adult	•
Cell 7	ypes		1	1	1			1	
Ganglion cell									
Amacrine cell									
Bipola	ar cell								
Photore	eceptor								

# Inaa is expressed in photoreceptor-like cells in the adult pineal gland



# Ultrastructure of IFs in the cell body of zebrafish pineal photoreceptor-like cells



(OS: outer segment; IS: inner segment)

Neuronal specific IF, inaa, could be one of cytoskeletal components in zebrafish pineal photoreceptor-like cells.

Cell Tiss. Res. 158, 409-424 (1975) © by Springer-Verlag 1975

#### Comparative Ultrastructure of Cerebrospinal Fluid-Contacting Neurons and Pinealocytes

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Fig. 6. Schematic drawing comparing the intraventricular dendritic terminal (FCN) of the CSF contacting neuron with pinealocytic outer and inner segments  $(EPI \ 1-5)$  in 1 fishes, 2 amphibians, 3 reptiles, 4 birds, 5 mammals. Arrows indicate the direction of the regression of photoreceptor lamellae. In mammals  $(EPI \ 5)$  the structure of the outer segment is identical with that of the cilium of the CSF contacting terminal (FCN)

## What a PhD student learned from my Lab.

DNA level	Molecular cloning					
	Transfection / expression ( <i>Ex ovo</i> electroporation for chick embryo)					
RNA level	in situ hybridization & RT-PCR					
	morpholino knockdown (for Zebrafish)					
Protein level	QC for the antibodies, Western blot < immunohistochemistry < immunocytochemistry					
Cell level	Transmission electron microscopy Confocal microscopy Live Image of YFG-product (Tagged with GFP)					
Organism level	Developmental/ Species differences					

# 解剖學與細胞生物學發展與願景

教學熱忱,研究初衷 擴大視野,跨域合作 兄弟登山,各自努力 經驗傳承,提攜後進

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