Maintaining an Endoscopy system

- Principles of operation
  - function
  - use
  - scientific principles
- construction
  - components
  - system diagram
  - inputs/outputs

13.6.6 Principles of operation of an endoscopy system

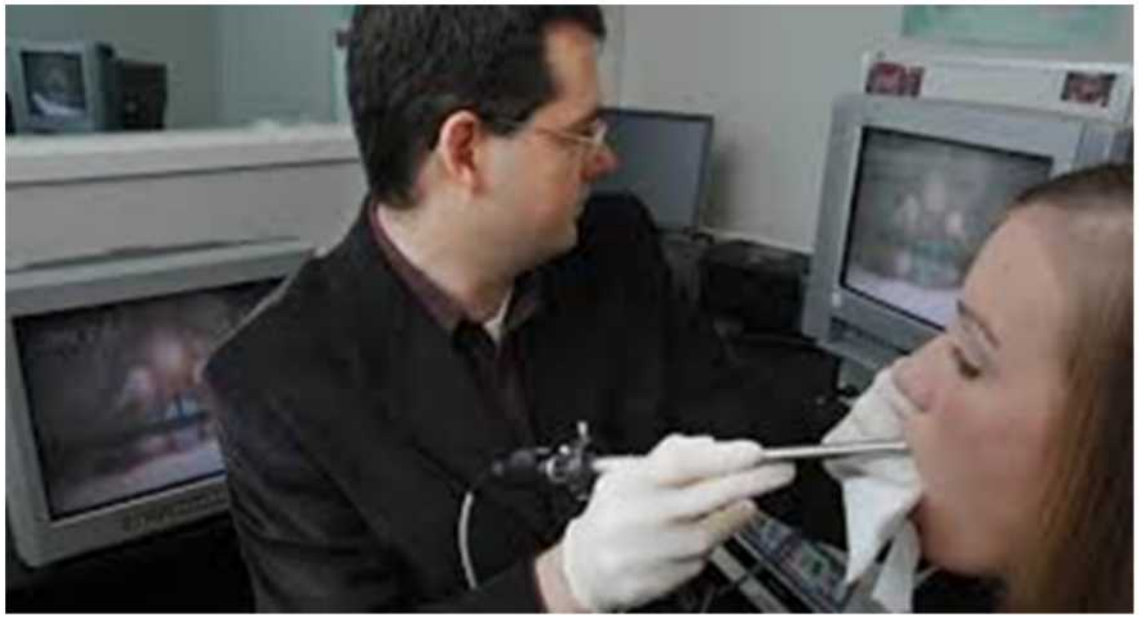
Unit B 13.6 Maintaining theatre and surgery equipment

Module 279 18 B Medical Instrumentation I

Endoscopy system: function

Endoscopy means **looking inside** and typically refers to looking inside the body for medical reasons using an endoscope, an instrument used to examine the interior of a hollow organ or cavity of the body.

Traditional **non-video** endoscopy systems ('fiber scopes') allow the viewing of **live, colour, (mono-scopic)** images of the interior of the body during **diagnostic** and **therapeutic** endoscopic procedures.



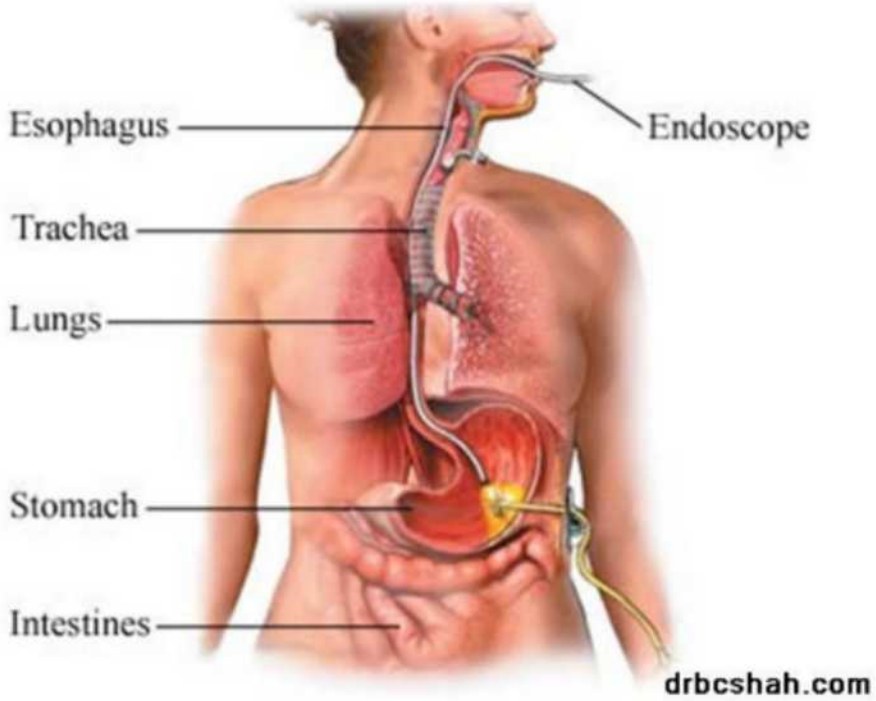
Video endoscopes – in addition - enable these images to be stored, retrieved, and electronically processed.

Endoscopy system: Use

Endoscopy can be applied to:

All natural body openings:

- the gastrointestinal tract, esophagus, stomach
- small intestine, large intestine, colon, bile duct
- the respiratory tract, the nose, the lower respiratory tract
- the ear
- the urinary tract
- the female reproductive system, the cervix, the uterus, the fallopian tubes



Normally closed body cavities (through a small incision):

- the abdominal cavity
- the interior of a joint (arthroscopy)
- the organs of the chest

1.9mm Autoclavable Arthroscope

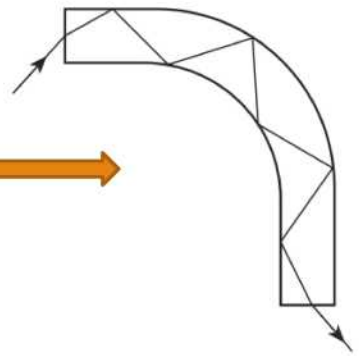
Risks include

- Infection
- Punctured organs
- Over-sedation

Scientific Principles: fiber optics

Fiber-optic instruments are based on optical **viewing bundles**. The viewing bundle of a standard fiber-endoscope is 2–3 mm in diameter and contains **20·000–40·000** fine glass fibers, each close to 10 µm in diameter.

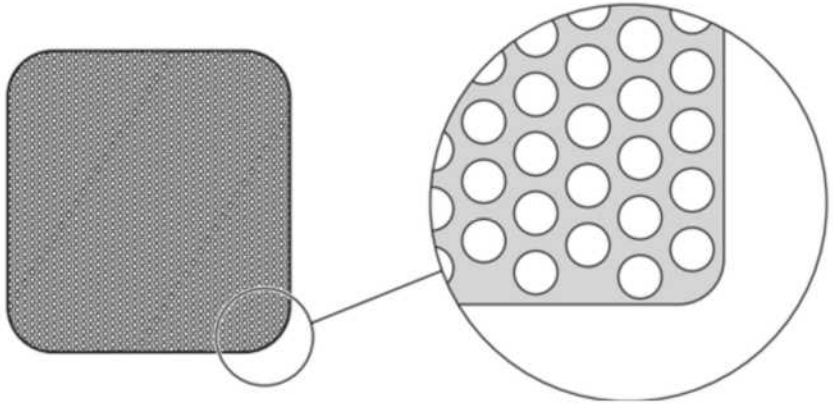
Light focused onto the face of each fiber is transmitted by repeated internal reflections (Figure). Each individual **glass fiber** is **coated** with glass of a lower optical density to prevent leakage of light from within the fiber, since the coating does not transmit light (**mirror**).



total internal reflection of light down a glass fiber

The image quality of a fiber optic bundle is excellent but can never equal that of a rigid lens system. However, fiber optic bundles are extremely flexible, and an image can be transmitted even when the fiber is tied in a knot.

fiber bundle showing the packing of fibers

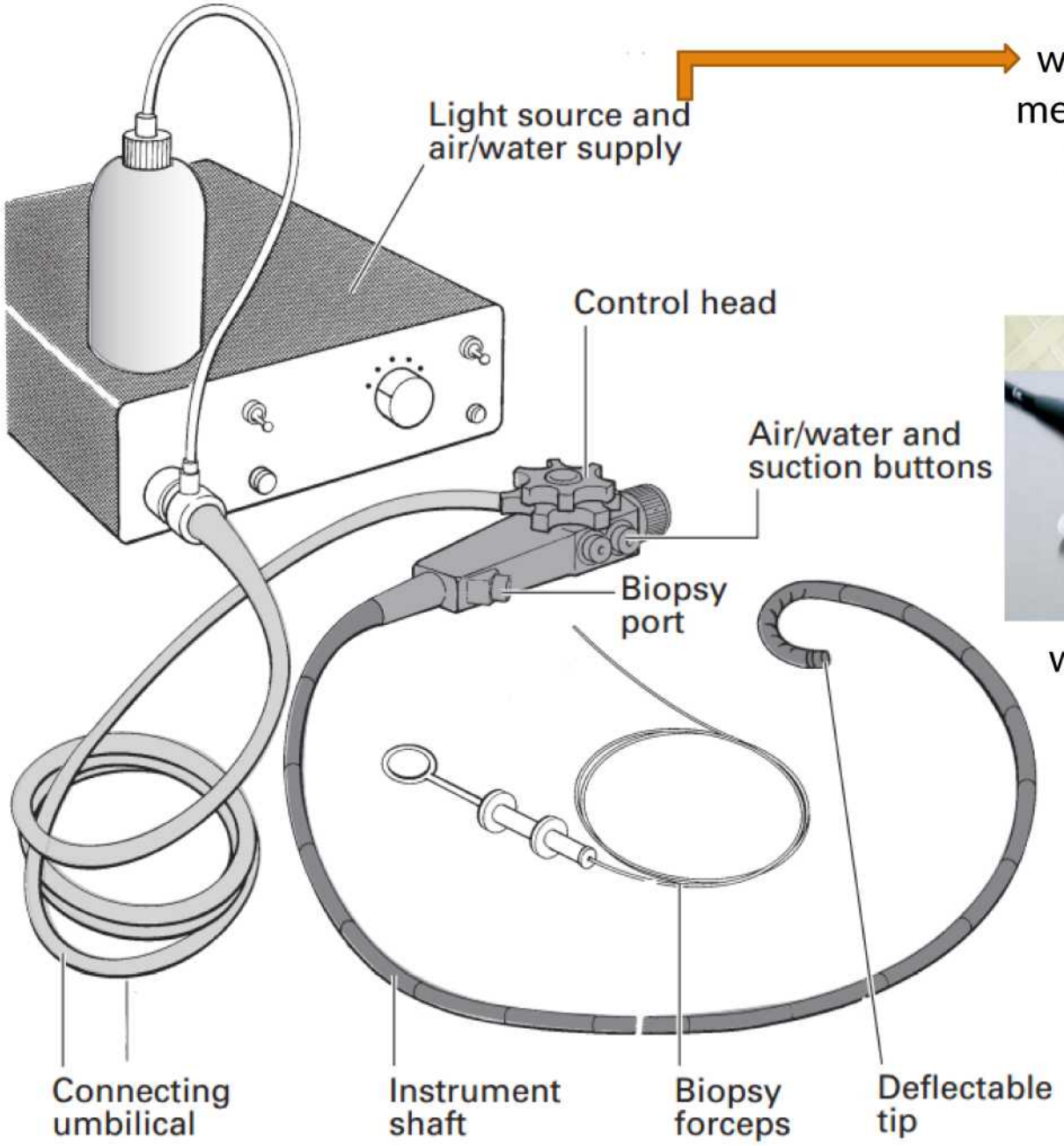


Endoscopy system: Construction

A traditional endoscope consists of:

- a rigid or flexible **tube**
- a **light** delivery system to illuminate the organ or object under inspection. The light source is normally outside the body and the light is typically directed via an optical fibre system
- a **lens** system transmitting the image to the viewer from the fiberscope
- optionally: **additional channels** to allow entry of instruments, etc.

Fiber-optic endoscope system (non-video)



with xenon, LED, or metal-halide arc bulb (e.g. 300 Watts)

water jet function

Additional Channels

Air insufflation is typically used to expand the intestines to insert and manoeuvre the scope and increase the FOV.

Suction helps remove debris from the distal tip of the endoscope

Sterile water or saline are used to 'wash' the surgical site.

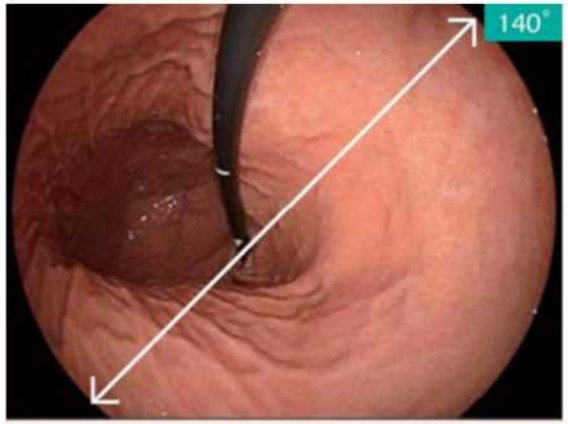
Video endoscopy system: Construction / camera

Video endoscopy systems can be an **add-on** to traditional endoscopy systems and then consists of:

- a (mechanical) **camera head adapter**
- an image detection system (**video camera**) and **image processor**
- a **display** (monitor) and a **recording device**
- **accessories** (suction pumps, insufflators, ...)

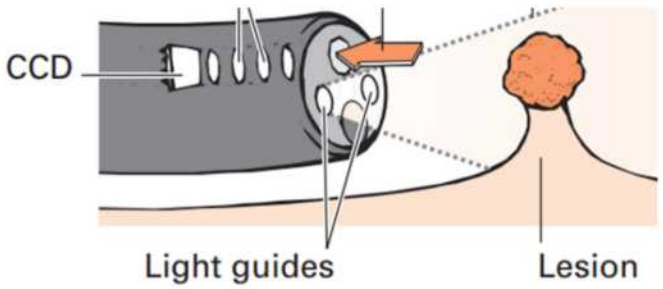
HD 3CCD Cartridge Camera Head

A video camera typically uses a photosensitive silicon sensor, called a charge-coupled device (**CCD-chip**), which is composed of **hundreds of thousands** of photoelectric picture elements (pixels) arranged in a rectangular grid (like a smart phone camera) .



EG-530NW with a 140° field of view

Using a fibre-optic light source for illumination, the lens system focuses the light reflected from the field of view (FOV) onto the CCD's pixels, to capture the image.



In modern video endoscopy systems, the CCD camera is mounted on the tip of the endoscope.

EG-530WR

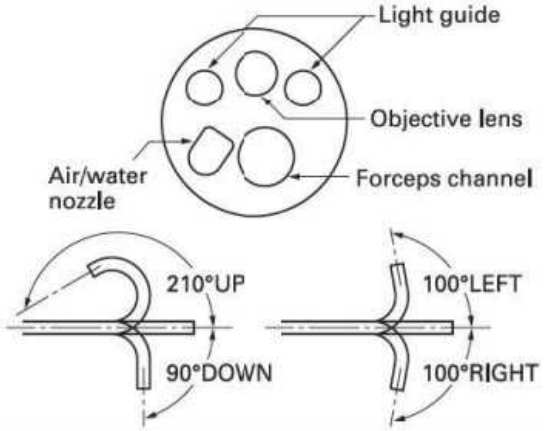
Video Gastroscope - Standard Type

WIDE VIEW

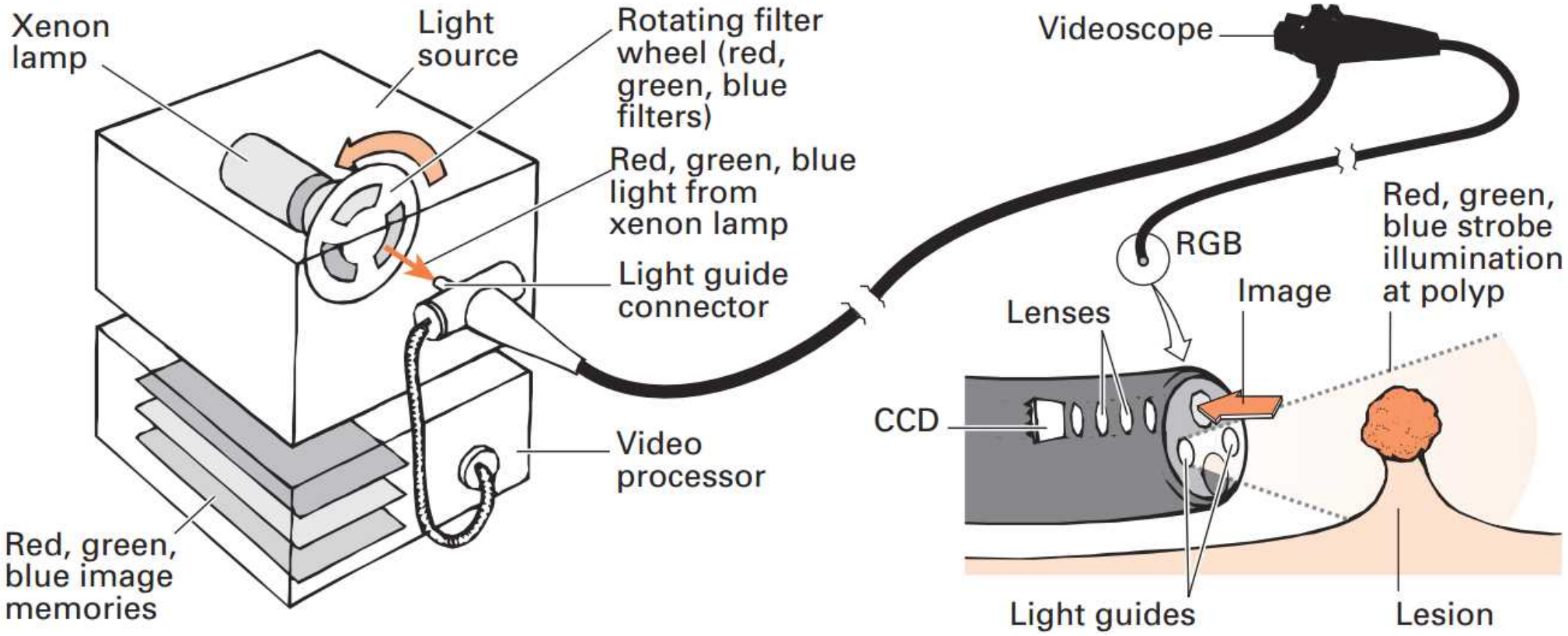
The EG-530WR uses SUPER IMAGE with a 140° wide field of view and a CCD chip to provide exceptional visualization. With the forceps channel of 2.8mm, it is a standard endoscope producing high quality images, which is highly suited for biopsies and treatment.

	EG-530WR
Viewing direction	0°(Forward)
Field of view	140°
Observation range	4 - 100mm
Distal end diameter	9.4mm
Flexible portion diameter	9.3mm
Bending capability	UP 210° / DOWN 90° RIGHT 100° / LEFT 100°
Working length	1,100mm
Total length	1,400mm
Forceps channel diameter	2.8mm

Generic Name : Flexible video gastroduodenoscope



Scientific Principles: colour recording with B/W camera



Sequential colour illumination (alternative schemes are also used)

Video Processor (Camera Control Unit)

Video processors (or: camera control units [CCUs]) have inputs for either one or two video-endoscope cables. The front panel also usually has controls that can **adjust the brightness and color** of the image and operate the video systems.

HD Camera Controller

The processor sorts the electric signal from the camera head according to pixel location and intensity, converting the image to a usable electronic format. It compiles the color elements into a full-color electronic image that is filtered and displayed on one or more monitors, output to a recording or storage device.

Several processing systems can display the image in various formats, including picture-in-picture and four images on one display, and many suppliers also offer remote controls for operating the processor and video systems.

Monitor and connectivity

HD 1080p LCD Monitor

Some systems offer HD (high definition) images. These require special connectors and cabling, 16:9 aspect ratio and have better resolution. These are often incompatible with traditional cathode ray tube (CRT) monitors.

In some systems, the image occupies only a certain portion of the screen, allowing room for patient data. Many suppliers offer data-entry keyboards so that endoscopy staff can enter data into the video image frame.

VP8500 Video Cart

The processed images can displayed be documented and archived using various recording devices and printers.

Advanced systems offer connectivity to Picture Archiving and Communication Systems (PACS) using Digital Imaging and Communications in Medicine (DICOM) or hospital information systems using the Health Level (HL7) standard.

END

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