

# AN ONLINE GENITOURINARY RESOURCE

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## Introduction

The **GenitoUrinary Development Molecular Anatomy Project (GUDMAP)** is a consortium of laboratories working to provide the scientific and medical community with gene expression data and tools to facilitate research ([www.gudmap.org](http://www.gudmap.org)).

## GUDMAP Gene Expression Data

The data provided by GUDMAP include **large in situ screens** and **expression microarray analysis** of components of the developing mouse urogenital system.

The **Gene Strip** interface allows users to access these datasets easily.

Select All | Deselect All | Column Selection | Display 20 entries per page | Flexible Scroll

| Gene | Synonyms                        | Disease | Theiler Stage | In situ expression profile | In situ expression images | Microarray expression profile | Genesets    |
|------|---------------------------------|---------|---------------|----------------------------|---------------------------|-------------------------------|-------------|
| Jag1 | Serrate-1, Htt, Headturner, ... | OMIM(2) | TS17-28       | [Color bars]               | [Image]                   | [Heatmap]                     | Genesets(n) |

Items in my Genes: 0  
 Add to my Genes  
 Replace my Genes  
 View my Genes (or other selections)

## Disease Resource

A searchable database of associations between genes, OMIM diseases (with GU component) and mammalian renal/urinary & reproductive phenotypes.

Table showing result of a query to find diseases associated with the gene

| OMIM ID | Disease Name  | Gene Symbol | Gene MGI ID | ISH data | Flag | NCBI |
|---------|---|-------------|-------------|----------|------|------|
| 194070  | WILMS TUMOR 1   | Wt1         | MGI:98968   | 1        | N    | 1    |
| 194080  | DENYS-DRASH SYNDROME  | Wt1         | MGI:98968   | 1        | N    | 1    |
| 256370  | NEPHROTIC SYNDROME, EARLY-ONSET, WITH DIFFUSE MESANGIAL SCLEROSIS               | Wt1         | MGI:98968   | 1        | N    | 1    |
| 194072  | WILMS TUMOR, ANIRIDIA, GENITOURINARY ANOMALIES, AND MENTAL RETARDATION SYNDROME | Wt1         | MGI:98968   | 1        | N    | 1    |
| 136680  | FRASIER SYNDROME  | Wt1         | MGI:98968   | 1        | N    | 1    |
| 109800  | BLADDER CANCER  | Wt1         | MGI:98968   | 1        | N    | 0    |
| 601363  | WILMS TUMOR 4   | Wt1         | MGI:98968   | 1        | R    | 0    |

Link out to OMIM disease page

Link in to GUDMAP gene expression data

Associations are obtained from NCBI and through text-matching gene symbols in OMIM entries.

## Markers

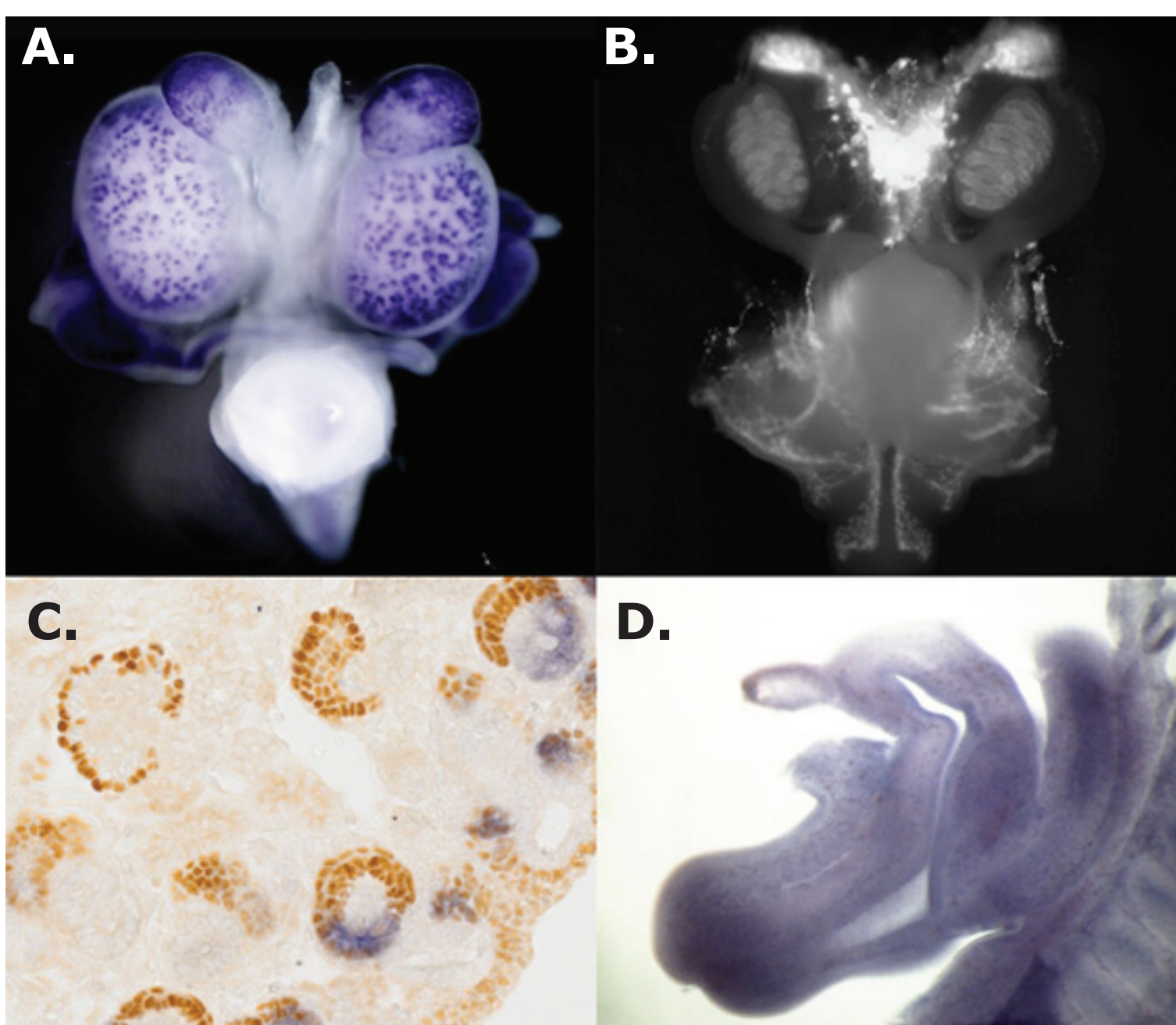
In situ hybridization screens have revealed novel markers for specific anatomical components.

The **renal vesicle**, a structure once believed to be homogeneous, has both **proximal** and **distal** domains.

| Gene    | Expression Pattern  | Domain                  |
|---------|---|-------------------------|
| Dkk1    | not detected maturing nephron   | Distal domain markers   |
| Papss2  | early proximal tubule of maturing nephron (possible weak expression in immature loop of Henle of medulla) |                         |
| Greb1   | not detected maturing nephron   |                         |
| Jag1    | anlage and immature loop of Henle of maturing nephron   |                         |
| Pcsk9   | uncertain expression in early proximal and distal tubules of maturing nephrons                            |                         |
| Lhx1    | no expression in cortical renal tubules of maturing nephron   |                         |
| Bmp2    | not detected maturing nephron   | Proximal domain markers |
| Wt1     | expression in visceral epithelium of maturing nephron   |                         |
| Tmem100 | not detected maturing nephron   |                         |

### In situ data

- In situ hybridization screens (wholemound and section)
- In situ analysis of transgenic reporter screens (wholemound)
- Immunohistochemistry (section)



**A:** (GUDMAP:11296) Wnt4 RNA expression in the early nephron.  
**B:** (GUDMAP:10716) A Sox10-YFP transgene labels neural crest cells as they stream into the urogenital tract.  
**C:** (GUDMAP:8200; GUDMAP:8209) Metanephros double-stained for Wt1 protein (orange) and Wnt4 RNA (blue).  
**D:** (GUDMAP:11389) Ets1 RNA expression in components of the urogenital sinus and urorectal septum.

### cDNA Microarray data

- Array analysis of laser-captured components of the developing GU system
- Array analysis of FACS-isolated cells from transgenic reporter mice

Microarray Expression Profile for: Hif1a

Select All | Deselect All | Column Selection | Display 20 entries per page | Flexible Scroll

| Probe Id   | Gene Symbol |
|------------|-------------|
| 1416035_at | Hif1a       |
| 1427418_at | Hif1a       |
| 1431981_at | Hif1a       |
| 1448183_at | Hif1a       |

Items in my Probes: 0  
 Add to my Probes  
 Replace my Probes  
 View my Probes (or other selections)

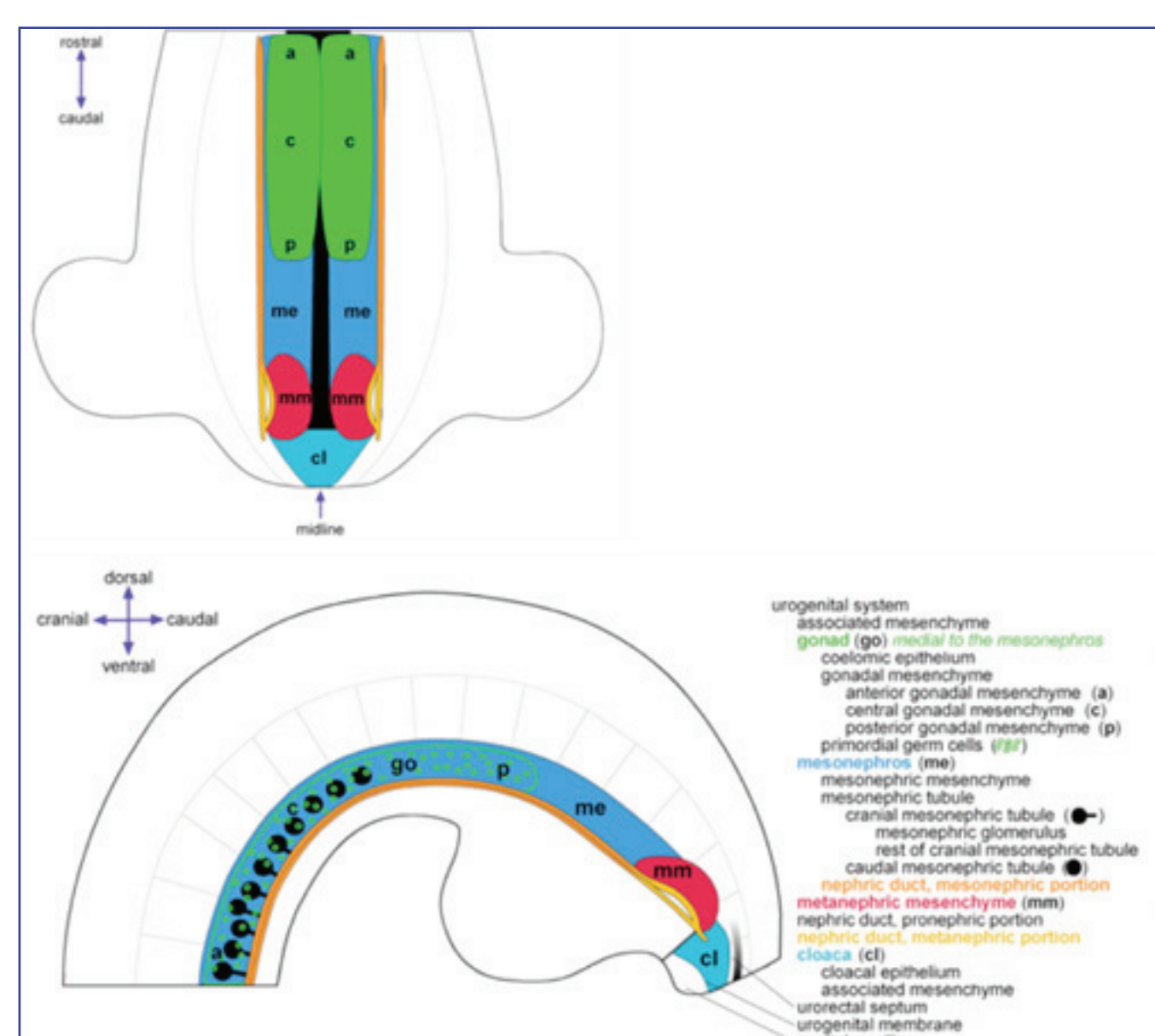
Microarray Expression Profile for Hif1a. The heatmap displays the level of expression for four different Hif1a probes across a range of components of the renal/urinary system.

## GUDMAP Tutorial

- The website has **tutorials** describing GU organogenesis.

### The development of the murine kidneys

The **metanephros** develops from the most caudal part of the nephrogenic cord that is itself derived from the intermediate plate mesoderm. The initial renal anlage that develops from the most rostral part of the nephrogenic cord is termed the pronephros. The latter is not believed to function in the mouse, or in any other mammal. However, within the pronephros, a relatively small number of pronephric (or nephrotomal) vesicles form in a cranio-caudal direction, and these "drain" into the pronephric duct. As the pronephros is a relatively transient structure in mammals, the absence of differentiated **glomeruli** within it strongly suggests that it probably does not act as even a primitive excretory organ. Despite the complete degeneration of the pronephros, the pronephric duct is retained. This structure is then taken over by the **mesonephros** (also termed the "Wolfian" body), and is only then termed the **mesonephric portion of the nephric duct**.



- A **high-resolution anatomy ontology** has been developed by the GUDMAP consortium to describe the subcompartments of the developing murine genitourinary tract.

Expression Mapping

View annotated components as a list | Show annotation under groups

Expression Strengths Key:

- Present (unspecified strength)
- Present (strong)
- Present (moderate)
- Present (weak)
- Uncertain
- Not Detected

Expression Patterns Key:

- Graded
- Regional
- Spotted
- Ubiquitous
- Restricted
- Single cell
- Contains note

Stage: TS23

Component: Name: renal vesicle, ID: EMAP:27831, Main Path: mouse

Expression: Strength: present, strong, Pattern: Location(s): regional, proximal

Note: signal is strongest on the side of the vesicle furthest from the ureteric tip.

Screenshot of expression annotation, with renal vesicle notes, of GUDMAP:8200 (gene Wt1).

## Using The Database

Expression is: present, not detected, uncertain

in: nephrogenic interstitium, TS17 to: TS28

with: pattern, at, location

AND

Expression is: present, not detected, uncertain

in: renal capsule, TS17 to: TS28

with: regional, at, location, caudal, deep

AND

Expression is: present, not detected, uncertain

in: distal, TS17 to: TS28

with: pattern, at, location, lateral, medial, proximal, radial, rostral, surface, ventral

### Boolean Query

The web interface enables users to perform advanced, Boolean queries in addition to more basic browse/query functions. Complex queries can be constructed to search for gene expression based on selected anatomical structures.

| Select                              | Gene | GUDMAP Entry Details |
|-------------------------------------|------|----------------------|
| <input checked="" type="checkbox"/> | Wnt2 | GUDMAP:10258         |

Search and select

Items in my Genes: 3

Add to my Genes

Replace my Genes

View my Genes (or other selections)

Build, edit, view collection

My Genes

Get intersection with my Genes

Get difference with my Genes

Analyse collection

### Collections

Enable users to build collections of GUDMAP entries, genes and images. It is then possible to further analyse these sets using standard operators (e.g. union, intersect) to find similarities and differences.

## References

Little MH et al. (2007). A high-resolution anatomical ontology of the developing murine genitourinary tract. *Gene Expr Patterns*. 7(6):680-99.

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