[Lesson 10]

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What we learnt last time?

- JavaScript Arrays
- Array methods
- Rest and Spread operators
- Iterables
- Set
- Map

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[Our targets for today]

- Working with DOM
- DOM Tree
- Searching nodes

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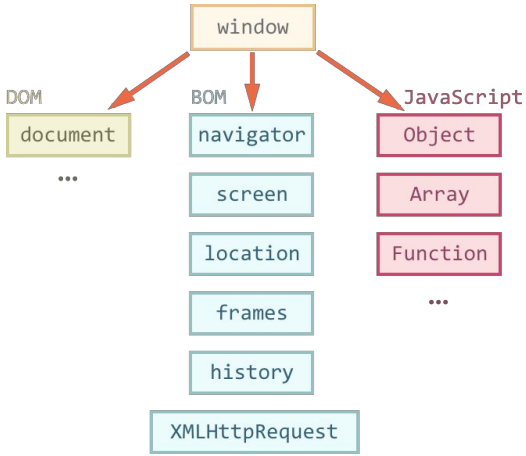
[Browser Environment]

- Here's a bird's-eye view of what we have when JavaScript runs in a web-browser:



- There's a "root" object called window. It has two roles:
  - First, it is a global object for JavaScript code
  - Second, it represents the "browser window" and provides methods to control it

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The window Object

- For instance, here we use the window as a global object:

```
function sayHi() {
    alert("Hello");
}

// global functions are accessible as properties of window
window.sayHi();
```

- And here we use it as a browser window, to see the window height:

```
alert(window.innerHeight); // inner window height
```


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Document Object Model (DOM)

- The **document** object gives access to the page content
- We can change or create anything on the page using it
- For instance:

```
// change the background color to red
document.body.style.background = "red";

// change it back after 1 second
setTimeout(() => document.body.style.background = "", 1000);
```

- The **DOM specification** explains the structure of a document and provides objects to manipulate it
- It is being developed by two groups:
  - W3C – the documentation is at https://www.w3.org/TR/dom
  - WhatWG – publishing at https://dom.spec.whatwg.org

Browser Object Model (BOM)

- **Browser Object Model** (BOM) are additional objects provided by the browser (host environment) to work with everything except the document
- For instance:
  - The navigator object provides background information about the browser and the OS
  - The location object allows us to read the current URL and redirect the browser to a new one
- Here's how we can use the location object:

```
alert(location.href); // shows current URL
if (confirm("Go to wikipedia?")) {
    location.href = "https://wikipedia.org"; // redirect the browser to another URL
}
```

- BOM is the part of the general HTML specification

DOM Tree

- The backbone of an HTML document are tags
- According to Document Object Model (DOM), every HTML tag is an object
- Nested tags are called “children” of the enclosing one
- The text inside a tag it is an object as well
- All these objects are accessible using JavaScript

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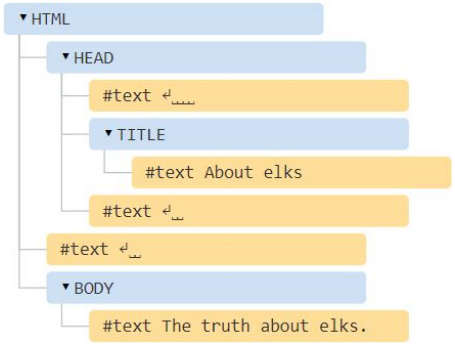
[Example of DOM]

→ For instance, let's explore the DOM for this document:

```
<!DOCTYPE HTML>
<html>
<head>
    <title>About elks</title>
</head>
<body>
    The truth about elks.
</body>
</html>
```



→ We have a tree of elements: <html> is at the root, then <head> and <body> are its children, etc.

→ The text inside elements forms *text nodes*, labeled as #text

  → A text node contains only a string. It may not have children and is always a leaf of the tree.

  → Spaces and newlines – form text nodes and become a part of the DOM

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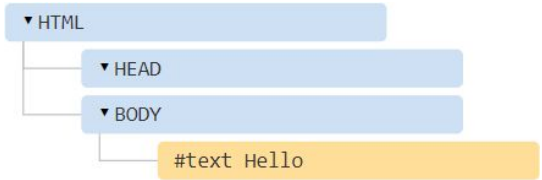
[Autocorrection]

- If the browser encounters malformed HTML, it automatically corrects it when making DOM
- For instance, the top tag is always <html>
  - Even if it doesn't exist in the document - the browser will create it
  - The same goes for <body>
- As an example, if the HTML file is a single word "Hello", the browser will wrap it into <html> and <body>, add the required <head>, and the DOM will be:



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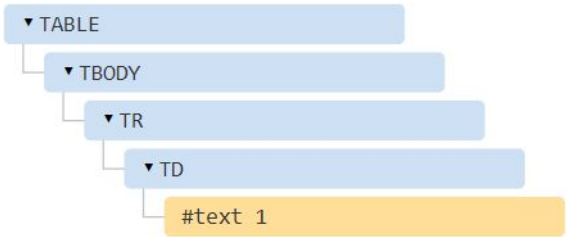
[Autocorrection]

- An interesting “special case” is tables
- By the DOM specification they must have <tbody>, but HTML text may (officially) omit it. Then the browser creates <tbody> in DOM automatically.
- For the HTML:

```
<table id="table"><tr><td>1</td></tr></table>
```

- DOM-structure will be:



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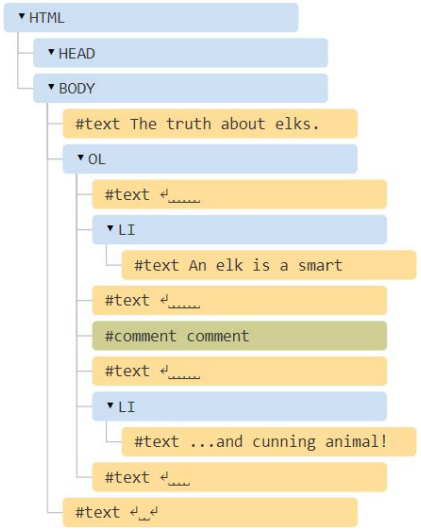
Other Node Types

→ Let's add more tags and a comment to the page:

```
<!DOCTYPE HTML>
<html>
<body>
    The truth about elks.
    <ol>
        <li>An elk is a smart</li>
        <!-- comment -->
        <li>...and cunning animal!</li>
    </ol>
</body>
</html>
```



→ Everything in HTML, even comments, becomes a part of the DOM

[Other Node Types]

- There are 12 node types
- In practice we usually work with 4 of them:
  - document – the “entry point” into DOM
  - element nodes – HTML-tags, the tree building blocks
  - text nodes – contain text
  - comments – sometimes we can put the information there, it won’t be shown, but JS can read it from the DOM

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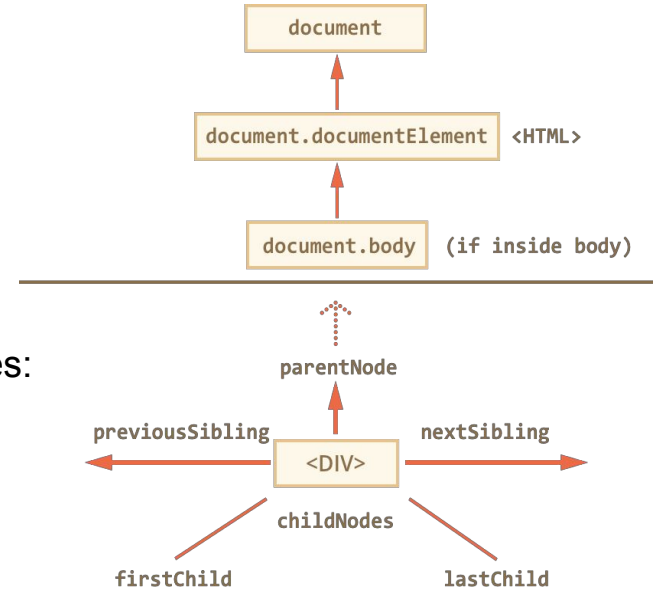
[Walking the DOM]

- The DOM allows to do anything with elements, but first we need to reach the corresponding DOM object, get it into a variable, and then we are able to modify it
- All operations on the DOM start with the document object
- From it we can access any node
- The topmost tree nodes are available as document properties:
  - <html> = document.documentElement
  - <body> = document.body
  - <head> = document.head



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[Walking the DOM]

→ For example, the following script changes the background color of the body:

```
<html>
<head>
    <title></title>
</head>
<body>
    <script>
        document.body.style.backgroundColor = "red";
    </script>
</body>
</html>
```

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[Walking the DOM]

- Note that a script cannot access an element that doesn't exist at the moment of running
- In particular, if a script is inside <head>, then document.body is unavailable, because the browser did not read it yet

```
<html>
<head>
    <title></title>
    <script>
        document.body.style.backgroundColor = "red";
    </script>
</head>
<body>
</body>
</html>
```

```
Uncaught TypeError: Cannot read property 'style' of null
    at DocumentBody.html:7
```

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[Child Nodes]

- **Child nodes (or children)** – elements that are direct children, i.e., they are nested exactly in the given one
  - For instance, <head> and <body> are children of <html> element
- The childNodes collection provides access to all child nodes, including text nodes
- The example below shows the children of document.body:

```
<body>
    <div>Begin</div>
    <ul>
        <li>Information</li>
    </ul>
    <div>End</div>
    <script>
        for (let i = 0; i < document.body.childNodes.length; i++) {
            alert(document.body.childNodes[i]); // Text, DIV, Text, UL, ..., SCRIPT
        }
    </script>
    ...more stuff...
</body>
```

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[Child Nodes]

- Properties **firstChild** and **lastChild** give fast access to the first and last children
- If there exist child nodes, then the following is always true:

```
elem.childNodes[0] === elem.firstChild
elem.childNodes[elem.childNodes.length - 1] === elem.lastChild
```

- There's also a special function **elem.hasChildNodes()** to check whether there are any child nodes

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DOM Collections

- childNodes looks like an array, but it is rather a *collection* – a special array-like iterable object
- There are two important consequences:
  - We can use for..of to iterate over it:

```
for (let node of document.body.childNodes) {
      alert(node); // shows all nodes from the collection
}
```

  - Array methods won't work, because it's not an array:

```
alert(document.body.childNodes.filter); // undefined (there's no filter method!)
```

- DOM collections are read-only
  - We can't replace a child by something else, assigning childNodes[i] = ...
- Almost all DOM collections are *live*
  - They reflect the current state of DOM

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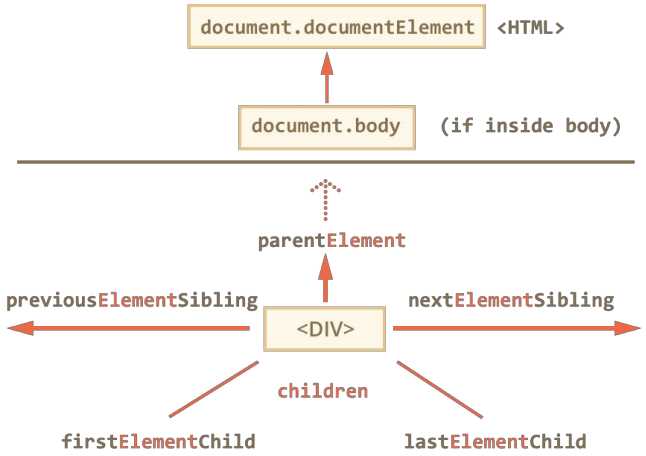
Siblings and the Parent

- **Siblings** are nodes that are children of the same parent
  - The next node of the same parent is available as **nextSibling**
  - The previous node of the same parent is available as **previousSibling**
- The parent is available as **parentNode**

```
<html><head></head><body><script>
    // HTML is "dense" to evade extra "blank" text nodes.

    // parent of <body> is <html>
    alert(document.body.parentNode === document.documentElement); // true

    // after <head> goes <body>
    alert(document.head.nextSibling); // HTMLBodyElement

    // before <body> goes <head>
    alert(document.body.previousSibling); // HTMLHeadElement
</script></body></html>
```

[Element-Only Navigation]

- Navigation properties listed above refer to *all* nodes
  - For instance, in childNodes we can see text nodes, element nodes, and even comment nodes if there exist
- But for many tasks we want to manipulate only element nodes that represent tags
- The following navigation links take only *element nodes* into account:



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[Element-Only Navigation]

→ For example, the following script it shows only the child elements of document.body:

```
<html>
<body>
    <div>Begin</div>
    <ul>
        <li>Information</li>
    </ul>
    <div>End</div>

    <script>
        for (let elem of document.body.children) {
          alert(elem); // DIV, UL, DIV, SCRIPT
        }
    </script>
</body>
</html>
```

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[Exercise (1)]

- For the page:

```
<html>
<body>
    <div>Users:</div>
    <ul>
        <li>John</li>
        <li>Adam</li>
    </ul>
</body>
</html>
```

- How to access:
  - The DOM node?
  - The <ul> DOM node?
  - The second <li> (with Adam)?

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[Exercise (2)]

- Write the code to paint all diagonal table cells in red:
- The result should be:

1:1	2:1	3:1	4:1
1:2	2:2	3:2	4:2
1:3	2:3	3:3	4:3
1:4	2:4	3:4	4:4

- Hint: Use the browser inspector to examine the DOM tree structure

```
<html>
<body>
    <table>
        <tr>
            <td>1:1</td>
            <td>2:1</td>
            <td>3:1</td>
            <td>4:1</td>
        </tr>
        <tr>
            <td>1:2</td>
            <td>2:2</td>
            <td>3:2</td>
            <td>4:2</td>
        </tr>
        <tr>
            <td>1:3</td>
            <td>2:3</td>
            <td>3:3</td>
            <td>4:3</td>
        </tr>
        <tr>
            <td>1:4</td>
            <td>2:4</td>
            <td>3:4</td>
            <td>4:4</td>
        </tr>
    </table>
</body>
</html>
```

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[Searching Elements]

- DOM navigation properties are great when elements are close to each other
- What if they are not? How to get an arbitrary element of the page?
- There are additional searching methods for that, which we'll see on the next slides

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[getElementById]

- If an element has the id attribute, then there's a global variable whose name is identical to that id
- We can use this variable to access the element, like this:

```
<div id="elem">Some element</div>

<script>
    alert(elem); // DOM-element with id="elem"
    alert(window.elem); // accessing global variable like this also works
</script>
```

- However, if we declare another variable with the same name, it shadows the variable created by the browser
- Also, when we look in JS and don't have HTML in view, it's not obvious where the variable comes from

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[getElementById]

- The better alternative is to use a special method document.getElementById(id):

```
<div id="elem">Some element</div>

<script>
    let elem = document.getElementById("elem");
    elem.style.background = "red";
</script>
```

- The id must be unique
  - If there are multiple elements with the same id, the behavior of the corresponding methods is unpredictable
  - The browser may return any of them at random
  - So please stick to the rule and keep id unique

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[getElementsBy*]

- There are also other methods to look for nodes:
  - **elem.getElementsByTagName**(tag) looks for elements with the given tag and returns the collection of them
  - **elem.getElementsByClassName**(className) returns elements that have the given CSS class
  - **document.getElementsByName**(name) returns elements with the given name attribute
    - Exists for historical reasons, very rarely used

```
<div>First</div>
<div>Second</div>
<div>Third</div>

<script>
    // get all divs in the document
    let divs = document.getElementsByTagName("div");
    for (let div of divs) {
        alert(div.innerHTML); // First, Second, Third
    }
</script>
```

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[QuerySelectorAll]

- **elem.querySelectorAll**(css) returns all elements inside elem matching the given CSS selector (elem can also be the document itself)
- That's the most often used and powerful method
- For instance, here we look for all <li> elements that are last children:

```
<ul>
    <li>The</li>
    <li>test</li>
</ul>
<ul>
    <li>has</li>
    <li>passed</li>
</ul>
<script>
    let elements = document.querySelectorAll('ul > li:last-child');

    for (let elem of elements) {
        alert(elem.innerHTML); // "test", "passed"
    }
</script>
```

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[QuerySelector]

→ **elem.querySelector**(css) returns the first element for the given CSS selector

→ The result is the same as elem.querySelectorAll(css)[0], but the latter is looking for all elements and picking one, thus elem.querySelector is faster and shorter to write

```
<ul>
    <li>The</li>
    <li>test</li>
</ul>
<ul>
    <li>has</li>
    <li>passed</li>
</ul>
<script>
    let firstList = document.querySelector('ul:first-child');
    firstList.style.color = "red";
</script>
```

- The
- test

- has
- passed

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Live Collections

- All methods "getElementsBy*" return a *live* collection
- Such collections always reflect the current state of the document and “auto-update” when it changes.
- In the example below, there are two scripts:
  - The first one creates a reference to the collections of . As of now, its length is 1.
  - The second script runs after the browser meets one more , so its length is 2.

```
<div>First div</div>
<script>
    let divs = document.getElementsByTagName('div');
    alert(divs.length); // 1
</script>

<div>Second div</div>
<script>
    alert(divs.length); // 2
</script>
```

Live Collections

- In contrast, querySelectorAll returns a *static* collection
- It's like a fixed array of elements
- If we use it instead, then both scripts output 1:

```
<div>First div</div>
<script>
    let divs = document.querySelectorAll('div');  alert(divs.length); // 1
</script>

<div>Second div</div>

<script>
    alert(divs.length); // 1
</script>
```

[Summary]

→ There are 6 main methods to search for nodes in DOM:

Method	Searches by…	Can call on an element?	Live?
getElementById	id	-	-
getElementsByName	name	-	√
getElementsByTagName	tag	√	√
getElementsByClassName	class	√	√
querySelector	CSS-selector	√	-
querySelectorAll	CSS-selector	√	-

→ Note that methods getElementById and getElementsByName can only be called in the context of the document: document.getElementById(...), while other methods can be called on elements too, e.g., elem.querySelectorAll(...) will search inside elem (in the DOM subtree)

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[Exercise (3)]

- Here's a document with a table and a form:
- How to find?
  - The table with id="age-table"
  - All label elements inside that table (there should be 3 of them)
  - The first td in that table (with the word "Age")
  - The form with the name search
  - The first input in that form
  - The last input in that form

```
<!DOCTYPE HTML>
<html>
<body>
    <form name="search">
        Search the visitors:
        <table id="age-table">
            <tr>
                <td>Age:</td>
                <td id="age-list">
                    <label>
                        <input type="radio" name="age" value="young">less than 18
                    </label>
                    <label>
                        <input type="radio" name="age" value="mature">18-50
                    </label>
                    <label>
                        <input type="radio" name="age" value="senior">more than 50
                    </label>
                </td>
            </tr>
            <tr>
                <td>Additionally:</td>
                <td>
                    <input  type="text" name="info[0]">
                    <input  type="text" name="info[1]">
                    <input  type="text" name="info[2]">
                </td>
            </tr>
        </table>

        <input type="submit" value="Search!">
    </form>
</body>
</html>
```

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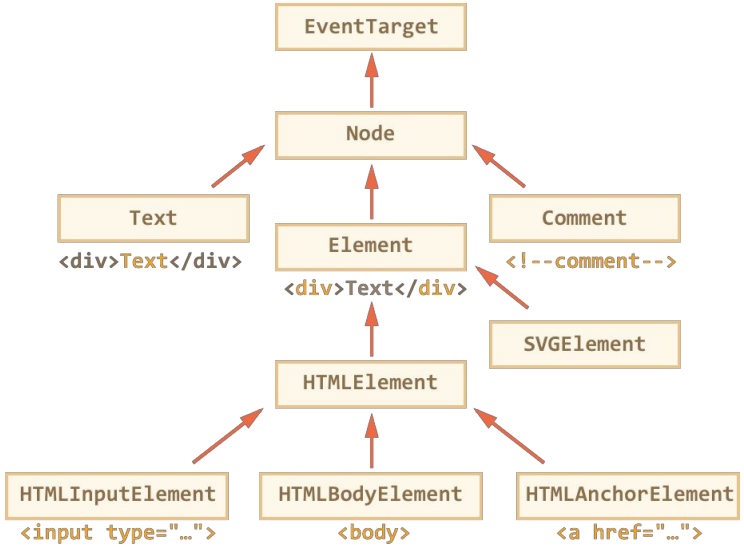
DOM Node Classes

- Each DOM node belongs to the corresponding built-in class
- The root of the hierarchy is EventTarget, that is inherited by Node, and other DOM nodes inherit from it



DOM Node Classes

- To see the DOM node class name, we can recall that an object has the constructor property, which references to the class constructor:

```
alert(document.body.constructor.name); // HTMLBodyElement
```

- We also can use instanceof to check the inheritance:

```
alert(document.body instanceof HTMLBodyElement); // true
alert(document.body instanceof HTMLElement); // true
alert(document.body instanceof Element); // true
alert(document.body instanceof Node); // true
alert(document.body instanceof EventTarget); // true
```

  - To inspect a DOM element in the console, use:
- **console.log**(elem) shows the element DOM tree
- **console.dir**(elem) shows the element as a DOM object, good to explore its properties

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[DOM Node Properties]

- DOM nodes have different properties depending on their class
- The full set of properties and methods of a given node comes as the result of the
- inheritance hierarchy
- For example, let's consider the DOM object for an <input> element
- It belongs to the **HTMLInputElement** class
- It gets properties and methods as a superposition of:
  - HTMLInputElement – this class provides input-specific properties
  - HTMLElement – provides common HTML element methods (and getters/setters)
  - Element – provides generic element methods
  - Node – provides common DOM node properties
  - EventTarget – gives the support for events (to be covered)
  - and finally it inherits from Object, so "pure object" methods like toString are also available

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innerHTML

- The **innerHTML** property allows to get the HTML inside the element as a string
- We can also modify it, so it's one of most powerful ways to change the page.
- The example shows the contents of document.body and then replaces it completely:

```
<body>
    <p>A paragraph</p>
    <div>A div</div>

    <script>
        alert(document.body.innerHTML); // read the current contents
        document.body.innerHTML = 'The new BODY!'; // replace it
    </script>
</body>
```

- We can append "more HTML" by using elem.innerHTML+="something"
  →However, we should be very careful about it, because this causes a full overwrite of the element's content

[textContent: pure text]

- The **textContent** provides access to the *text* inside the element: only text, minus all <tags>
- Compare the two:

```
<body>
    <div id="‘></div>
    <div></div>

    <script>
        document.body.children[0].innerHTML = "Hello<br/>World";
        document.body.children[1].textContent = "Hello<br/>World";
    </script>
</body>
```

Hello
World
Hello
World

- The first gets the text “as HTML”: all tags become tags, so we see the line break
- The second gets the name “as text”, so we literally see Hello
World

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The “hidden” Property

- The “hidden” attribute and the DOM property specifies whether the element is visible or not
- We can use it in HTML or assign using JavaScript, like this:

```
<body>
    <div>Both divs below are hidden</div>
    <div hidden>With the attribute "hidden"</div>
    <div id="elem">JavaScript assigned the property "hidden"</div>
    <script>
        elem.hidden = true;
    </script>
</body>
```

Both divs below are hidden

- Technically, hidden works the same as style="display:none". But it’s shorter to write.

More Properties

- DOM elements have additional properties, many of them provided by their class:
  - **value** – the value for <input>, <select> and <textarea>
  - **href** – the “href” for <a href="...">
  - **id** – the value of “id” attribute, for all elements
  - and many more…

```
<input type="text" id="elem" value="5"/>
<script>
    alert(elem.type); // text
    alert(elem.id); // elem
    alert(elem.value); // 5
</script>
```

- Most standard HTML attributes have the corresponding DOM property, and we can access them using JavaScript
- You can output the full list of properties of a given element using **console.dir**(elem)

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Exercise (4)

→ What does this code show?

```
<html>
<body>
    <script>
        let body = document.body;
        body.innerHTML = "<p>My paragraph</p>";

        alert(document.body.lastChild.constructor.name); // what's here?

    </script>
</body>
</html>
```

[Exercise (5)]

→ Create a colored clock like here:

11:08:42

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Control questions

1. What is DOM?
2. How can we walk a DOM Tree?
3. What is Parent, Child and Siblings in DOM Tree?
4. Which methods can you use to get a single DOM element?
5. What are the ways to get multiple DOM elements?

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